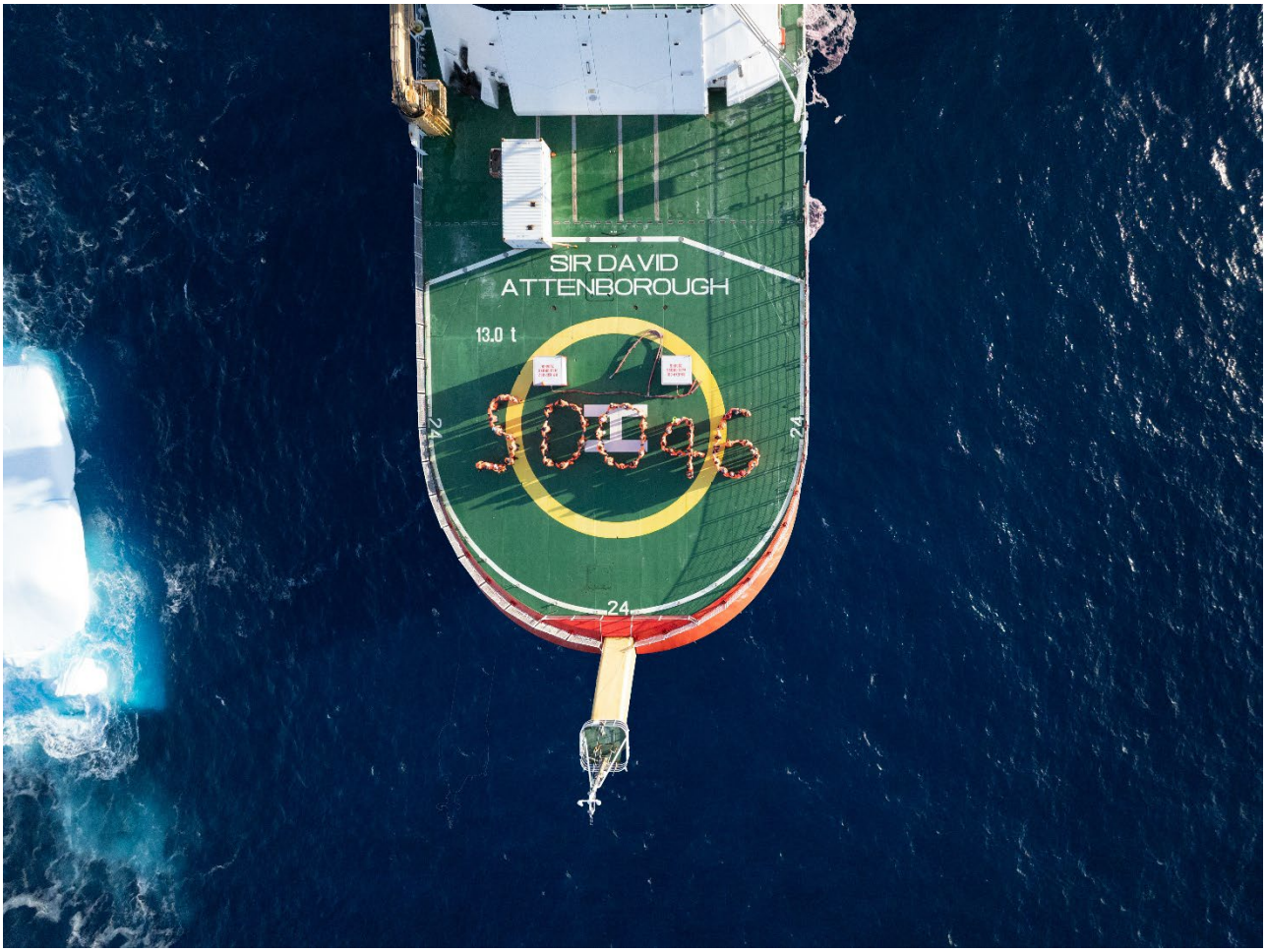
SD046
Cruise report

05/02/25 to 28/3/25



PSOs: Sophie Fielding and Geraint Tarling

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Crew

Bridge

Matt Neill (Captain)

Robert Bellis (Chief Officer)

Oliver Bates (2nd Officer)

Ben Bourne (2nd Officer)

Elliot Johnston (3rd Officer)

Nisha Mistry (Doctor)

Catering

Rich Turner (Purser)

Steve Carpenter (Chief Cook)

Juan Bellanto Chapela (2nd Cook)

Eric Bourne (Senior steward)

David Williams (Steward)

Joseph Sutherland (Cook steward)

Doreen Thomson (Steward)

Deck Team

Mark (Tugs) Taylor (Science Bosun)

Martin Rowe (Bosun)

Graham Hall (Launchman)

Robert Paylor (Bosun's mate)

Spencer Morris (AB)

Jack Wilmhurst (AB)

Graham Waylett (AB)

Mitchel Brock (AB)

Denys Alesyeysev (AB)

Engineers

Feilim O'Muiri (Chief Engineer)

Adrian Coveney (PO Motorman)

Gareth Wale (CPO Motorman)

Shawn Swanney (Deck Engineer)

Hans Braten (Deck Engineer)

Steve Stiglic-Buxton (ETO)

Piotr Kusmierek (ETO)

Julian (Jules) Klepacki (ETO)

Josh Murray (2nd Engineer)

Chris Haynes (3rd Engineer)

Megan Jones (3rd Engineer)

Thomas King (3rd Engineer)

Harry Jones (4th Engineer)

Scientists

Chief Scientists

Sophie Fielding

Geraint Tarling

Physics Team

Hugh Venables

Sally Thorpe

Rachael Sanders

Michael Haigh

Shenjie Zhou

Kat Turner

Biogeochemistry team

Laura Taylor

Izzy Cooper

Emily Rowlands

Lisa Friberg

Joana Fragão

Edward Mawji

Zooplankton team

Dan Mayor

Kathryn Cook

Elodie Jacob

Jen Freer

Gabi Stowasser

Nadine Johnston

Ryan Saunders

Fadhili Malesa

Jasmine Yang

Phytoplankton team

Amanda Burson

Laura Wilkie-Johnston

Benthic Biology Team

Katrin Linse

Gonzalo Giribet

Huw Griffiths

Leo Verheyen

Lydia Schmidt

Cetacean Team

Manu Bassoi

Halyley McLennan

Eléna Josso

Hannah Cubaynes

Media team

Maddy de Marchis

Cam Batten

Braydon Moloney

Science Support

Kinzie Orton

Joshua Holder

Eloise Littley

Chris Gray

Liam Tracy

Matt Hood

Simon Wright

Petra ten Hoopen

Natalie Ensor (Mobilisation only)

Katy Cartlidge (Mobilisation only)

Cruise overview

The SD046 was a multidisciplinary science comprising three distinct phases: 1) South Georgia, 2) A23 transect and 3) BIOPOLE.

The South Georgia phase (SG) comprised of the Western Core Box transects, some benthic stations and mooring work at the sites P3, Western Core Box and Eastern Core Box. This work was part of the POETS Western Core Box long-term time series, to understand the long-term variability of the marine ecosystem, in particular krill biomass, at South Georgia. This work also assesses the mesoscale distribution and abundance of macro-zooplankton and micronekton, and the physical environmental variability at South Georgia from 1996 onwards. Analyses of benthic community composition during the present cruise compliments the above work, particularly in considering the impact of carbon flux on the sea-bed.

The A23 transect phase (A23) consisted of oceanographic measurements at predefined transect points and mooring work at the South Sandwich Trench sites SST-C and SST-W. The A23 repeat transect phase aims to understand warming trends in the dense Antarctic Bottom Water and underlying causes, and to uncouple interannual variability from the long-term warming trend. The SST-C and SST-W moorings were part of the OCEAN:ICE programme with complimentary aims.

The BIOPOLE phase (BP) consisted of seven stations with intensive biological net and trawl sampling and mooring work at the sites M2, M3, OP1, OP2, OP3 and OP5. The BIOPOLE programme aims to investigate how nutrients in polar waters drive the global carbon cycle and primary productivity in ocean. Measurements were made for determining ocean circulation and the tracing of nutrient sources to examine the coupling between physical, biogeochemical, and ecological processes during the austral autumn in the area of Powell Basin and South Orkneys, extending vertically from the surface through the upper water column, the Mixed Layer Depth, into the upper layers of the Circumpolar Deep Water. Information from the moorings provides a further temporal context on water movements in this region, being part of a timeseries of deployments in this region.

Towards the end of the BIOPOLE phase, there was an opportunity to visit the A23a iceberg newly grounded on the western South Georgia shelf, with sampling carried out on all four sides of the iceberg. There was also a swath survey on the northern side. This work was intermingled with a further visit to the P3 site principally to complete a postponed mooring deployment. Work around the iceberg considered the plankton community and sea surface ice, as well as oceanographic measurements. It compliments previous iceberg sampling, e.g. A76a (2023), A68a (2021) or A23a (2023).

It is to be noted that sampling of the uncontaminated seawater system and marine mammal efforts took place on a semi-continuous basis across all cruise phases.

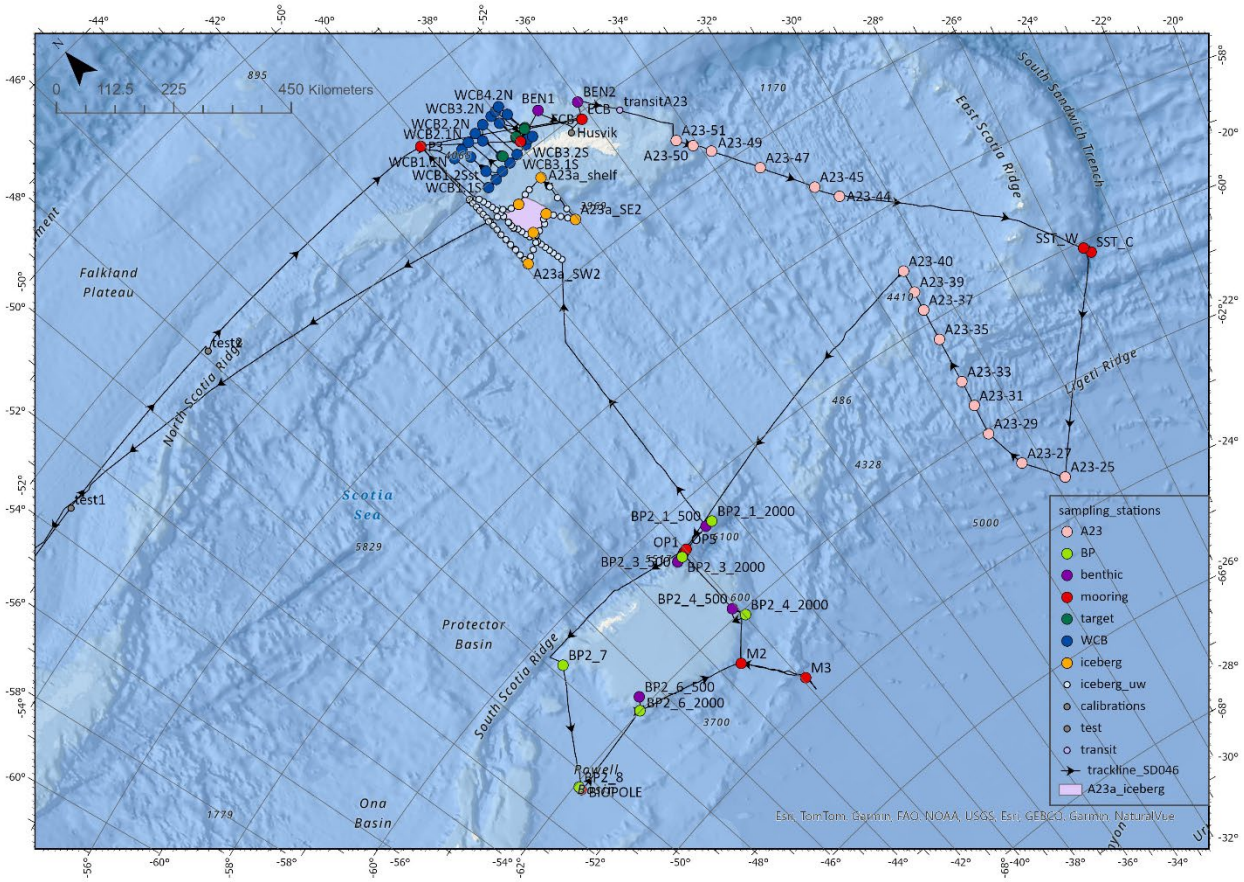


Figure 1: Map of the cruise path and stations during SD046

Calling Us

The docked, red-hulled vessel looms high
A quiet promise in the air unseen
Of thrilling risk and watery wonder
Calling us out to the open sea

But, like an obstinate young child
Woken too early on a wintry morn
She too quickly went asunder
With wincing winches came frustration's plea

Through long nights and vexed censure
Coddled and not so gently coerced
She at last agreed to the adventure
And oh, what an adventure it would be!

Water teemed with swarming krill
The lifeblood of Antarctica
A beating heart in her watery breast
Captured in our nets of curiosity

Winds forced refuge in the island's lee
Whose ferric richness fuels vast blooms
Of miniscule glass-housed browns and greens
Allowing life to abound generously

Sheltered, we waited out the storm
Serenaded by eerie calls from ashore
Mingled with the good-will whispers
Of explorers long before

Once past, we were southward bound
With baleen escorts showing the way
Their breathy exhales filled the horizon
Misty smoke signals of polar life at play

Water swirled, flowed and plunged below
Mechanical tasting of the salty layers
Again, and again, and again, and again
Helped us place their worldly origin

Whales came along to inspect and sing
While we called out to the deep canyon probes
Lured in by the din of the searching ping
As we recovered our scientific hopes

While they settle down for their deepest rest
The hunt was on for sleekit wee beasties
Scooped by cheeky nets and sneaky nets
For a final sleep in our observatories

Deeper still we wanted to explore
For wondrous beasts with strange ecologies
Creatures found along the seafloor
Drawing crowds to witness their oddities

One last stop before we depart
A brief rapport with a famous floe of ice
We danced with joy between her cliffs of white
And sailed for home with sirenic memories
Calling us out to the open sea.

-A.B.

1. PSO Narrative

Authors: Geraint Tarling and Sophie Fielding

Introduction

The following are brief notes of the significant activities of each day of the SD046 cruise, mainly to provide a rough indication of the order of stations and science events and key considerations contributing to the decision-making process along the way. Please consult the event log for precise details of science events.

Narrative

1 Saturday / February 2025
Onto SDA
Arrived at ship from hotel around 11am. Had lunch and then a briefing meeting in Conference Room going over some H&S and IT matters. Unpacked 3 containers in the afternoon.

2 Sunday / February 2025
Setup day 2
Started with 8am meeting and went over priorities and help required. Each of the teams set off with their tasks. Some difficulties with pressure cylinders for copepod work which were chain lifted over the water tight steps and trollied into CT2. By lunch, CT1 microscopes were mostly set up, Jasmine started on EDNA setup, Nadine had fridges waiting outside Seawater lab, and Laura had started with filter rigs. Net construction a focus for post lunch work.

3 Monday / February 2025
Mobilisation and walk to Punta Arenas
Mobilisation most of the day consolidating labs and prepping of deployment cables. Many science staff had some R&R in the afternoon, spending time in Punta Arenas town. Last science group had arrived by that evening.

4 Tuesday / February 2025
Last day before sailing
Safety briefs and drills today plus a lab induction. Tidied up and organised decks PM. Documentary crew worried about missing bags but resolved later in afternoon - hopefully arriving by this evening. Captain will delay until 12pm which will miss the tide but needed to be cautious on a number of matters. Katie Cartlidge from AME still working on Deep tow cable late into the evening - she departs tomorrow

5 Wednesday / February 2025
Leaving Punta Arenas
Morning was spent tidying up hangar and tying down. Had science meeting where “Sea Fever” by John Masefield was read out. Left port at 12:15 but had to go against the tide since we had to delay from our original departure time of 8am. Afternoon full of meetings

including going over duties for watch leaders. There was a media presentation with scientists and with crew. Went over working shift patterns with Rob, Chief Officer. Evening comfortable but more swell through the night

6 Thursday / February 2025
En route to P3 via test stations
Slight swell and rainy. There were talks today on Respectful working and Pola Abandonment. Also, an evening presentation from PSOs to all scientists and crew in the evening that was well received.

7 Friday / February 2025
Test station 1
Lots of meetings in morning covering media, zooplankton sampling and underway sampling then the Science meeting at 11:00. Started Test station at 13:00 but had problems with the CTD. Put nets on MOCNESS and MAMMOTH. Moved onto doing AGT, which went well. CTD went in late evening but still having some problems spooling. Fired bottles at 10 m for practise taking water off.

8 Saturday / February 2025
Test station 2
Still having problems with CTD so started with RMT. Started at 12pm. Did a total of 2 RMT deployments all of which went well but the release on the second net fell without being triggered. Did a cursory examination of the net catches and saw Euphausia vallentini, Themisto and Primno. Gonzalo took some nice photos and
videos of Gymnosomes. Tried CTD but still had problems. No time for Bongo since we had to move off by 8 to get to P3 mooring in good time for tomorrow. Travelled at 13 knots overnight.

9 Sunday / February 2025
P3 mooring
Bad weather will hit on Tuesday so made a strategic decision to collect all 3 moorings (P3, WCB and ECB) before heading for shelter on Tuesday. Did a media interview in the morning with captain and Sophie re weather. Explained revised plan to team at science team at 14:00 (which will be the regular time for science meetings from now on). At P3 by 15:30. Tried to ping at 16:15. No response from inside kab but did get a response from sounder lowered over the sude Moved around and pinged at different locations. Released at 18:15. Iridium had it at 3 km away. Got the buoy around 19:30. Difficulty getting the buoy on but then kore straight forward. OPIC destroyed but good set of samples from sediment trap. All done by 10pm. Did a trial with standard CTD wire with weight but still problems with spooling mechanism. Did a Bongo to 50 m then a Rapid cast. Left station at 2am.

10 Monday / February 2025
WCB mooring
Arrived at the WCB mooring site around 10am. Struggled to find mooring on echosounders and put the small sounder over the side. Eventually had the correct codes to communicate - battery charge was quite low at 5V and could only communicate with 1 release. Captain said weather may be more workable on Tuesday but no ECB mooring today because of work hours. Needed a workplan post WCB. Met with benthic team prior to science meeting at 2pm and identified a spot near to mooring site to save transit time. WCB recovery went followed by Rapidcast then transit to the benthic site. Deployed an Agassiz trawl around 20:30 and up around 21:30. Contained loads of krill exuviae. EBS deployed and back on board by 00:30 and went well (also with some krill moults).

11 Tuesday / February 2025

Husvik day 1

Travelled overnight to Husvik. Laid anchor around 11am and did a Rapidcast after lunch. Weather dreadful (wind and rain). Ropes for acoustic releases around set up by 14:30.. There was some difficulty with the winches re comms and paying out - was a network issue. Sphere found at 20:30. Finished calibration of EK80 at 01:00.

12 Wednesday / February 2025

Husvik day 2

Still at anchor in the morning. Terminations on clean chemistry wire and standard CTD wire completed last night and left to set. Clean chem wire load tested this morning. Working on mooring instruments in order to redeploy WCB configuration at ECB site tomorrow AM straight after the ECB mooring is retrieved. Trial of CTD x 2 in the afternoon went well. Sophie calibrated WBAT. Assembled sediment traps and UVP ready for upcoming moorings. Engineers working on broken science mooring winch and hope it may be repaired.

13 Thursday / February 2025

ECB mooring

Left Husvik around 9 AM and went out to ECB mooring about 90 minutes away. Found mooring on echosounder and released it just after lunch. Recovery straightforward but large amount of biofouling. Both beacons were corroded and presumably dysfunctional. Ship's CTD had problems with its pumps which delayed deployments somewhat. Finally deployed and recovered by 17:20. MOCNESS after dinner went well (max depth 200 m) but lost bucket 9 probably because jubilee clips were not sufficiently fastened. Catch contained krill and Thysanoessa but C. acutus a bit beaten up. Catch split with half preserved. Decided not to do a CTD at a WCB station as originally planned but headed directly for P3 - expected arrival midday. Memorable moment was some Southern Right Whales that came up right next to the ship when doing the MOCNESS with a beautiful sunset backdrop. Earlier that afternoon, a Blue whale mother and calf came close by - camera crew got some amazing footage by drone.

14 Friday / February 2025

P3 redeployment (not)

Arrived at P3 just before midday. Simon, Matt and Sophie have been working particularly hard in turning around instruments for the mooring. Sally and GT mounted and tested the UVP over past couple of days. Emily and Gabi worked on the sediment trap. Emily preparing the PPS today. Order of events is CTD, mooring redeployment then MOCNESS and Bongos if any spare time. CTD went to full depth with ~17 depths on return to surface. Bit of a delay bringing CTD on board - result of wrong settings on weight thresholds on the boom - eventually resolved and water taken. P3 mooring did not go well - the rope snagged just after the buoy reached the water. All was retrieved successfully and the mooring deployment abandoned. Rope now unusable and need to assess what possibilities remain to deploy the mooring later in the cruise. MOCNESS deployed around 8pm - down to 1000m - incremented in 125 m intervals to the surface. All worked well but copepods a bit bashed. Did 3 Bongos to 200 m (100um and 200um mesh). The last of the 3 was preserved.

15 Saturday / February 2025

WCB 1.1 and 1.2

Arrived at WCB 1.1 acoustic transect around 5am. Struggled with the Rapidcast and eventually had to handcrank it on board and untangle it. Did remainder of transect without Rapidcast. Arrived at WCB 1.1NSt around 5 and did double oblique RMT (small amount of krill plus other zooplankton and myctophids) followed by CTD. Little sign of krill in water column during target fishing hunt. Headed for 1.1SSt for 1am. Did an RMT - small amount of krill plus myctophids and zooplankton). CTD out of water just before 4am. Headed for WCB 2.2S.

16 Sunday / February 2025

WCB 2.1 and 2.2

Wind started to pick up last night but still workable for acoustic transect. Arrived at WCB 2.2Sst around 5pm. Did an RMT standard haul to 165 m. Caught enough krill in net 2 to do a population LF analysis. Saw a superswarm soon after, so did a target fish and caught sufficient krill in both nets for LF analysis. Successful CTD to 200 m between two net catches without any major delays although crew are still going through training to shadow each other. Headed WCB 2.2N at just after 10pm. Carried out RMT and CTD and headed for WCB 3.2N by 3:45AM.

17 Monday / February 2025

WCB 3.1 and 3.2

Weather picked up a bit so WCB 3.2 transect was a bit bumpy. Finished the transect around 15:30. Did 3.2SSt CTD as first activity. Loads of krill in the water so decided to do a krill target haul as first RMT net. Successful in catching loads of krill in net 1and 2. Moved off station to find an area of water without krill. Did a stratified station but net 2 did not work (double fired). Sorted and preserved net 1. Ran out of time to move to next station and do a CTD so decided to do 2 x Bongos as last activity here. Moved off to the start WCB 4.1

18 Tuesday / February 2025

WCB 4.1 and 4.2

Weather calmer today. Acoustic transects finished around 3pm finishing at the southerly waypoint. Moved on to location of mooring station and did a CTD around 4:30pm. Preparations for mooring redeployment have been ongoing all day. Specific issues with the iridium beacons taking time to resolve. Mooring design tweaked to include the UVP and sediment trap in addition to acoustics on surface buoy and Sonovaults. Went in successfully around 8:30pm. Located at -53.79560 -37.94293. Did a successful target fish on way to 4.2SSt followed by a stratified standard haul at 4.2SSt. Note that bridle came free on net 2 half way back to surface. Net 1 was therefore sorted and preserved. Net 2 actually contained lots of krill so was considered as a bonus target fish. CTD followed at dawn. Worked up stages and lengths.

19 Wednesday / February 2025

Northern RMT stations

Moved off from dawn CTD at 4.2SSt to 3.2NSt to do a CTD to 1000 m and RMT standard haul. Then over to 4.2NSt to do the same. Moved inshore to go target fishing. ME70 poll was down. Found some swarms easily and did an RMT. Finished night with two Bongos. Tap issues on 100um cod end on second dip and lost sample. Went on a downwind course for rest of evening collecting ME70 data on the many krill swarms that were around.

20 Thursday / February 2025 22:17

ECB mooring

Started the day with a CTD at the ECB mooring site. Spent a further hour prepping the mooring for deployment. Used the repaired scientific mooring winch. Deployment went smoothly - had a WBAT, ADCP, CTD, 2 X Iridium beacons and a Sonovaults. Mooring found by ship's acoustics straight away. Moved further offshelf to a 500 m depth site and deployed the AGT. It was successful and caught some spider crabs and sea urchins amongst other things. The EBS was due to follow but wind conditions made deployment unsafe and the event was cancelled after a few failed attempts. Did not consider weather conditions suitable to test the Mammoth as scheduled. Ended the day heading for start of A23 transect but at a slow speed to remain in the lee of South Georgia by dawn for a pre-transect CTD and Bongo. Expect to start A23 CTDs by midday tomorrow.

21 Friday / February 2025

Start of A23

Did a predawn CTD followed by a 3 x Bongos in advance of getting to A23. Water was pretty clear of phytoplankton but still plenty of copepods in the water. Some issues with the hydrowire and biowire occurred that needed further resolving. Arrived at first A23-52 station 13:20. Stayed on station after CTD was complete to test reterminated hydrowire. Strategic decision was made to carry out priority A23 stations only which was almost every other station along the transect. Other CTDs completed before end of the day were A23-51, A23-50, A23-49. A predawn 2× Bongo was carried out at the last of those stations.

22 Saturday / February 2025

A23 day 2

CTD deployments carried on apace with A23-47, A23-45 and A23-44 completed. 3 x Bongos carried out at latter station. Bad weather midweek has led to us making the decision to head over to the South Sandwich Trench moorings earlier than ideal. We make for their location straight after A23-44 operations completed - a 16-18 hour steam.

23 Sunday / February 2025

Arrival at SST moorings

Steamed over to SST mooring site. Arrived 8pm. Established comms with releases on both moorings, although only one release was communicating on the deeper mooring (SST-C). Trilaterated both moorings. Acoustic survey located the top buoy of the deep mooring but no luck with the shallow mooring. Interestingly, top buoy of shallow mooring was 400 m shallower than according to the mooring schematic.

24 Monday / February 2025

Recovery of SST-C

Hanging a mile upwind of position of deep mooring (SST-C) waiting for fog to clear since 8AM. Visibility has been less than a mile although it is variable. Bridge will call down when they are happy with visibility to release mooring. The absence of a GPS beacon makes visual obs even more critical.

Fog lifted around 3pm and released mooring. Quickly spotted at surface. Cluster of floats at surface tricky were to bring on board but rest of recovery straight forward with instruments clamped onto 5 mm Dyneema. Finished recovery around 7pm. Relocated to SST-C trilateration point to carry out full depth CTD (6000 m). Moved over to SST-W and carried out full depth CTD (3500 m) by 5am.

25 Tuesday / February 2025

SST-C recovery

Both SST-C and SST-W CTDs happened overnight, although there was certain difficulties spooling on the wire after the 6000 m cast. Above SST-W by 6am and communicated with mooring. Released but slow coming to surface. No sign of top buoy after 15-20 mins. Moved around a bit to see if distances to releases changed. Released the second release in case it was holding onto chain. Bottom floats were seen around 10 mins
later but no sign of top float. Secured bottom floats and hauled in remaining mooring white rope. Recovered an Aquadopp and a mini CTD but all other parts of the mooring were no longer there – rope had parted. Once mooring operations were complete, headed back to southernmost part of A23 transect.

26 Wednesday / February 2025

South to North A23

Arrived at southernmost priority station A23-25 at 05:00 and carried out CTD only. A23-27 completed by 15:45. CTD wire looking a bit ragged on the drum as a consequence of the

spooling issue when 6000 m out at SST-C. On way to A23-29, decided to change to standard wire for which the spooling mechanism was now fixed. This will be routed through the starboard gantry, which has also been passed as functional after concerns about the hydraulic oil leak. Carrying out electric and load tests on route. Mammoth net has been set up ready for a test but abandoned for today to prioritise CTD wire switch.

27 Thursday / February 2025
A23-31 and northwards
Spooling issues with the standard wire through the starboard gantry overnight meaning that Science Bosun Tugz stayed up late. Eventually A23-29 CTD was completed but no Bongo to follow. Tried to deploy CTD at A23-31 but had some electrical issues. Decided to do an epoxy potted termination to rectify the problem and make it more robust going forwards. Pot takes 3-4 hours to set well. Also, day crew will not start till 12 because of their late night with the spool problem. In all, around 6 hours of delay. Further delay on CTD as potting compound had not completely set until 2pm. CTD finally complete by 5pm. 2 h steam to A23-33 started at 7pm with two Bongos.

28 Friday / February 2025
Completion of A23 transect
A23-35 arrived at by 04:30. Some worry that there is still water within the new termination but decided to proceed and the CTD worked well. Arrived at 23-37 at 09:45 which again showed no real problems with termination. At A23-39, we started with a Mammoth net test over starboard side, which went to 200 m with all nets firing. Need to improve deployment technique both in and out somewhat but otherwise safe. Top two nets very green but not so many copepods. Followed by a CTD which worked without any notable problems. Weather set to deteriorate after midnight so decided not to proceed to A23-42 and make A23-40 our last station. Started A23-40 with 2 x Bongos followed by a CTD.

1 Saturday / March 2025
Transit to BIOPOLE phase and open day
Broke off from A23 transect around 2am at A23-44 without reaching A23-42. Headed into some weather coming from the west plus fog and growlers, which slowed transit speed. Did an open day in the afternoon where we had science stations around the ship that the crew could wander between – 8 stations in all. Event was well attended and appreciated. Laura Taylor gave a talk on large icebergs in the evening, followed by a viewing of the footage from the
Northern Lights documentary crew.
Fancy dress party in the evening.

2 Sunday / March 2025
Arrived at BP2_3
Arrived a BP2_3 around 9am. Wind between 30 and 40 knots so delayed start of activities. Agassiz trawl on at 11:30 but swell still marginal. Too much swell to deploy EBS so deployed Mammoth instead at 16:00. Deployment went in water OK – paid out at 0.3 m/s and returned at 0.3 m/s with top 200 m at 0.5 m/s. Mammoth heavily damaged with several nets ripped and cod ends lost. Also a spring- loaded bar on side snapped. Paused activities until 22:30 and did 4 x Bongos. CTD overnight.

3 Monday / March 2025
BP2_3 continued
Weather much calmer this morning. EBS went out at 4am without any difficulties. Returned around 8am with relatively clean catch. Moved on to mooring work, which started with the nearest mooring to BP2_3 site, which was OP3. Released without difficulty and quickly spotted. Retrieval was a bit awkward with some loops in the wire. Ended with hand hauling final instrument free loop of 150 m. Felt tension part way through, followed by a

whale spout, suggesting the whale tugged at the loop. Moved onto OP1 because iceberg on top of OP2. Contacted releases but response indicated they were horizontal (ie rest of mooring was lost). Moved back to OP2 which was now free of the iceberg. Releases were triggered successfully but when they came to the surface there was only releases and buoys - rest of mooring was lost. Will carry out CTDs at these three mooring stations overnight followed by benthic hauls at shallow stations.

4 Tuesday / March 2025
BP2_3 shallow
Carried out 3 x CTDs overnight at OP1, OP2 and OP3. All went well but termination now defunct and needs reterminating. AGT in at 05:00 and EBS at 7:15. Both went well. Conditions a bit foggy as we sit over OP5 mooring. OP5 releases are communicating and are upright with good remaining voltage. CTD at 12pm and conditions for retrieval reassessed at 3pm. Fog lifted and mooring released. Spotted after a short interval and recovered without incident with all sensors retrieved - maybe one broken microcat and the top buoy will need inspection since may have lost some buoyancy. Headed to BP2_7 overnight.

5 Wednesday / March 2025
Hesperides deep and onto BP2_7
Foggy overnight so slowed to around 8 knots. Had a provisional plan to carry out shallow benthic work at BP2_7 before heading to Hesperides deep 1.5 hrs away to carry out re-reeling work on Metal free drum and bring that wire back into service. Fog delay meant the benthic work had to be postponed and we headed for Hesperides Deep directly, arriving around 10:30 AM. Spooling out to 6100 m was complete by 12:00. Some care was needed on spooling in again but successfully completed. The wire needed reterminating nevertheless. Moved towards BP2_7 but stopped short to do test deployment of the now repaired Mammoth net over the starboard gantry to 200 m. Worked OK, although inner spindle came loose from the cod-end carousel. Moved onto BP2_7 and did a couple of Mammoth hauls to 1000 m.

6 Thursday / March 2025
End of BP2_7 and onto BP2_8 (BIOPOLE Mooring station)
Mammoth hauls overnight worked well although the condition of the animals caught was not great. Also very few C. acutus in the water. Did a CTD on the Metal Free wire from the CTD boom which went well and covered both the oceanography and pre-dawn requirements of phytoplankton biologists. Conditions starting to become marginal but ship went sideways to the wind to give enough lee for a couple of Bongo nets – catches were in really good condition despite the wind and rising swell but again very few copepods. Decided against doing an EBS and moved on to AGT which is more robust in marginal conditions. Deployment and recovery went well although the catch itself contained a rock which smashed up many of the shelled organisms. Finished station around 10:00. Headed for BP2_8 into the worsening weather - 125 nm away. Arrived around 21:00 but conditions unsuitable for science deployments on first arrival. A full depth CTD deployment was started just after midnight.

7 Friday / March 2025
BP2_8
CTD full depth retrieved around 02:15 and was successful although there were some growlers around. Paused to sample water from bottles and then turned around for shallow predawn CTD started around 03:00 and up at 04:15. Holding station to consider conditions for AGT deployment. Note that first attempts to communicate with mooring were not successful but may be issues with the comms box communicating via ship's sounders. Conditions not suitable to put hydrophone over the side as yet.

AGT went on at 07:00 - seabed at 3400m. Came up around 13:00 but net had inverted so no catch. Then deployed the EBS which worked well and got a muddy sample full of life. Moved back to station and did 3 x Bongo nets followed 2 x Mammoth. Decided to put Mammoth to max depth of 1300 m making the bottom two intervals 1300-1000 m and 1000-750m - note that there are just 8 nets on the device making the remainder 125 m depth intervals to the surface. C. acutus were caught in greatest abundance in the deepest interval.

8 Saturday / March 2025
BP2_8 mooring
Did a further 3 x Bongo nets - not many copepods in the upper water column it seems. Then moved back to above the mooring and started comms with it around 8am. Released but took a while to find. Recovery went relatively smoothly although had to deal with lack of recovery links on some devices making them difficult to stop off. All finished by 13:00 by which time we had recovered the top buoy with ADCP and CTD, 2 x sediment traps
and a Seaguard doppler. Deeper sediment trap worked well but 400 m one appeared to have stopped after some months. Mammoth deployed to 1300 m after lunch although wind had increased to just under 30 knots making it a little difficult over the starboard quarter. Many humpbacks came to visit the ship during the deployment - echosounders showed there was a krill swarms below us. Recovery of Mammoth was a bit fraught with high winds but got some good samples. CTD had some difficulties with TS sensors and had to be recovered and redeployed. Most likely it was due to freezing of the sensors. Second attempt was just at the edge of daylight given our aim was for a daytime deployment for Jasmine's eDNA work.

9 Sunday / March 2025
End of BP2_8 and onto BP2_6
Attempted some deployments with newly reterminated Biowire overnight. Difficulties in getting comms with instruments, most likely due to freezing issues. Eventually managed to get adequate comms with RMT so decided to deploy that, opening nets at 500-250 m and 250 to surface in oblique tows. Good catches of mesopelagic fishes and krill - mostly preserved in formalin. Decided against a MOCNESS due to time and moved on to BP2_6 to arrive just after 10am. Did deep AGT followed by deep EBS at 1500 m station both worked well without problems. Moved onto 2000 m station. Still having trouble communicating with MOCNESS net. Tried a deployment to 1000 m. Could not communicate to get the nets to increment so just had a sample in Net 1 on retrieval, representing a double oblique to 1000 m.

10 Monday / March 2025
BP2_6
Dawn shallow CTD then Mammoth deployed which went well although catch was a little beaten up - wind gusting to 30 knots on retrieval. Deep and shallow nets picked for C.acutus by Jen Freer under red light. Did 2 x Bongos again picked by Jen. Weather too bad for Mammoth as scheduled so headed to 500 m station to do benthic work. AGT and EBS deployments went well catching quite a lot of seapigs. Went back to 2000 m station and succeeded in deploying the Mammoth net over aft end around 17:30. Two Bongos were deployed afterwards. Tried to deploy Mammoth again around midnight but wind had picked up too much so abandoned deployment. Headed for BP2_5/M2 for mooring recovery - scheduled arrival time of 08:00.

11 Tuesday / March 2025 09:07
BP2_5 and M2 mooring
Arrived at mooring site at 8am. Established comms through hydrophone. Released both releases around 9am. Further contact with the releases indicated that they were not rising to the surface. The second release was fired but still no movement. Around 10:30 we considered other options such as dragging for the mooring. Ryan Saunders contacted

technicians that were on the previous expedition in RRS Discovery DY158 where we also had to drag for this same mooring. Their reply indicated that there was 2000 m of sacrificial wire and weak links used plus a number of specialised grappling hooks. We do not have such equipment on board. By 11:00 we had decided not to proceed with any attempts to drag for the mooring. The mooring owners in Cambridge were informed.
3 x CTDs were carried out while remaining just off the M2 site - first to full depth, second to 10 m for filming by Northern Pictures and the third to around 750 m, for further water and to calibrate instruments. We left M2 in late evening heading for M3.

12 Wednesday / March 2025 09:11
Heading to M3 mooring through storm
Weather worsened overnight as we entered the storm. By 06:00 we were just off M3 and hove to. Stayed there for rest of day, moving off station to maintain head to wind and avoid icebergs.

13 Thursday / March 2025 10:18
At M3 mooring
Weather abated somewhat overnight. Went back to M3 site from hove to location arrived around 10:00. Still a lot of swell even if wind had lessened to below 30 knots. Put in hydrophone at 10:15 to communicate with releases. Weather calmer by 15:30 although still some swell - able to try comms with the mooring releases without constant use of thrusters. Also gain had been turned up but still no response from releases. Tried again in the evening and turned up the listening sensitivity, which was successful. Will wait till tomorrow AM to release the mooring. Did a full depth CTD and predawn CTD overnight, with some Bongos in between. Bongos mostly contained CIV C. acutus

14 Friday / March 2025 08:00
M3 mooring recovery and redeployment
Started comms with releases around 7:45. Released around 08:30. Buoy spotted around 09:15. Recovery was relatively straightforward although the wire did have a few loops and twists that needed sorting out. Also one of the SBE CTDs had water pouring out of it when it was inspected later. Lithium battery warm for a bit and regularly inspected but started to cool. Mooring recovery finished at 12:00. Rope was wound off then a new 500 m rope wound on but turned out to be 750m long despite the labelling. Therefore, we wound that one off and wound on another of correct length which slowed things up somewhat. Started deployment around 18:15. Slight delay in finding a suitable way to release the weight. Mooring completed around 20:30. Steamed off to M2 overnight to check if it is still there (and not released from its snag).

15 Saturday / March 2025
BP2_4 day 1
Stopped at M2 and communicated with releases, which were still in place and vertical. Then headed to BP2_4
Arrived at BP2_4 at 08:30 and deployed AGT at 08:45. Weather beautiful, with clear skies, low wind and lots of humpback whales around. EBS had some difficulties during deployment with the device twisting before
it entered the water. Finally went out on third attempt and worked well with nice clean samples. During relocation to 2000 m site, we stopped by a charismatic iceberg and took the cruise photo by drone, spelling out “SD046” on the helideck. Arrived at 2000 m site just before dinner and setup Mammoth before getting some food. Mammoth went out over starboard side at 18:30 and sampled well - catching C. acutus throughout the water column - CIV
stages in the surface and CV and females in the deep. Did back to back Mammoths, the first for preservation, the second for picking out plankton by physiologists (and not preserved).

16 Sunday / March 2025

BP2_4 day 2

Followed nighttime Mammoth with a couple of Bongos, dominated by CIVs. Pre-dawn CTD was to 100 m followed by a full depth CTD to 2000 m. Some issues with CTD retrieval onto deck. Set off to relocate to 500 m station. AGT around 09:30 and retrieved by 11:00. EBS in water by 11:30 and back on board by 14:30. Both hauls worked really well and got clean catches including glass sponges and corals. Some welds on the EBS were broken and need repair but Hans, the deck engineer on board is confident this can be done.
Relocated to 2000 m site and carried out a MOCNESS starting around 4pm. Instrument worked perfectly. Caught good stratified samples - half preserved and half for picking. Lots of copepods and krill larvae (surface nets)
and euphausiids deeper down. Full depth CTD, principally for eDNA, carried out in darkness around 7:30pm. Activities at BP2_4 completed with an RMT to 500 m, which had some issues with nets closing unexpectedly. Nevertheless, some krill were caught and measured. Headed to OP moorings straight after, by around 00:30. Slowed for a little bit of time around 01:00 to sort out some deck gear.

17 Monday / March 2025

OP moorings and BP2_3

Foggy overnight so progress a bit slow arriving a OP/BP2_3 location around 09:00. Started with a swath survey to identify a cruise path and drop location for mooring OP2 (bearing around 280°). In position around 10:30. Mooring deployment went relatively smoothly - had a slight issue with one of the salinity measuring instruments in a plastic sheave where the metal bolt dethreaded itself. Hans, deck engineer, rebored the holes for bigger bolts which seemed to work. Mooring released around 14:00. Decided to postpone further moorings until tomorrow and focus more on sampling operations for rest of the day. Started with a 1300 m Mammoth, deployed around 15:30, which was successful and caught deep copepods. Did a combination of CTD and trilateration of OP2 until midnight Mammoth which again was successful but was a bit challenging to recover since wind picked up towards the end of the deployment.

18 Tuesday / March 2025

OP1 and OP5 moorings

Moved to OP1 position overnight to do a full depth CTD, which came on board around 05:45. Then started OP1 mooring around 8am. Mooring operations went smoothly and weight was deployed just before midday. Then moved to OP5 position to do a full depth CTD before starting mooring operations there. Mooring again went smoothly and was finished by 17:30. Spent rest of evening trilaterating OP1 and OP5 before moving off to station BP2_1.

19 Wednesday / March 2025

BP2_1

Had a time restriction to start Mammoth by midnight in order for dawn CTD to start at 3am. Hence stopped around 30 mins short of preset position of BP2_1 in around 2000 m water depth. Mammoth did not fire all nets stopping at the 6th net (called net7) at ~400 m - this net remained open all the way to the surface. Most likely problem was batteries running out (these were subsequently changed). The catch from this deployment was for picking by physiologists and not preserved.
Dawn CTD took place to 100 m, then a second Mammoth, again catching 1300-surface which was preserved.
Then a full depth CTD to 2000 m before moving off to a 500 m benthic site where we started with an EBS - in the water by 12:30 and recovered around 14:00 followed by an AGT which was completed by 16:30. Both trawls had magnificent catches. Set off to P3 after securing items on deck because of the big storm forecasted.

20 Thursday / March 2025

Transit to P3

Bit of a stormy day as we headed north - speed slowed somewhat as we drove straight into the weather coming from a northerly direction. Had a meeting about the science plan for sampling around the A23a giant iceberg. Decided on doing an underway transect as close in a straight line that went as close as possible to the westerly edge of the iceberg, with underway samples taken every 30 mins from 40 nm south of the iceberg to around the same distance north.

Pub quiz in evening written and hosted by Braydon was well received.

21 Friday / March 2025

First pass along A23a W

High frequency (every 30 mins) underway sampling started at 02:00. Arrived at SW corner of the iceberg just after 05:00. Misty and with brash ice all around but trying to keep a steady 10 knots while avoiding the brash ice going into the underway system. Mostly clear of brash ice in the system until almost at northern end of iceberg where a sample was lost to a blocked pipe but rectified soon after. Reached northern end by 10:00. Finished high frequency sampling around 13:00 and returned to standard underway observations for remainder of journey to P3.

Arrived at P3 around 21:00. First activity was a deep Mammoth net to 2000 m which caught C. acutus even in the deepest net. Then did 3 Bongos (full of copepods and phytoplankton) before a full depth CTD.

22 Saturday / March 2025

P3 mooring deployment (2nd attempt)

Full depth CTD between 03:00 and 07:00 and then onto final preparations for the P3 mooring deployment. A few issues with the Phytoplankton sampler (PPS) leading up to deployment with pumps and programmes. Also needed repair on some tubes just prior to deployment. Deployment went smoothly and we were a couple of km short of weight release point, so towed for an hour before final release at 13:00. Waited for an hour to let mooring settle then did a triangulation until 16:00 before leaving to return to A23a iceberg.

Spent rest of afternoon starting to dismantle Mammoth and MOCNESS nets, rinsing the nets for drying.

23 Sunday / March 2025

A23a western and southern side

Travelled south overnight to station SW2 to the southwest of A23a in an upstream location. High frequency underway sampling (every 30 mins) started around 21:00 previous evening to emulate the parallel coverage of that carried out closer to the western edge of the iceberg when travelling north. Started with a CTD to
1000 m. Wind too high for Bongos.

Entered fjord around 09:30 and steamed almost all the ways to the head of the fjord by 10:15. Did a CTD to 1000m during which we did line dancing on the heli deck.

Tried a Bongo around midday despite high winds. Went in water OK but then taken by a strong current such that
wire was hitting a block on the starboard gantry so brought the net back in immediately. 100um catch was no longer in the cod-end possibly due to a leak so catch was lost. Catch from 200 um was preserved, representing 0 to 5 m. Captured brash ice with a cargo cage before leaving the fjord.

Hugged the south coast of A23a heading eastwards until station SE0. Carried out another CTD to 1000 m with wind around 40 knots - no Bongos.

Headed to SE2 around 18:00. CTD to 1000 m but again no Bongos due to high winds.

24 Monday / March 2025

Shelf and Benthic sites to east and north of A23a

Arrived at the Shelf site around 03:00 and did a CTD followed by two Bongos which were the first Bongos completed during our visit to the iceberg. The catches were full of CV C. acutus but clear of phytoplankton. Then headed to the Benthic site chosen to be in an area where the iceberg has been before it pivoted further south.
Started with a swath survey at 08:00 which continued for the rest of the morning. Did not find any evidence of scouring by 14:00 so decided not to do any EBS sampling. Did a CTD and 2 x Bongos close into the iceberg which was within the area just surveyed by the swath. Also did another ice sample collection using a cargo cage. Left the site at 17:10 and continued to head along the north coast of the iceberg, taking underway samples every hour. Completed high frequency underway sampling by 21:30

25 Tuesday / March 2025
En route for Falkland Islands
Heading at full speed towards Falkland Islands as we try to avoid large storm heading from south west

26 Wednesday / March 2025
En route for Falkland Islands
Heading at full speed towards Falkland Islands as we try to avoid large storm heading from south west. Cruise dinner

27 Thursday / March 2025
Standing off at Mare Harbou
Arrived just off Mare Harbour by 10am. Packing of containers commenced

28 Friday / March 2025
Docked at Mare Harbour
Docked at Mare Harbour by 10am. Packing of containers continued although many went for a walk once most packing had been completed. Weather sunny and warm.

29 Saturday / March 2025
Departure of first science party
Containers for commercial freight lifted-off in morning. Labs cleaned and handed over to ship by early afternoon, First science party left at 13:30 to catch LATAM flight. Further packing of container to remain on the ship in late afternoon/evening including equipment for BIOPOLE 3 (May 25) and physical oceanographic cruise (June 25), both in Drakes Passage.

30 Saturday / March 2025
Final packing
Container to remain on ship finally packed. Remaining science party awaiting MOD flight scheduled for Tuesday 1st April.

2. Cruise phase narratives

2.1. WCB phase

Author: Sophie Fielding

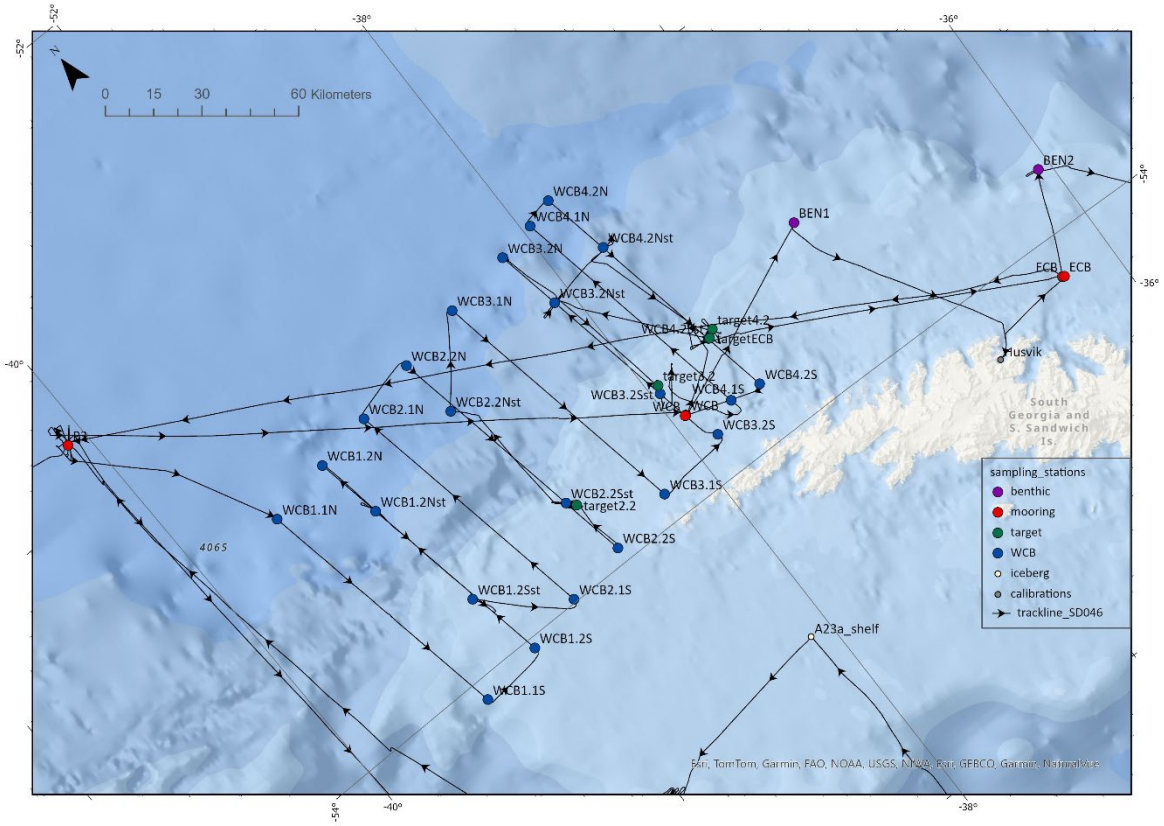


Fig 2.1.1 Cruise track and operations during WCB phase of SD046

Overview

Two key objectives of the Polar Ocean Ecosystem Time Series (POETS) Western Core Box (WCB)/Scotia Sea Open-Ocean Biological laboratories (SCOOBIES/PRESCIENT) phase were:

- To recover and re-deploy 3 long-term moorings in the South Georgia area. The deep water P3 (NC-PRESCIENT) carbon cycling mooring and the two shallow water ECB and WCB (NC-ALI) ecosystem moorings
- To undertake the WCB acoustic transects and associated netting, and any ECB transects possible within the time permitted.

Rationale

The archipelago of South Georgia is a large, isolated land and continental shelf area in the Atlantic sector of the Southern Ocean. The island of South Georgia is located approximately 1800 km to the east of the South American continental shelf and around 300 km south of the Polar Front (PF). The region is bisected by the Antarctic Circumpolar Current (ACC), with South Georgia to the north, which transports nutrients and organisms from the Antarctic Peninsula across the Scotia Sea to the South Georgia region.

South Georgia has been identified as a key source of regional biodiversity, potentially supporting anomalously high levels of endemic and range-edge species. The biota is generally considered Antarctic in character with organisms typically slow growing, long lived and with deferred sexual maturity. The best possibility to monitor biological response to climate change is probably where many species are highly thermally sensitive and at range edges. The pelagic ecosystem of South Georgia is extremely productive and intense phytoplankton blooms support a rich food web that includes zooplankton, in particular large densities of Antarctic krill, and vertebrate predators (penguins, seals and whales).

Antarctic krill (Euphausia superba) play a central role in the Southern Ocean food web as effective grazers on phytoplankton as well as a key prey item of a wide range of higher trophic predators. Inter-annual fluctuations in krill abundance at South Georgia were first noted during the whaling period in the early part of the twentieth century. There appear to be 2 to 3 years in each decade where the abundance of krill at South Georgia is low, the predator foraging and breeding performance is reduced, and the krill fishery reports reduced catch levels and rates.

The main deliverable of the WCB is a consistent unique time series of mesoscale distribution and abundance of Antarctic krill and an understanding of the physical environment they are within at South Georgia, South Atlantic (1996 – current). These data are required to understand the long-term variability in krill biomass at South Georgia and the influences from climate variability, fishing pressure and predation.

Implementation

We arrived at P3 (deep-water) mooring for recovery 09/02/2025. The mooring buoy came up several miles from the release location but was found using the iridium beacon and successfully brought onboard. The CTD wasn't working properly and with incoming weather, we headed to Stromness/Husvik to undertake the acoustic calibration and assess the CTD scrolling gear. On the way to Husvik the WCB mooring was also recovered successfully as well as a benthic EBS and AGT undertaken.

Whilst in Husvik (12/02/2025) the acoustic calibration was undertaken as well as two blind calibrations of the WBATs due to be deployed on the ECB and WCB moorings. In addition the CTD boom was switched from the standard wire to the metal free wire to facilitate CTDs.

On the way back to P3 to deploy the deep-water mooring, the ECB was recovered (13/02/2025). At P3 a CTD was undertaken whilst prepping for the mooring deployment. During the initial phases of deployment the rope slipped off the drum and got damaged. As a result the deployment of P3 was deferred to a later date. The ship then headed to the north end of the WCB transects to start the acoustic survey (15-18/02/2025).

The RapidCast system was used during the first leg of the WCB (WCB1.1). The first cast went smoothly, the second cast had an issue with winching, and the third cast ended with the motor burning out and the sensor retrieved more manually. That was the end of the Rapidcast system for the WCB and SD046. The rest of the transects were run without it. The

WCB 1.2 net and CTD stations were completed overnight before moving on to the next transect.

WCB2.1 commenced from the southern end and was completed smoothly (16/02/2025). Overnight station WCB2.2S RMT8 and CTD and WCB2.2N CTD were completed as well as a target haul on a krill swarm.

WCB 3.1 commenced from the northern end and the weather was more inclement. At the end of the transects a decision was made to head southwards to calmer waters to undertake inshore stations. A CTD was undertaken at WCB3.2S, followed by a target RMT8 haul and then the stratified RMT8 haul.

WCB 4.1 and 4.2 were undertaken in better weather. It was decided to deploy the WCB mooring at the end of the transects to utilise the fair weather. The WCB4.2S stations were completed after, before the vessel progressed offshore to complete the northern stations of transects 3 and 4 (19/02/2025).

The final activity of this phase of the cruise was the re-deployment of the ECB mooring, followed by some benthic work (EBS and AGT) which took place on the 20/02/2025 before the ship headed to the A23 transect.

2.2 A23 hydrographic section

Author: Sally Thorpe

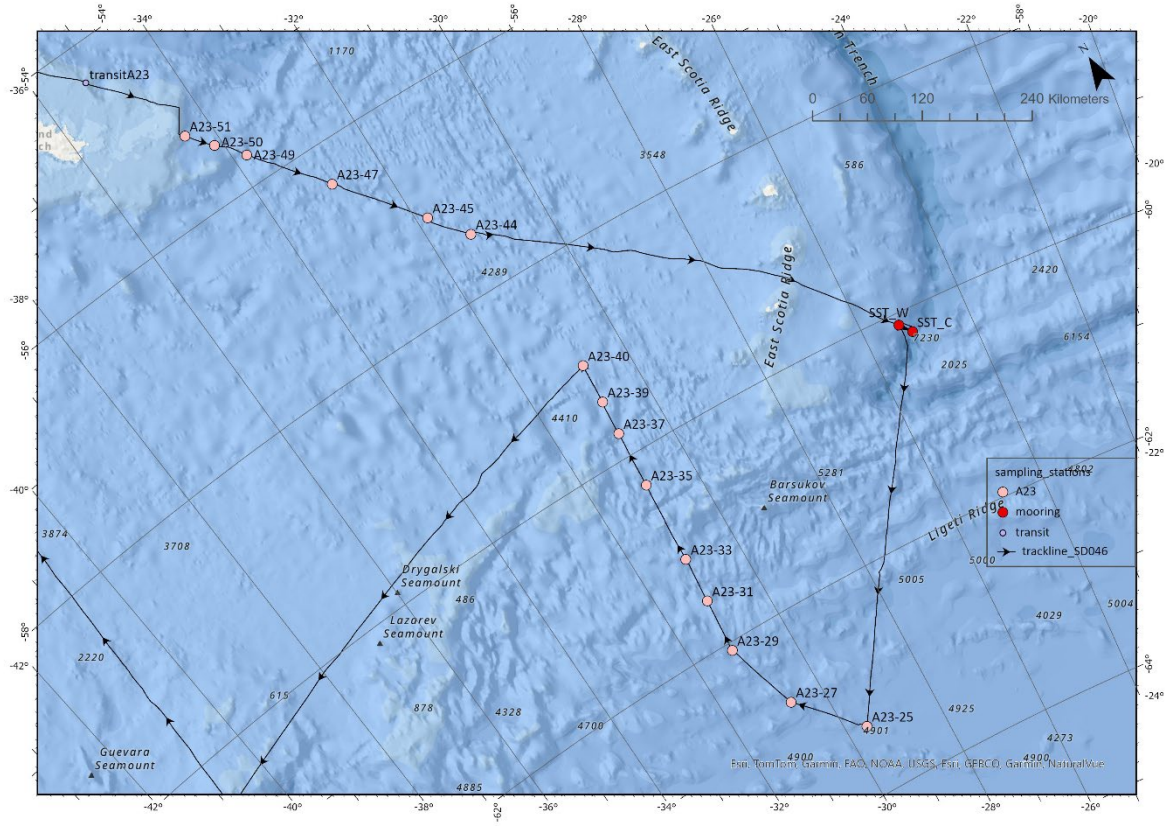


Fig. 2.2.1 Cruise track and stations occupied during the SD046 repeat of the A23 hydrographic transect.

Overview

As part of SD046, a repeat occupation of the hydrographic section A23 (https://www.bas.ac.uk/project/a23-repeat-section) was undertaken, giving a total of 16 repeats of this transect since 1995. Time constraints during the cruise meant that a subset of stations was occupied to give full latitudinal coverage of the section, albeit at a lower spatial resolution (Fig. 2.2.1). Alongside the physical oceanographic measurements, a suite of ecological sampling and experiments was carried out.

Rationale

A23 is part of the BAS Polar Oceans science team's long-term monitoring programme. The A23 section was first occupied in 1995 as part of the World Ocean Circulation Experiment and, in total, parts of the section have been occupied 15 times from 1995 to 2023. The current efforts repeat a subsection of the transect running from the continental shelf break of South Georgia across the Scotia Sea and over the South Scotia Ridge into the northern Weddell Sea. This allows for monitoring of long-term changes in Antarctic Bottom Water as it leaves the Weddell Sea, and as it circulates within the northern limb of the Weddell Gyre. Annual or biennial occupations of this section are needed to separate the interannual variability from the long-term warming trend, and thus better understand the causes of both.

Implementation

15 of the 31 CTD stations of the current effort of the A23 section were occupied during SD046 (Fig. 2.2.1, Table 3.2), between 21 February 2025 to 01 March 2025. Stations were selected based on a prioritisation provided by Povl Abrahamsen (BAS). We broke from the transect after station A23-44 to reach the South Sandwich trench moorings during an opportune weather window, then returned to the A23 transect to work northwards from station A23-25 to station A23-40. We were unable to carry out the final planned station, A23-42, due to incoming bad weather. CTDs were deployed to within 10 m of the seafloor, as determined by the altimeter on the CTD. All CTDs were sampled for salinity, oxygen isotopes, dissolved nutrients and phytoplankton community, with additional measurements of dissolved oxygen, biogeochemical parameters, black carbon, eDNA and microplastics at some stations, giving a comprehensive suite of information from the transect. At four of the stations (A23-49, A23-44, A23-33, A23-40), bongo nets were deployed to sample the mesozooplankton community and set up mesozooplankton experiments. Phytoplankton micrograzing experiments were carried out at two stations (A23-49, A23-35).

In addition to the CTDs, underway samples were taken while transiting between the A23 stations. These comprised salinity, oxygen isotopes, nutrients and biogeochemical parameters. Marine mammal observations were also carried out while on transit during daylight hours when weather permitted.

Outcomes

This was a successful repeat occupation of the A23 transect, extending the long-term monitoring time series of this region. The additional ecological data collected during SD046 at and between the stations are a valuable extension to the hydrographic data set.

2.3. South Sandwich Trench

Author: Rachael Sanders

Overview

The objective of the South Sandwich Trench Phase of Cruise SD046 was to recover two physical oceanography moorings deployed in early 2024 (see Fig 2.2.1).

Rationale

In February 2024, two moorings were deployed in the South Sandwich Trench by Povl Abrahamsen on board the FV Argos Georgia, to monitor Weddell Sea Deep Water export as part of the OCEAN ICE project (https://www.bodc.ac.uk/resources/inventories/cruise_inventory/report/18630/). On 23rd February, partway through the A23 transect, when the weather forecast was considered best, the ship diverted to the South Sandwich Trench with the aim of recovering these moorings.

Implementation

Since we arrived at the South Sandwich Trench overnight, and their positions had not been trilaterated after deployment, the first priority on arrival at the site of the moorings was to trilaterate the position of each set of releases at the seabed. The ship's acoustic system was also used to try to locate the top buoy of each mooring, but only that of the central, deeper mooring could be located.

Initially, bad visibility meant that recovery seemed unlikely, but the ship remained at the site of the central, deeper mooring (SST C) until mid-afternoon of the 24th February, when the visibility became good enough to release the mooring. The central mooring was then successfully recovered, and a CTD was done at the location for calibration purposes, with a range of samples also taken for both physical and biogeochemical parameters. The wire was deployed to 6059 m, with the CTD reaching a depth of 5993 m, the maximum of this cruise.

Another calibration CTD cast was done for the western mooring (SST W), far enough away to ensure that the CTD wire would not become entangled with the mooring rope. The western mooring was released on the morning of 25th February but only the lower buoys were spotted at the surface. Once recovered, the rope was found to have broken, and only two instruments still attached to the releases were recovered.

During this phase of the cruise, marine mammal observing was undertaken when visibility was good enough, and underway sampling of $\delta^{18}O$ was undertaken to determine the proportion of meteoric and sea ice-derived freshwater in the surface ocean.

2.4. BIOPOLE phase

Author: Geraint Tarling

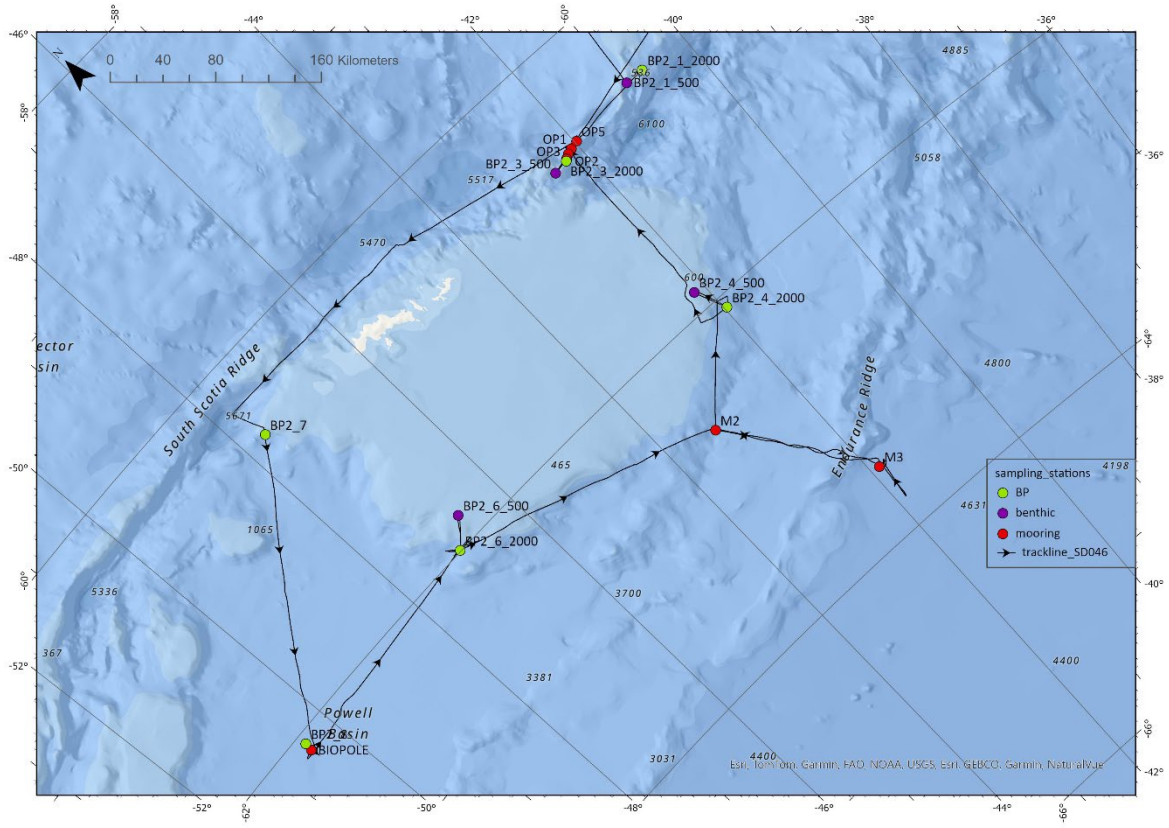


Fig 2.4.1 Cruise track and operations during BIOPOLE phase of SD046

Overview

There were three principal objectives during this phase of SD046

1. To carry out multidisciplinary sampling at between 7 and 9 stations around the South Orkney islands and the Powell Basin
2. To recover a number of moorings, the majority of which were to be redeployed
3. Carry out hourly underway measurements of nutrients, chlorophyll and carbon for periods of transit during this cruise phase

Rationale

For the first of these objectives, a prioritisation was given to the 9 stations originally identified to aid with the decision-making process should time not allow for all stations to be sampled. Of top priority were stations BP2_8 (BIOPOLE) and BP2_4. The lowest priorities were stations BP2_9 (towards the Antarctic Peninsula Shelf) and BP2_2 (en route from transect A23). Given the time allocation remaining when starting this phase of the cruise, these lowest priority stations were already ruled out, leaving 7 stations to focus on during our visit here.

Each of the stations had more than one location on which to carry out sampling. With the exception of BP2_8, the majority of activities were based around a 1500 m contour where there was to be a combination of pelagic and benthic sampling activities as well as a full depth CTD. In addition, a 500 m contour close to this location was also sampled for benthic organisms, to contrast with the 1500 m location. Part way through this phase, it was decided that the pelagic sampling was better sited at the 2000 m contour, such that there were three locations per station: 2000 m – Bongo net, Mammoth net, shallow predawn CTD, full depth CTD; 1500 m Agassiz benthic trawl, Epibenthic sledge; 500 m Agassiz benthic trawl, Epibenthic sledge. BP2_8 (which was also where the BIOPOLE mooring was located) was the only station with a deep bathymetry (~3500 m). Here there was a single location where all sampling activities took place, including benthic sampling.

The second of these objectives involved the recovery of four moorings physical oceanography moorings to the NW of the South Orkneys (OP1, OP2, OP3, OP5), a biophysical mooring in the Powell Basin (BIOPOLE) and two moorings either side of the Endurance Ridge (M2 and M3). All of these moorings, apart from the BIOPOLE mooring, were to be redeployed where possible.

The third objective for underway sampling was to be carried out continuously throughout all transits between stations or mooring locations.

Implementation

We arrived in this location on 2nd March and went to station BP2_3 which were also close to the OP moorings. After some station work, we released mooring OP3 successfully but had difficulties with OP1 and OP2 from which the mooring ropes had parted. OP5 was recovered successfully. Mammoth net was partially broken by the strong swell at this station and required repairs. This resulted in there being just 8 rather than the 9 nets for future deployments. Sampling at BP2_7 was also beset with difficult sampling conditions, with EBS and Mammoth deployments not taking place. The BIOPOLE mooring was successfully retrieved and station operations also successful apart from the AGT for which the net everted at some point during deployment. Also notable at this station was the Mammoth net deployment which sampled deeper to 1300 m rather than the 1000 m maximum depth up to this point. We also carried out an RMT at this station but no MOCNESS as it was broken. At BP2_6, we started the strategy of having three sampling locations, 2000m for pelagic+ CTD, and 1500m and 500 m for benthic work. Bad weather prevented us from completing all sampling operations. We did not carry out any sampling at BP2_5 to keep to schedule and focussed on retrieval of M2 mooring. Although this mooring was released, it did not rise to the surface, most likely because it was snagged. We did not have the equipment on board to trawl for the mooring so carried out a CTD and moved on to the M3 mooring. This was retrieved and redeployed successfully, including a CTD. We returned to the M2 mooring to check on it and confirmed it was still snagged. BP2_4 was a priority station and we carried out a full set of deployments at the 2000 m location including MOCNESS and RMT, although the latter misfired. Benthic hauls carried out at 1500 m and 500 m locations. We returned to BP2_3 where three of the four OP moorings were redeployed (OP2, OP1 and OP5). Also carried out a daytime and nighttime Mammoths given this was not possible during our first visit when this device was damaged. Our last station was OP2_1 in which we fitted in a day and night Mammoth, CTDs and benthic hauls at a 500 m station before moving off to P3 mooring site by afternoon of 19th March.

2.5. A23a iceberg phase

Author: Geraint Tarling

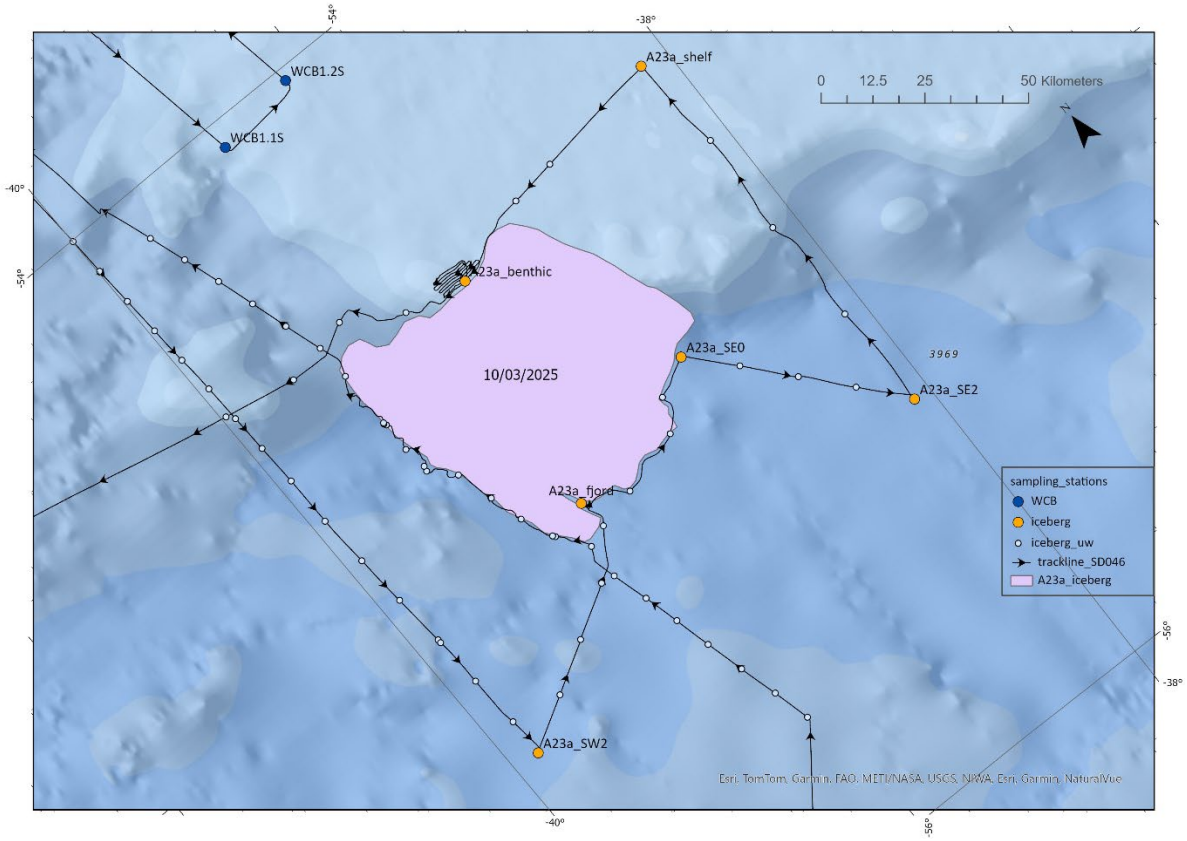


Fig 2.5.1 Cruise track and operations during A23a iceberg phase of SD046

Overview

To carry out observations in the vicinity of and around the grounded A23a iceberg comprising:

- Regular underway sampling during transects around the iceberg
- Station-based observations in strategic locations around the iceberg

Rationale

The A23a iceberg became grounded on the western edge of the South Georgia shelf, 73 km away from the coast on 4th March, 2025 (i.e. subsequent to our sampling of the South Georgia region during Phase Western Core Box). Over the next weeks, the iceberg had pivoted on the grounding position a short distance but had not moved further in the days prior to our visit.

Our sampling around A23a took advantage of two eventualities

1. It was necessary to revisit the P3 site to redeploy the mooring after abandoning our previous attempt in February
2. We had an extra couple of days of sampling time since as a result of leaving the BIOPOLE phase early to avoid an impending large storm.

We decided to limit over the side operations to just CTDs to 1000 m and Bongo nets to 200 m. The sampling rate of the non-contaminated sea-water supply was increased to every 30 mins when within 40 nm of the iceberg.

We identified 6 stations that captured the inflow (A23a_SW2), outflow (A23a_SE2), and shelf (A23a_shelf) regions as well as positions as close as feasible to the iceberg (A23a_fjord, A23a_SE0). There was a further site (A23a_benthic) we identified as being initially covered by the iceberg and then subsequently exposed once it had pivoted. Here we planned to carry out a swath survey and epibenthic sledge deployments inside and outside of scoured regions.

Implementation

We made a first pass along the western side of the A23a iceberg on 21st March. Higher frequency sampling of the non-contaminated sea-water supply started at 02:00, around 40 nm south of the iceberg. We arrived at the southwestern edge around 05:00. The ship skirted the western edge of the iceberg at around a distance of 0.5 nm. There was some difficulties with the supply close to the northwestern edge due to brash ice. High frequency was continued until 13:00 and we then headed to P3.

We returned to the vicinity of the iceberg on 23rd March and headed for station A23a_SW2. We resumed high frequency sampling of the non-contaminated sea-water supply en route, which provided a nice parallel transect ~10 nm to the west of that carried out on the 21st. We arrived at A23a_SW2 around 05:00. Did a CTD to 1000 m but wind too fierce for a Bongo net. Moved off to A23a_fjord. We entered the fjord around 09:30 and steamed to the head of the fjord until 10:15. CTD to 1000 m was successful and an attempt to deploy a Bongo was abandoned soon after deployment as a result of strong currents. The 200 um catch was retained despite only sampling to ~5 m. Followed the coast of the southern edge of the iceberg until arriving a A23a_SE0. Again, a CTD was successful but wind too high for a Bongo. Then to A23a_SE2 during nighttime for another CTD minus the Bongo. We arrived at the A23a_Shelf around 03:00 on 24th March and weather was considerably calmer. CTD was carried out to almost seabed of around 215 m. Two Bongos deployed 175 m. Arrived at A23a_Benthic at 08:00 and started Swath survey. This survey did not identify any scour marks so it was decided not to carry out any EBS deployments. A CTD was deployed to 213 m and two Bongos to 200 m. The ship followed the northern coast of the iceberg again to within 0.5 nm although a number of deviations were necessary to avoid icebergs. The high frequency sampling of the non-contaminated sea-water supply was completed by 21:30 (~10 nm from the NW edge of the iceberg) and the ship then headed for the Falkland Islands

3. Sampling Overview
3.1 Acoustics – EK80

Authors: Sophie Fielding, Hayley McLennan, Simon Wright, Matt Hood

Introduction

The SDA is equipped with a six frequency Simrad EK80 scientific echosounder operating at 18, 38, 70, 120, 200 and 333 kHz. All transducers are mounted on the hull behind ice windows.

During cruise SD046, the EK80 echosounders were operated continuously to collect information on the horizontal and vertical distribution of krill and micronekton (i.e small pelagic fish). At most times, transmission rates and intervals of all actively transmitting acoustic instruments were synchronised using the K-Sync to reduce interference. The only times that the EK80 was stopped was when the moorings were being pinged. The EK80 was calibrated anchored in Husvik, South Georgia on 11/02/2025.

Methodology

EK80 data

The EK80 was operated using Simrad EK80v. 21.15.1 software. The EK80 was switched on and temperature and salinity updated to values anticipated at South Georgia (T = 5°C, S = 33.2). The raw data files (SD-Dyyyymmdd-Thhmmss.raw) were logged to the local PC, which was backed up at regular intervals to the samba drive (data\cruise\sda\current\system\bioacoustic_simrad_ek80\acquisition\EK80_data). Raw data were collected to a range of 1100 m except during the calibration where data was collected to 500m.

The ping rate was generally maintained at 2 seconds whether the EK80 was controlled by the k-sync or internally, except during calibration where it was increased to 1 second. When data collection ranges were reduced pulse transmission rates (i.e. ping rates) of the echosounders could be increased to maximize horizontal resolution of the data.

When the ME70 was operated the EK80 only operated every other ping. When the EM124 was operated for mapping purposes the EK80 was enabled (in k-sync) to ping many times (maximise pingrate) during one EM124 ping. To enable this the EM124 could not be set to master, which meant that significant noise occurred in the EK80 data.

EK80 parameter settings

Data were collected using the following settings prior to calibration (Table 3.1.1.1). Transducer parameters and environmental settings were updated after the calibration (Table 3.1.1.2)

Variable	18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
Temperature	5	5	5	5	5	5
Salinity	33.5	33.5	33.5	33.5	33.5	33.5
Mode	Active	Active	Active	Active	Active	Active

Pulse type	CW	CW	CW	CW	CW	CW
Transducer type	ES18	ES38-7	ES70-7C	ES120-7C	ES200-7C	ES333-7C
Transducer Serial No.	2172	190-narrow	437	1588	666	210
WBT Serial no.	720835	721576	721579	721585	721591	721746
Transducer depth (m)	0	0	0	0	0	0
Pulse length (ms)	1.024	1.024	1.024	1.024	1.024	1.024
Max Power (W)	1600	2000	750	225	150	50

Table 3.1.1.1 EK80 initial settings

EK80 calibration

An acoustic calibration of the 18, 38, 70, 120 and 200 kHz transducers was carried out at anchor with relatively minimal DP usage on the 11/02/2025 at Husvik, utilising a period of poor weather outside of South Georgia. A boat was put in the water to enable a rope to be placed under the hull. Transmission of the EK80 was synchronised through the k-sync with a 1 second ping rate, along with the EA640. Each transducer was calibrated in turn, with all transducers transmitting through the entire calibration. Standard EK80 calibration procedures (ICES. 2015) were used as documented for previous cruises. The SDA's 38.1 mm tungsten carbide sphere was used for all transducers. TS gains were similar (within 0.3 dB) to values obtained in February 2024.

A CTD (Event 18) using the rapidcast CTD from the forward towing boom was undertaken prior to the calibration and this was used to average temperature and salinity from the surface to 30 m (depth of the calibration sphere) and were 2.8°C and 33.45 PSU.

Each transducer was calibrated at the environmental settings measured with the CTD cast and used throughout the cruise. Parameters from the EK80 lobes calibration were updated onto the EK80 software. The 120, 38 and 70 kHz calibrations went smoothly and were uploaded to the EK80 system. The 18 kHz calibration identified some alongbeam errors, that couldn't be removed even after removing extreme datapoints. However, the error of the model was 0.16 and therefore uploaded to the EK80. The 200 kHz calibration took longer and as motion of the ship started to influence the calibration it resulted in a poor model fit (error = 0.31). Therefore the calibration was redone – and on the second occasion the error was 0.20, and therefore uploaded to the EK80.

Quite a lot of time was spent trying to get the acoustic winches to work. It was eventually understood that two network ports were required for each winch, and that some of the network ports had been repurposed since the last calibration. Once the winches were up and running control of the sphere was relatively easy until the ship started to move as winds increased.

At the end of the calibration it became increasingly hard to move the sphere around any quadrants. Efforts to retrieve the sphere from the starboard forward winch failed, likewise

each winch was used to retrieve the sphere, but it became clear that the line was caught somewhere. In an effort to retrieve the sphere the port line was cut enabling the sphere to swing lose and be retrieved on the starboard forward side. The cause of why the sphere had become fast was not identified.

EK80 activities

The EK80 was run throughout the cruise and performed well, with few errors (occasional GPS warnings) and … Eight specific transects were run during the WCB component of the cruise. Specific activities are summarised in Table 3.1.1.3

Table 3.1.1.3 EK80 activities

Time (hh:mm, dd/mm/yy)	Action
17:27 06/02/2025	EK80 switched on, environment variables changed. T = 5 deg C, S = 33.5 PSU. EK80 initially pinging on internal trigger, then set to k-sync at a 2 second ping rate. EK80 set to logging
09:00 11/02/2025	Arrival in Husvik for calibration
16:13 11/02/2025	Ev018 Rapidcast CTD for calibration parameters
23:31 11/02/2025	Change environmental parameters to T = 2.8 deg C, S = 33.45 PSU
23:37 11/02/2025	Commence 120 kHz acoustic calibration
23:59 11/02/2025	Commence 38 kHz acoustic calibration
00:26 12/02/2025	Commence 70 kHz acoustic calibration
01:09 12/02/2025	Commence 18 kHz acoustic calibration
01:35 12/02/2025	Commence 200 kHz acoustic calibration
01:54 12/02/2025	Commence second 200 kHz acoustic calibration
08:00 – 13:23 15/02/2025	WCB1.1 transect (start N end)
14:39 – 19:02 15/02/2025	WCB1.2 transect (start S end)
08:55 – 13:15 16/02/2025	WCB2.1 transect (start S end)
14:26 – 18:50 16/02/2025	WCB2.2 transect (start N end)
08:10 – 12:32 17/02/2025	WCB3.1 transect (start S end)
13:58 – 18:27 17/02/2025	WCB3.2 transect (start N end)

08:25 – 12:41 18/02/2025	WCB4.1 transect (start S end)
13:14 – 17:36 18/02/2025	WCB4.2 transect (start N end)

WCB transect overview

The WCB commenced from the northern end of WCB1.1 following an attempt to deploy the P3 mooring. The Rapidcast CTD was deployed at the Start waypoint successfully. At the second waypoint (at 10 nm) the Rapidcast was deployed and an error received. At the third waypoint (at 20 nm) the Rapidcast was deployed and did not return successfully. The vessel remained at a slow speed whilst the Rapidcast sensor was retrieved, and no more deployments were made (xref AME report).

During the night of 17/02/2025, inclement weather meant that stations at the southern end of the transect were undertaken, where suitable environmental conditions were available for CTDs and RMTs. This meant that transect 4.1 was commenced from the southern end, and both 3.1 and 3.2 had considerable weather noise. A suitable weather window to deploy the WCB mooring was available immediately following transect 4.2.

A significant number of krill-like marks were found throughout the transects (Fig 3.1.1.1)

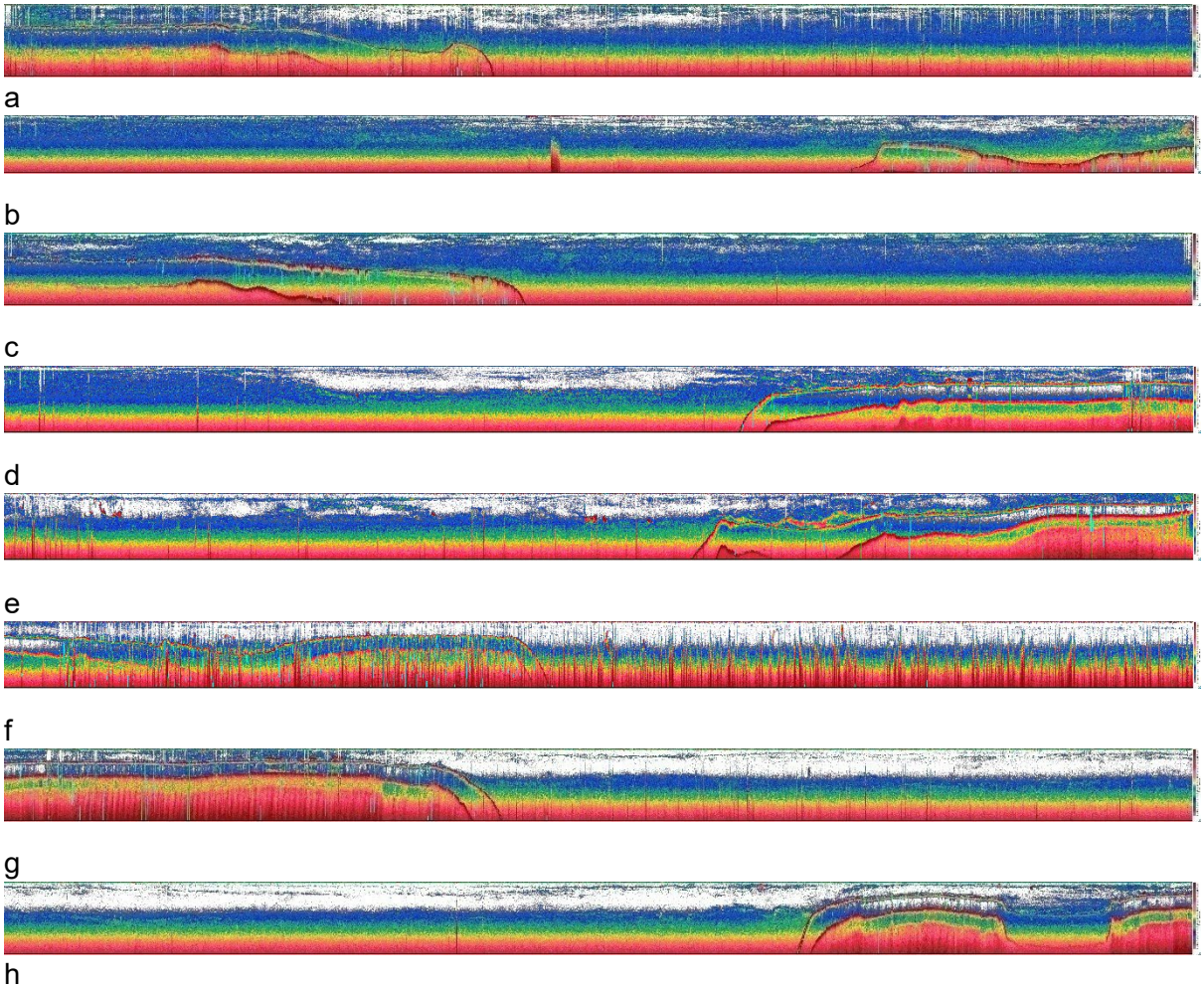


Fig 3.1.1.1

120 kHz echogram from (a) WCB transect 1.1, (b) WCB transect 1.2, (c) WCB transect 2.1, (d) WCB transect 2.2, (e) WCB transect 3.1, (f) WCB transect 3.2, (g) WCB transect 4.1, (h) WCB transect 4.2.

Recommendations

The EK80 generally performed correctly. The hard-drive still doesn't sync automatically to the storage resulting in the potential for the system to stop working.

When looking for the South Sandwich Trench mooring a layer was drawn at 1500 m in the acoustic data. All other depth zones were corrected to allow the 2 second ping rate (with the layer no longer showing on the display), but a 2 second ping rate could not be achieved until this layer had been removed, even though the data display was limited to 1000m and the data storage was set to 1100m.

References

ICES. 2015. Calibration of acoustic instruments. ICES Cooperative Research Report. Vol. 326, 136 pp. https://doi.org/10.17895/ices.pub.5494

3.2 CTD sampling overview

Author: Hugh Venables

During SD046 there were 71 CTD casts recorded, including casts that failed due to spooling issues and frozen sensors. Spooling and boom issues led to switches between the steel and metal-clean wires and between the CTD boom and starboard gantry, the latter with considerable effect on the safe weather window for deployments.

Freezing problems happened when the air temperature was about -5°C and the hangar doors were open. As well as causing delays, freezing the sensors can lead to jumps in calibration points, especially for conductivity and oxygen and should be avoided in future.

For all casts the steel CTD frame was used with 24 20L bottles, with two sets of temperature, conductivity and oxygen sensors, a fluorometer, transmissometer, PAR sensor and SBE35 calibration thermometer. Details of these, and when sensors were swapped are in the AME electrical report (Chapter 4). Processing and calibration is covered in the Physical Oceanography section (Chapter 7.1).

For each CTD there were a wide range of samples that could be taken, with almost all CTDs having a different combination of them. Each one is coded in the CTD table, as detailed below. The order largely reflects the priority order when sampling from the same bottle, though sampling was spread between different Niskins whenever water budget allowed, always in the case of microplastics.

O2: Dissolved Oxygen
DIC: Dissolved Inorganic Carbon
N: Nutrients
BGC: Biogeochemistry (Silicon isotopes, Dissolved Organic Carbon, Particulate Carbon and Biogenic silica
BC: Black Carbon
O18: Oxygen isotope
Ph: Phytoplankton sampling, and micrograzing experiments
POM: Particulate Organic Matter
E: Environmental DNA
G: Feedstock for copepod grazing experiments
MP: Microplastics
S: Salinity calibration samples

The variety in sampling, and depth patterns meant a separate water budget needed to be made for every CTD, which was communicated with the CTD operator and then onto a sample cop form to control, and facilitate water sampling. Bottle 7 was prone not to close so was doubled up with bottle 6 or 8 if possible. A dot in the corner of a box was used to show it was to be sampled, with the priority running from left to right. The bottle number, or a tick, then showed it had been sampled. Scanned forms are in L:\work\scientific_work_areas\ctd\CTD_sample_cop_logsheets and were digitised to L:\work\data_management\data_products\ CTD_bottle_sampling_SD046_SG_A23_BP_iceberg.xls
Operator logsheet scans are in L:\work\X_other_work_areas\AME E\CTD Logsheets

A table was fixed near the CTD in the hangar to help with equipment, especially giving a controlled area for spiking dissolved oxygen samples.

CTD cast +A1:K172number	Event Number	Station	Month	Day	Start/bottom/end times	Start/bottom/end position			Sampled for:	Footnotes
			2	8	21:23:29	-52 52.21	-47 51.51			
2	9	Test 2	2	8	21:41:04	-52 52.21	-47 51.51	32	BC	
			2	8	22:07:38	-52 52.21	-47 51.51			
			2	13	19:23:52	-54 06.21	-36 14.75			
6	25	ECB Mooring	2	13	19:38:58	-54 06.21	-36 14.75	262	O2,N,Ph,O18,E,G,MP,S	
			2	13	20:14:19	-54 06.21	-36 14.75			
			2	14	15:08:30	-52 51.30	-40 05.19			
7	27	P3	2	14	16:22:20	-52 51.30	-40 05.19	3745	O2,DIC,N,BGC,BC,Ph,O18,POM,E,G,MP,S	
			2	14	17:50:26	-52 51.30	-40 05.19			
			2	15	22:50:44	-53 29.56	-39 15.03			
8	37	WCB1.2N	2	15	23:20:27	-53 29.56	-39 15.03	1001	O2,N,E,G,MP,S	
			2	15	23:54:15	-53 29.56	-39 15.04			
			2	16	05:58:22	-53 49.67	-39 09.89			

9	39	WCB1.2S	2	16	06:17:37	-53 49.67	-39 09.89	303	O2,N,Ph,E,MP,S	
			2	16	06:44:49	-53 49.67	-39 09.89			
			2	16	22:28:31	-53 47.11	-38 35.01			
10	41	WCB2.2S	2	16	22:47:46	-53 47.11	-38 35.01	195	O2,N,E,MP,S	
			2	16	23:09:58	-53 47.11	-38 35.01			
			2	17	05:24:56	-53 24.84	-38 43.56			
11	44	WCB2.2N	2	17	05:51:20	-53 24.84	-38 43.56	1002	N,Ph,POM,E,MP,S	
			2	17	06:34:54	-53 24.85	-38 43.56			
					22:32:00	-53 42.85	-37 57.92			
12	45	WCB3.2S	2	17						Aborted for DP issues
					22:37:00					
			2	17	23:05:25	-53 42.85	-37 57.92			
13	46	WCB3.2S	2	17	23:18:03	-53 42.85	-37 57.93	125	O2,N,MP,S	
			2	17	23:34:07	-53 42.85	-37 57.92			
			2	18	19:19:12	-53 47.95	-37 56.29			

14	51	WCB Mooring	2	18	19:36:27	-53 47.95	-37 56.29	285	O2,N,BGC,BC,Ph,POM,MP,S	No Si Isotopes
			2	18	20:09:12	-53 47.95	-37 56.29			
			2	19	07:04:20	-53 40.69	-37 39.00			
15	55	WCB4.2S	2	19	07:19:12	-53 40.69	-37 39.00	119	N,BC,Ph,E,MP,S	
			2	19	07:42:58	-53 40.69	-37 39.00			
			2	19	11:05:33	-53 21.69	-38 04.90			
16	56	WCB3.2N	2	19	11:33:17	-53 21.69	-38 04.90	1002	O2,N,E,MP,S	
			2	19	12:09:01	-53 21.69	-38 04.90			
			2	19	16:41:33	-53 19.51	-37 46.25			
17	58	WCB4.2N	2	19	17:11:46	-53 19.51	-37 46.25	1000	O2,N,Ph,E,G,MP,S	
			2	19	17:37:59	-53 19.51	-37 46.25			
			2	20	09:57:40	-54 06.20	-36 14.81			
18	63	ECB Mooring	2	20	10:14:03	-54 06.20	-36 14.81	261	N,Ph,POM,G,MP,S	
			2	20	10:39:05	-54 06.20	-36 14.81			
			2	21	06:04:29	-54 20.41	-35 14.98			
19	67	SG shelf	2	21	06:19:17	-54 20.41	-35 14.98	355	N,Ph,G,S	

			2	21	06:58:30	-54 20.41	-35 14.98			
			2	21	16:16:41	-55 12.82	-34 30.43			
20	71	A23-52	2	21	16:36:00	-55 12.83	-34 30.43	534	O2,N,BGC,O18,Ph,S	
			2	21	17:05:19	-55 12.82	-34 30.43			
			2	21	18:05:13	-55 15.58	-34 26.58			
21	72	A23-51	2	21	18:40:17	-55 15.58	-34 26.58	1502	O2,N,BGC,O18,Ph,POM,E,S	
			2	21	19:29:08	-55 15.58	-34 26.58			
			2	21	22:05:15	-55 29.09	-34 08.05			
22	73	A23-50	2	21	22:59:11	-55 29.09	-34 08.05	2443	O2,N,O18,Ph,S	
			2	22	00:17:35	-55 29.09	-34 08.05			
			2	22	02:23:57	-55 43.50	-33 47.13			
23	74	A23-49	2	22	03:31:43	-55 43.39	-33 47.05	3453	N,BGC,O18,Ph,G,S	
			2	22	05:13:45	-55 43.15	-33 46.90			
			2	22	11:13:36	-56 22.83	-32 52.29			
24	77	A23-47	2	22	12:18:40	-56 22.83	-32 52.30	3126	O2,N,BGC,O18,Ph,POM,MP,S	
			2	22	13:34:52	-56 22.83	-32 52.30			

			2	22	17:53:54	-57 07.12	-31 48.86			
25	78	A23-45	2	22	19:03:18	-57 07.12	-31 48.86	3442	O2,N,BGC,BC,Ph,E,S	
			2	22	20:17:37	-57 07.12	-31 48.86			
			2	22	22:44:36	-57 27.50	-31 19.72			
26	79	A23-44	2	22	23:55:40	-57 27.50	-31 19.72	3743	O2,N,O18,Ph,POM,G,S	
			2	23	01:44:56	-57 27.50	-31 19.72			
			2	24	22:42:51	-60 12.82	-25 07.31			
27	84	SST Central	2	25	00:52:01	-60 12.82	-25 07.31	5995	O2,N,BGC,BC,O18,E,S	
			2	25	03:17:52	-60 12.82	-25 07.31			
			2	25	04:47:46	-60 07.71	-25 22.57			
28	85	SST West	2	25	06:07:08	-60 07.71	-25 22.57	4015	N,O18,Ph,POM,S	
			2	25	08:00:17	-60 07.71	-25 22.57			
			2	26	08:04:29	-63 20.79	-29 34.13			
29	87	A23-25	2	26	09:36:25	-63 20.79	-29 34.13	4725	O2,N,BGC,O18,Ph,POM,E,MP,S	
			2	26	11:22:09	-63 20.79	-29 34.13			
			2	26	15:16:27	-62 47.04	-30 41.75			

30	88	A23-27	2	26	16:48:19	-62 47.04	-30 41.74	4817	O2,N,BGC,O18,Ph,POM,S	
			2	26	18:29:04	-62 47.04	-30 41.74			
					23:47:00					
31	89	Test	2	26	23:48:00	-62 04.53	-31 11.01			Starboard gantry test
					23:49:00					
			2	27	00:06:39	-62 04.53	-31 11.01			
32	90	A23-29	2	27	01:38:56	-62 04.53	-31 11.01	4845	N,BGC,O18,Ph,POM,S	
			2	27	05:23:07	-62 04.53	-31 11.01			
			2	27	16:54:05	-61 33.08	-31 06.25			
33	91	A23-31	2	27	18:09:26	-61 33.08	-31 06.25	4067	O2,N,BGC,O18,Ph,POM,E,S	
			2	27	19:37:55	-61 33.08	-31 06.25			
			2	28	00:34:27	-61 06.55	-31 02.47			
34	94	A23-33	2	28	01:36:46	-61 06.55	-31 02.46	2558	O2,N,BGC,O18,Ph,POM,G,MP,S	
			2	28	03:14:16	-61 06.55	-31 02.46			
			2	28	07:38:30	-60 18.95	-30 57.51			

35	95	A23-35	2	28	08:40:59	-60 18.95	-30 57.50	2738	N,BGC,O18,Ph,POM,S	
			2	28	09:50:30	-60 18.94	-30 57.49			
			2	28	12:53:35	-59 45.99	-30 54.34			
36	97	A23-37	2	28	14:06:39	-59 45.99	-30 54.34	3780	O2,N,BGC,O18,Ph,S	
			2	28	15:22:23	-59 45.99	-30 54.34			
			2	28	19:25:39	-59 26.15	-30 51.61			
37	98	A23-39	2	28	20:38:01	-59 26.15	-30 51.61	3440	O2,N,BGC,O18,Ph,E,G,S	
			2	28	21:45:55	-59 26.15	-30 51.61			
			3	1	02:26:32	-59 02.98	-30 49.71			
38	101	A23-40	3	1	03:31:24	-59 02.98	-30 49.71	3109	N,BGC,O18,Ph,POM,G,S	
			3	1	05:05:02	-59 02.98	-30 49.73			
			3	3	05:19:31	-60 40.00	-42 15.20			
39	108	BP2_3	3	3	06:00:39	-60 40.00	-42 15.20	1503	DIC,N,BGC,Ph,POM,E,G,MP,S	
			3	3	07:01:26	-60 40.00	-42 15.20			
			3	3	21:07:06	-60 37.71	-42 05.48			
40	113	OP1	3	3	22:20:24	-60 37.71	-42 05.46	3601	O2,N,O18,S	

			3	3	23:54:54	-60 37.71	-42 05.45			
			3	4	01:19:06	-60 38.50	-42 10.19			
41	114	OP2	3	4	02:21:46	-60 38.50	-42 10.19	3065	O2,N,O18,E,S	
			3	4	03:43:45	-60 38.50	-42 10.19			
			3	4	04:45:22	-60 39.39	-42 13.67			
42	115	OP3	3	4	05:27:47	-60 39.39	-42 13.67	1708	N,O18,S	
			3	4	06:18:53	-60 39.39	-42 13.67			
			3	4	15:07:12	-60 36.89	-41 58.50			
43	118	OP5	3	4	16:15:21	-60 36.89	-41 58.50	3373	O2,N,O18,E,S	
			3	4	17:31:28	-60 36.89	-41 58.51			
			3	6	05:53:50	-60 32.39	-47 39.34			
44	123	BP2_7	3	6	06:40:01	-60 32.39	-47 39.33	1455	DIC,N,BGC,O18,Ph,POM,G,S	
			3	6	07:33:26	-60 32.39	-47 39.34			
			3	7	02:31:14	-62 04.10	-50 28.50			
45	127	BP2_8	3	7	03:44:57	-62 04.11	-50 28.49	3357	O2,DIC,N,BGC,BC,O18,POM,E,G,MP,S	
			3	7	05:16:34	-62 04.14	-50 28.42			

			3	7	06:49:44	-62 04.13	-50 28.41			
46	128	BP2_8	3	7	07:01:29	-62 04.13	-50 28.41	103	N,BC,Ph,G,S	
			3	7	07:29:30	-62 04.14	-50 28.39			
47	141	BP2_8	3	8						Frozen sensors, aborted
			3	8	22:17:49	-62 04.04	-50 28.30			
48	142	BP2_8	3	8	22:46:04	-62 04.05	-50 28.26	1011	E,S	Frozen sensors, continued
			3	8	23:17:18	-62 04.05	-50 28.26			
			3	10	07:31:50	-61 59.68	-47 01.00			
49	149	BP2_6	3	10	08:01:41	-61 59.68	-47 01.01	1012	N,Ph,POM,E,G,S	
			3	10	08:41:22	-61 59.67	-47 01.00			
			3	10	10:15:37	-61 59.68	-47 00.99			
50	152	BP2_6	3	10	11:01:14	-61 59.68	-47 00.99	1965	O2,DIC,N,BGC,O18,POM,E,MP,S	
			3	10	11:56:09	-61 59.68	-47 00.99			
			3	11	15:37:39	-62 37.71	-43 15.61			

51	159	M2	3	11	16:38:35	-62 37.71	-43 15.60	3039	O2,DIC,N,BGC,O18,POM,E,G,S	
			3	11	17:59:58	-62 37.71	-43 15.61			
52	160	Media 10m								
			3	11	19:59:26	-62 37.71	-43 15.61			
53	161	M2	3	11	20:22:13	-62 37.71	-43 15.61	751	N,Ph,G,S	
			3	11	21:01:14	-62 37.71	-43 15.61			
54	162	Media 10m								
			3	13	22:39:25	-63 31.19	-41 43.88			
55	163	M3	3	14	00:06:52	-63 31.23	-41 43.93	4508	O2,DIC,N,BGC,O18,G,S	
			3	14	01:50:37	-63 31.23	-41 44.01			
			3	14	06:06:09	-63 31.23	-41 44.17			
56	167	M3	3	14	07:01:12	-63 31.23	-41 44.18	109	O2,N,Ph,G,S	Frozen, defrosted in water
			3	14	07:26:54	-63 31.23	-41 44.17			

			3	16	06:07:29	-62 05.01	-41 57.69			
57	178	BP2_4	3	16	06:21:10	-62 05.01	-41 57.69	99	N,Ph,G,S	
			3	16	06:44:60	-62 05.01	-41 57.69			
			3	16	07:51:58	-62 05.01	-41 57.70			
58	179	BP2_4	3	16	08:36:49	-62 05.01	-41 57.70	1954	O2,DIC,N,BGC,O18,POM,MP,S	
			3	16	09:41:47	-62 05.01	-41 57.70			
			3	16	22:21:32	-62 04.46	-42 12.22			
59	183	BP2_4	3	16	23:08:22	-62 04.46	-42 12.22	1735	O2,DIC,O18,E,S	
			3	16	23:54:12	-62 04.46	-42 12.22			
			3	17	22:12:06	-60 39.88	-42 07.81			
60	187	OP2	3	17	23:25:33	-60 39.88	-42 07.81	3138	O2,N,G,S	
			3	18	00:48:45	-60 39.88	-42 07.81			
			3	18	06:02:50	-60 37.66	-42 05.54			
61	189	OP1	3	18	07:13:37	-60 37.66	-42 05.54	3604	N,POM,S	
			3	18	08:40:59	-60 37.66	-42 05.54			
			3	18	15:46:50	-60 36.79	-41 58.11			

62	191	OP5	3	18	16:53:37	-60 36.79	-41 58.10	3361	O2,N,S	
			3	18	18:10:43	-60 36.79	-41 58.10			
			3	19	06:31:06	-60 32.83	-40 41.61			
63	194	BP2_1	3	19	06:40:48	-60 32.83	-40 41.61	105	N,Ph,G,S	
			3	19	07:05:58	-60 32.83	-40 41.61			
			3	19	12:25:46	-60 32.98	-40 41.71			
64	198	BP2_1	3	19	13:11:33	-60 32.98	-40 41.71	2096	DIC,N,BGC,POM,S	
			3	19	14:03:55	-60 32.98	-40 41.71			
			3	22	06:37:58	-52 50.95	-40 04.61			
65	205	P3 deployment	3	22	08:01:05	-52 50.95	-40 04.52	3742	DIC,N,BGC,O18,G,S	
			3	22	09:15:59	-52 50.95	-40 04.52			
			3	23	08:42:22	-55 24.00	-39 53.99			
66	207	A23a_SW2	3	23	09:10:44	-55 24.00	-39 53.99	1008	DIC,N,BGC,BC,O18,Ph,POM,G,S	
			3	23	09:59:58	-55 24.00	-39 53.99			
			3	23	13:01:37	-55 03.93	-39 13.09			
67	208	A23a_fjord	3	23	13:24:40	-55 03.93	-39 13.09	1005	DIC,N,BGC,BC,O18,Ph,POM,E,G,S	

			3	23	14:10:21	-55 03.93	-39 13.09			
			3	23	18:54:01	-54 57.72	-38 37.24			
68	211	A23a_SE0	3	23	19:26:28	-54 57.72	-38 37.24	1007	DIC,N,BGC,BC,O18,Ph,POM,S	
			3	23	20:03:39	-54 57.72	-38 37.24			
			3	23	23:22:33	-55 19.31	-38 04.00			
69	212	A23a_SE2	3	23	23:49:15	-55 19.34	-38 03.93	1008	DIC,N,BGC,BC,O18,Ph,POM,S	
			3	24	00:39:12	-55 19.34	-38 03.82			
			3	24	06:17:51	-54 27.06	-38 06.04			
70	213	A23a Shelf	3	24	06:35:58	-54 27.06	-38 06.04	214	DIC,N,BGC,O18,Ph,POM,G,S	
			3	24	07:05:13	-54 27.06	-38 06.04			
			3	24	17:27:48	-54 34.10	-39 02.59			
71	216	A23a Benthic	3	24	17:43:48	-54 34.10	-39 02.59	212	DIC,N,BGC,BC,O18,Ph,POM,E,G,S	
			3	24	18:09:30	-54 34.10	-39 02.59			

Table 3.2: SD046 CTD deployments. See list at the start of Section 3.2 for sampling abbreviations.

3.3 Mooring sampling overview

Author: Sophie Fielding

Mooring	Recovery date	Redeployment Date	Deployment Position	
P3	10/02/2025	22/03/2025	52° 51.3767' S	40° 05.0480' W
Western Core Box	10/02/2025	18/02/2025	53° 47.74' S	37° 56.58' W
Eastern Core Box	13/02/2025	20/02/2025	54° 06.21' S	36° 14.41' W
BIOPOLE	08/03/2025	-		-
South Sandwich Trench Central	24/02/2025	-	-	-
South Sandwich Trench West	25/02/2025	-	-	-
OP1	-	18/03/2025	60° 37.380' S	42° 5.700' W
OP2	-	17/03/2025	60° 38.388' S	42° 10.557' W
OP3	03/03/2025	-	-	-
OP5	04/03/2025	18/03/2025	60° 36.960' S	41° 58.620' W
M3	14/03/2025	14/03/2025	63° 31.920' S	41° 46.247' W

Table 3.3.1 Mooring recoveries and redeployments on SD046

3.4 Pelagic netting overview

3.4.1 Bongo Netting

Author Nadine Johnston

To collect copepods for physiology experiments (direct respiration at normal pressure and at depth, ETS, grazing, activity, and isotopic analyses) and to determine the composition of mesozooplankton community (including copepods *Calanoides acutus*) in the upper layers of the study area in the autumn period during the descent of *C. acutus* to depth for winter diapause (see Fig X Chapter X) a Bongo net (Figure 1, below) was used. The Bongo net, containing a spring-tensioned motion compensation unit, was deployed at a range of stations throughout the cruise during darkness and daylight hours (see Table 1). The Bongo net is made up of 2 x 61 cm diameter metal rings, each fitted with a 200 µm mesh and one 100 µm mesh. The cod-ends (custom made by AME) 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 and gantry. Between deployments, the Bongo nets were removed and the frame rested vertically on a made to specification metal stand (designed by AME). Descent and ascent of the net was carried out at a speed of 0.3 m/s. All deployments were made to 200m. Once on board the 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. In the case of activity experiments, buckets were promptly covered in black plastic bags on deck. In general, 2 deployments were made per station, with the first one being picked for copepods, and the second preserved complete in 4% formaldehyde. In total, 50 deployments were made during SD046 (see Table 1, below).

Issues encountered: Due to adverse weather the Bongo was not deployed at every station, and on one occasion (Event 209, at the A23a iceberg) deployment was aborted due to strong winds and currents that deflected the hydrowire off the gantry. On two occasions the orange plastic taps on the custom made codends twisted open during deployment and the catch was lost. On the penultimate deployment, codends with these orange taps were replaced with an alternative set fitted with metal lever style taps. These taps were far superior, closed securely and did not open on deployment. Do not use orange taps in future, replace with metal lever style.

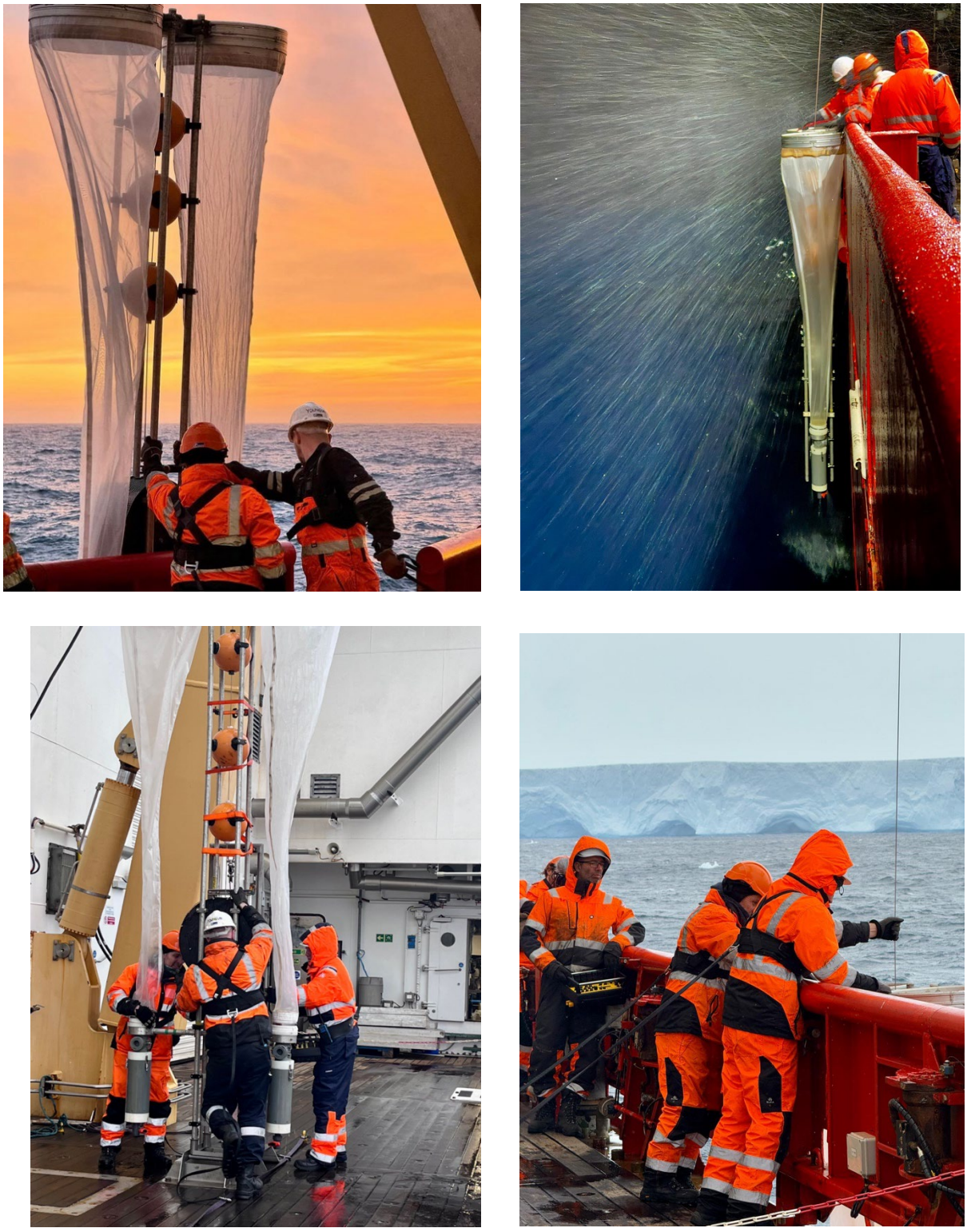


Figure 3.4.1.1 Collection of *Calanoides acutus* and mesozooplankton samples on SD046 using Bongo nets. Top: Deployments were made during the day and night (images, including deployment at the A23a iceberg shelf station, courtesy Dan Mayor https://www.instagram.com/oceanplankton). Bottom: Note purpose-built frame designed by Thomas Gillum-Webb, AME, BAS).

time	latitude (dd)	longitude (dd)	event	station	mesh size	net depth (m)	SST (C)	SSS (psu)	chl	PAR	transmittance	action	depth EA640	comment	analysis
24/03/2025 19:29	-54.5683	-39.0432	218	A23a_benthic	100/200		0.662964	33.8129	62	63.453	0.241	outWater	214.94		
24/03/2025 19:17	-54.5683	-39.0432	218	A23a_benthic	100/200	200	0.639374	33.7991	63	80.894	0.241	atDepth	208.36		
24/03/2025 19:06	-54.5683	-39.0432	218	A23a_benthic	100/200		0.547272	33.7639	56	110.093	0.237	inWater	215.08		
24/03/2025 18:55	-54.5683	-39.0432	217	A23a_benthic	100/200		0.597992	33.7646	57	146.898	0.24	outWater	214.27		Picked for zoo phys
24/03/2025 18:45	-54.5683	-39.0432	217	A23a_benthic	100/200	200	0.532806	33.7397	58	153.268	0.238	atDepth	207.31		
24/03/2025 18:33	-54.5683	-39.0432	217	A23a_benthic	100/200		0.470764	33.7114	59	188.01	0.235	inWater	213.53		
24/03/2025 08:28	-54.4511	-38.1006	215	A23a_shelf	100/200		3.23645	33.7269	143	0.327	0.612	outWater	225.56		Preserved
24/03/2025 08:14	-54.4511	-38.1006	215	A23a_shelf	100/200	175	3.241791	33.732	147	-0.006	0.599	atDepth	226.93		
24/03/2025 08:03	-54.451	-38.1006	215	A23a_shelf	100/200		3.243469	33.7319	143	-0.034	0.618	inWater	224.96		
24/03/2025 07:58	-54.451	-38.1006	214	A23a_shelf	100/200		3.240906	33.7327	144	-0.036	0.602	outWater	225.24		Picked for: Direct resp, CHN (nmj); zoo phys
24/03/2025 07:45	-54.451	-38.1006	214	A23a_shelf	100/200	175	3.244659	33.7312	141	-0.035	0.602	atDepth	225.5		
24/03/2025 07:33	-54.451	-38.1006	214	A23a_shelf	100/200		3.24765	33.739	143	-0.039	0.598	inWater	225.8		
23/03/2025 15:17	-55.0657	-39.2166	209	A23a_fjord	100/200		0.936035	34.0455	53	385.062	0.152	aborted	3536.35	too windy	
23/03/2025 15:10	-55.0656	-39.2175	209	A23a_fjord	100/200		0.943176	34.0372	54	356.275	0.147	inWater	3537.86		
22/03/2025 06:02	-52.8495	-40.0773	204	P3	100/200		4.088837	33.7722	120	-0.036	0.549	outWater	3788.93		Picked for zoo phys
22/03/2025 05:51	-52.8506	-40.0784	204	P3	100/200	200	4.091797	33.7743	127	-0.037	0.541	atDepth	3789.5		
22/03/2025 05:40	-52.8514	-40.0793	204	P3	100/200		4.063477	33.7736	132	-0.043	0.556	inWater	3789.5		
22/03/2025 05:35	-52.8514	-40.0795	203	P3	100/200		4.069336	33.7751	133	-0.037	0.557	outWater	3802.75		Picked for activity; zoo phys
22/03/2025 05:23	-52.852	-40.0807	203	P3	100/200	200	4.098541	33.7752	136	-0.038	0.552	atDepth	3791.09		
22/03/2025 05:12	-52.8525	-40.0819	203	P3	100/200		4.098663	33.7732	137	-0.035	0.548	inWater	3789.79		
22/03/2025 05:06	-52.8528	-40.0825	202	P3	100/200		4.091919	33.7725	133	-0.037	0.537	outWater	3803.47		
22/03/2025 04:54	-52.8537	-40.0837	202	P3	100/200	200	4.101746	33.775	134	-0.037	0.531	atDepth	3801.74		
22/03/2025 04:42	-52.8544	-40.0839	202	P3	100/200		4.094147	33.7725	134	-0.037	0.539	inWater	3789.94		
19/03/2025 12:07	-60.5495	-40.6951	197	BP2_1	100/200		0.580933	33.4934	56	211.479	0.241	outWater	2121.19		
19/03/2025 11:55	-60.5495	-40.695	197	BP2_1	100/200	200	0.567566	33.4935	60	220.066	0.242	atDepth	2123.03		
19/03/2025 11:42	-60.5495	-40.6951	197	BP2_1	100/200		0.58252	33.498	59	171.977	0.238	inWater	2122.55		
19/03/2025 11:34	-60.5496	-40.695	196	BP2_1	100/200		0.59964	33.4989	62	161.657	0.244	outWater	2124.34		Picked for zoo phys
19/03/2025 11:22	-60.5496	-40.6951	196	BP2_1	100/200	200	0.596619	33.5012	63	177.002	0.248	atDepth	2124.15		
19/03/2025 11:08	-60.5496	-40.6951	196	BP2_1	100/200		0.616547	33.504	63	165.401	0.245	inWater	2124.25		
16/03/2025 05:39	-62.0834	-41.9616	177	BP2_4	100/200		-0.06665	33.483	74	-0.039	0.327	outWater	1985.68		Picked for zoo phys
16/03/2025 05:26	-62.0834	-41.9616	177	BP2_4	100/200	200	-0.06656	33.4813	72	-0.044	0.322	atDepth	1986.52		
16/03/2025 05:12	-62.0837	-41.9613	177	BP2_4	100/200		-0.07434	33.4803	75	-0.041	0.334	inWater	1995.76		
16/03/2025 05:06	-62.0837	-41.9613	176	BP2_4	100/200		-0.07697	33.4788	76	-0.038	0.323	outWater	1995.42		
16/03/2025 04:53	-62.0837	-41.9613	176	BP2_4	100/200	200	-0.07538	33.4776	75	-0.043	0.322	atDepth	1987.84		
16/03/2025 04:39	-62.0841	-41.961	176	BP2_4	100/200		-0.07321	33.4793	75	-0.042	0.335	inWater	1993.57		
14/03/2025 04:39	-63.5205	-41.7363	166	M3	100/200		-0.55197	34.0106	87	-0.043	0.455	outWater	4570.61		Picked for zoo phys
14/03/2025 04:26	-63.5205	-41.7363	166	M3	100/200	200	-0.53305	34.0177	86	-0.04	0.448	atDepth	4562.12		
14/03/2025 04:14	-63.5205	-41.7362	166	M3	100/200		-0.51563	34.0088	87	-0.039	0.442	inWater	4562.46		

14/03/2025 04:09	-63.5205	-41.7363	165	M3	100/200		-0.52484	34.0078	92	-0.042	0.443	outWater	4562.44		Picked for zoo phys
14/03/2025 03:58	-63.5205	-41.7362	165	M3	100/200	200	-0.52777	34.0107	88	-0.047	0.448	atDepth	4560.44		
14/03/2025 03:45	-63.5205	-41.7362	165	M3	100/200		-0.54407	34.0169	86	-0.043	0.452	inWater	4570.02		
14/03/2025 02:41	-63.5205	-41.7362	164	M3	100/200		-0.54062	34.0104	98	-0.044	0.455	outWater	4561.12		
14/03/2025 02:26	-63.5205	-41.7362	164	M3	100/200	200	-0.53055	34.0099	97	-0.044	0.505	atDepth	4561.37		
14/03/2025 02:14	-63.535	-41.7822	164	M3	100/200		-0.46317	34.0426	83	62.256	0.536	inWater			
11/03/2025 01:11	-61.9936	-47.0282	157	BP2_6	100/200		0.299774	33.5902	98	-0.033	0.584	outWater	1964.42		
11/03/2025 00:57	-61.9936	-47.0282	157	BP2_6	100/200	200	0.293121	33.5906	95	-0.036	0.592	atDepth	1963.67		
11/03/2025 00:45	-61.9936	-47.0282	157	BP2_6	100/200		0.297455	33.5908	100	-0.035	0.595	inWater	1963.42		
11/03/2025 00:41	-61.9936	-47.0282	156	BP2_6	100/200		0.300201	33.5904	96	-0.039	0.598	outWater	1965.26		Picked for zoo phys
11/03/2025 00:27	-61.9936	-47.0282	156	BP2_6	100/200	200	0.310455	33.5909	97	-0.037	0.594	atDepth	1963.84		
11/03/2025 00:15	-61.9936	-47.0282	156	BP2_6	100/200		0.308289	33.5919	98	-0.035	0.598	inWater	1964.34		
10/03/2025 09:57	-61.9628	-46.936	151	BP2_6	100/200		0.306976	33.5685	79	130.911	0.63	outWater			Picked for activity
10/03/2025 09:44	-61.9946	-47.0166	151	BP2_6	100/200	200	0.288116	33.5705	95	23.176	0.609	atDepth	2012.47		
10/03/2025 09:33	-61.9946	-47.0166	151	BP2_6	100/200		0.322266	33.5694	103	17.797	0.607	inWater	2013.48		
10/03/2025 09:28	-61.9946	-47.0166	150	BP2_6	100/200		0.294403	33.5703	100	14.307	0.607	outWater	2012.47		Picked for zoo phys
10/03/2025 09:15	-61.9946	-47.0167	150	BP2_6	100/200	200	0.288971	33.57	99	9.401	0.612	atDepth	2013.23		
10/03/2025 09:04	-61.9946	-47.0166	150	BP2_6	100/200		0.301636	33.5701	96	5.402	0.606	inWater	2013.4		
08/03/2025 10:01	-62.0661	-50.4802	138	BP2_8	100/200		-0.67719	33.3139	98	44.755	0.512	outWater	3417.46		Picked for:
08/03/2025 09:48	-62.0663	-50.4795	138	BP2_8	100/200	200	-0.67801	33.3144	98	28.32	0.497	atDepth	3417.29		
08/03/2025 09:36	-62.0665	-50.479	138	BP2_8	100/200		-0.68381	33.3167	94	29.103	0.49	inWater	3417.79		
08/03/2025 09:33	-62.0665	-50.4788	137	BP2_8	100/200		-0.68564	33.317	98	23.2	0.491	outWater	3418.21		Picked for: CHNT0 (nmj); zoo phys
08/03/2025 09:20	-62.0667	-50.4782	137	BP2_8	100/200	200	-0.68179	33.3188	97	12.779	0.485	atDepth	3417.62		
08/03/2025 09:08	-62.0669	-50.4776	137	BP2_8	100/200		-0.67737	33.3272	94	6.744	0.485	inWater	3419.3		
08/03/2025 09:04	-62.0669	-50.4776	136	BP2_8	100/200		-0.70456	33.3523	95	5.729	0.477	outWater	3417.62		Preserved
08/03/2025 08:51	-62.0669	-50.4774	136	BP2_8	100/200	200	-0.67166	33.3246	90	3.457	0.483	atDepth	3417.71		
08/03/2025 08:41	-62.0669	-50.4774	136	BP2_8	100/200		-0.66666	33.3217	92	1.723	0.486	inWater	3425.86		
08/03/2025 00:16	-62.0689	-50.4753	133	BP2_8	100/200		-0.57767	33.28	92	-0.04	0.469	outWater	0		Picked for:
08/03/2025 00:05	-62.0689	-50.4753	133	BP2_8	100/200	200	-0.58994	33.2866	96	-0.038	0.464	atDepth	0		
07/03/2025 23:54	-62.0689	-50.4753	133	BP2_8	100/200		-0.58695	33.2833	95	-0.039	0.462	inWater	0		
07/03/2025 23:47	-62.0689	-50.4753	132	BP2_8	100/200		-0.60538	33.3081	96	-0.04	0.459	outWater	0		Preserved
07/03/2025 23:36	-62.0689	-50.4753	132	BP2_8	100/200	200	-0.58102	33.2836	97	-0.04	0.463	atDepth	0		
07/03/2025 23:25	-62.0689	-50.4753	132	BP2_8	100/200		-0.58197	33.2841	95	-0.038	0.467	inWater	0		
07/03/2025 23:18	-62.0689	-50.4753	131	BP2_8	100/200		-0.57739	33.2836	91	-0.04	0.465	outWater	0		Picked for activity; zoo phys
07/03/2025 23:04	-62.0689	-50.4753	131	BP2_8	100/200	200	-0.58347	33.2847	96	-0.025	0.464	atDepth	0		
07/03/2025 22:51	-62.0689	-50.4753	131	BP2_8	100/200		-0.58057	33.2831	97	0.043	0.463	inWater	3418.45		
06/03/2025 09:00	-60.8356	-48.1401	125	BP2_7	100/200		0.439178	33.6483	83	264.663	0.656	outWater	2608.9		
06/03/2025 08:48	-60.5402	-47.6583	125	BP2_7	100/200	200	0.341187	33.5065	98	4.074	0.614	atDepth	1509.39		
06/03/2025 08:35	-60.5401	-47.6573	125	BP2_7	100/200		0.308289	33.5107	94	1.474	0.624	inWater	1499.84		
06/03/2025 08:29	-60.54	-47.6571	124	BP2_7	100/200		0.298645	33.5096	93	1.035	0.628	outWater	1496.31		Picked for zoo phys

06/03/2025 08:16	-60.5399	-47.6563	124	BP2_7	100/200	200	0.273254	33.515	92	0.181	0.634	atDepth	1482.94		
06/03/2025 08:05	-60.5398	-47.6557	124	BP2_7	100/200		0.274841	33.5147	92	0.027	0.634	inWater	1477.63		
03/03/2025 04:47	-60.6667	-42.2534	107	BP2_3	100/200		-0.08069	33.7163	109	-0.042	0.417	outWater	1529.99		Picked for zoo phys
03/03/2025 04:33	-60.6667	-42.2534	107	BP2_3	100/200	200	-0.07544	33.7184	106	-0.045	0.424	atDepth	1529.53		
03/03/2025 04:23	-60.6667	-42.2534	107	BP2_3	100/200		-0.07587	33.7203	110	-0.04	0.424	inWater	1529.81		
03/03/2025 04:16	-60.6667	-42.2534	106	BP2_3	100/200		-0.05747	33.7178	104	-0.039	0.43	outWater	1529.49		Picked for zoo phys
03/03/2025 04:05	-60.6667	-42.2534	106	BP2_3	100/200	200	-0.07123	33.7171	106	-0.039	0.417	atDepth	1529.51		
03/03/2025 03:54	-60.6667	-42.2534	106	BP2_3	100/200		-0.06479	33.7168	107	-0.042	0.413	inWater	1529.37		
03/03/2025 02:50	-60.6667	-42.2534	105	BP2_3	100/200		-0.06586	33.719	102	-0.039	0.421	outWater	1530.11		Picked for: activity
03/03/2025 02:38	-60.6667	-42.2534	105	BP2_3	100/200	200	-0.07541	33.7181	109	-0.042	0.423	atDepth	1528.82		
03/03/2025 02:26	-60.6668	-42.2534	105	BP2_3	100/200		-0.07367	33.7193	106	-0.043	0.428	inWater	1527.43		
03/03/2025 02:21	-60.6677	-42.2564	104	BP2_3	100/200		-0.08508	33.7174	105	17.898	0.486	outWater	1483.25		Preserved
03/03/2025 02:08	-60.6668	-42.2533	104	BP2_3	100/200	200	-0.08606	33.72	110	-0.04	0.428	atDepth	1526.07		
03/03/2025 01:55	-60.6676	-42.2561	104	BP2_3	100/200		-0.08362	33.7159	109	16.264	0.486	inWater			
01/03/2025 01:48	-59.0497	-30.8287	100	A23-40	100/200		0.877106	33.5317	90	-0.045	0.372	outWater	3165.64		Picked for zoo phys
01/03/2025 01:35	-59.0501	-30.8298	100	A23-40	100/200	200	0.881012	33.5305	90	-0.044	0.374	atDepth	3165.83		
01/03/2025 01:24	-59.0502	-30.8304	100	A23-40	100/200		0.865662	33.5255	93	-0.043	0.37	inWater	3164.71		
01/03/2025 01:17	-59.0502	-30.8304	099	A23-40	100/200		0.865234	33.5272	91	-0.039	0.371	outWater	3166.24		Preserved
01/03/2025 01:04	-59.0502	-30.8304	099	A23-40	100/200	200	0.87851	33.532	90	-0.042	0.367	atDepth	3166.55		
01/03/2025 00:52	-59.0502	-30.8304	099	A23-40	100/200		0.87796	33.5367	88	-0.04	0.361	inWater	3166.18		
27/02/2025 23:29	-61.1091	-31.0411	093	A23-33	100/200		0.255676	33.6935	74	-0.04	0.314	outWater	2548.56		Picked for zoo phys
27/02/2025 23:15	-61.1092	-31.0411	093	A23-33	100/200	200	0.253357	33.6962	73	-0.038	0.309	atDepth	2523.72		
27/02/2025 23:04	-61.1092	-31.0411	093	A23-33	100/200		0.264954	33.7121	76	-0.045	0.302	inWater	2523.54		
27/02/2025 22:51	-61.1091	-31.0411	092	A23-33	100/200		0.250458	33.7102	70	-0.039	0.312	outWater	2517.82		Preserved
27/02/2025 22:41	-61.1092	-31.0411	092	A23-33	100/200	200	0.259674	33.6965	78	-0.043	0.31	atDepth	2527.78		
27/02/2025 22:28	-61.1091	-31.0411	092	A23-33	100/200		0.261841	33.6952	73	-0.041	0.308	inWater	2529.97		
23/02/2025 03:25	-57.4585	-31.3353	082	A23-44	100/200		1.812988	33.8373	76	-0.035	0.512	outWater	3779.66		Picked for activity
23/02/2025 03:12	-57.4584	-31.3335	082	A23-44	100/200	200	1.840576	33.8364	83	-0.041	0.515	atDepth	3776.26		
23/02/2025 03:02	-57.4584	-31.3326	082	A23-44	100/200		1.872925	33.8344	77	-0.042	0.513	inWater	3775.08		
23/02/2025 02:56	-57.4584	-31.3326	081	A23-44	100/200		1.878357	33.8351	82	-0.038	0.512	outWater	3774.81		Picked for: Direct resp, CHN, CHNT, lipids (nmj);
23/02/2025 02:45	-57.4583	-31.3315	081	A23-44	100/200	200	1.87796	33.8348	80	-0.037	0.534	atDepth	3774.43		
23/02/2025 02:35	-57.4583	-31.3305	081	A23-44	100/200		1.875366	33.835	83	-0.037	0.531	inWater	3774.11		
23/02/2025 02:29	-57.4583	-31.3303	080	A23-44	100/200		1.881622	33.8328	81	-0.043	0.535	outWater	3774.19		Picked for zoo phys
23/02/2025 02:18	-57.4582	-31.3293	080	A23-44	100/200	200	1.887238	33.833	81	-0.035	0.533	atDepth	3775.16		
23/02/2025 02:07	-57.4582	-31.3286	080	A23-44	100/200		1.884155	33.8327	82	-0.04	0.533	inWater	3775.44		
22/02/2025 06:54	-55.7107	-33.7769	076	A23-49	100/200		2.328949	33.8478	114	0.116	0.541	outWater	3163.66		Preserved
22/02/2025 06:41	-55.7131	-33.7782	076	A23-49	100/200	200	2.329376	33.8473	106	-0.011	0.548	atDepth	3525.74		
22/02/2025 06:29	-55.7153	-33.7794	076	A23-49	100/200		2.337006	33.8472	98	-0.035	0.538	inWater	3507.58		
22/02/2025 06:22	-55.7163	-33.78	075	A23-49	100/200		2.3479	33.8494	122	-0.038	0.551	outWater	3576.3		Picked for: Direct resp, CHN,

															CHNT0 (nmj); zoo phys
22/02/2025 06:11	-55.7179	-33.7808	075	A23-49	100/200	200	2.353607	33.8488	105	-0.036	0.547	atDepth	3522.88		
22/02/2025 05:58	-56.3802	-32.87	075	A23-49	100/200		2.216675	33.7869	70	212.629	0.569	inWater			
21/02/2025 08:54	-54.3401	-35.2497	070	transitA23	100/200		2.939728	33.806	78	36.187	0.497	outWater	365.89		Picked for: CHNT0 (nmj);
21/02/2025 08:38	-54.3401	-35.2497	070	transitA23	100/200	200	2.933746	33.8074	82	25.98	0.494	atDepth	365.26		
21/02/2025 08:27	-54.3401	-35.2497	070	transitA23	100/200		2.940979	33.8069	82	19.858	0.494	inWater	365.65		
21/02/2025 08:21	-54.3401	-35.2497	069	transitA23	100/200		2.938934	33.8063	79	20.059	0.488	outWater	365.55		Picked for: activity
21/02/2025 08:11	-54.3401	-35.2497	069	transitA23	100/200	200	2.924591	33.8078	78	29.681	0.48	atDepth	365		
21/02/2025 07:59	-54.3401	-35.2497	069	transitA23	100/200		2.921295	33.809	78	18.951	0.487	inWater	365.6		
21/02/2025 07:54	-54.3401	-35.2497	068	transitA23	100/200		2.914459	33.8117	82	9.881	0.486	outWater	364.23		Preserved
21/02/2025 07:41	-54.3401	-35.2497	068	transitA23	100/200	200	2.910675	33.8114	79	8.166	0.487	atDepth	365.29		
21/02/2025 07:30	-54.3401	-35.2497	068	transitA23	100/200		2.930603	33.8106	82	3.123	0.487	inWater	365.16		
20/02/2025 01:51	-53.6738	-37.7407	062	targetECB	100/200		3.285431	33.626	82	-0.039	0.898	outWater	123.64		
20/02/2025 01:45	-53.6738	-37.7407	062	targetECB	100/200	100	3.269714	33.6264	85	-0.039	0.895	atDepth	123.81		
20/02/2025 01:40	-53.6738	-37.7407	062	targetECB	100/200		3.274292	33.6264	84	-0.04	0.898	inWater	123.76		
20/02/2025 01:34	-53.6738	-37.7407	061	targetECB	100/200		3.245026	33.6294	83	-0.039	0.89	outWater	124.65		Picked for: Direct resp, CHN, CHNT0 (nmj); zoo phys
20/02/2025 01:29	-53.6738	-37.7407	061	targetECB	100/200	100	3.260895	33.6274	85	-0.038	0.895	atDepth	124.16		
20/02/2025 01:23	-53.6738	-37.7407	061	targetECB	100/200		3.256042	33.6247	85	-0.041	0.895	inWater	122.39		
18/02/2025 06:12	-53.7125	-37.9134	050	WCB3.2Sst	100/200		2.720154	33.7641	84	-0.041	0.587	outWater	117.39		Picked for:
18/02/2025 06:06	-53.7125	-37.9134	050	WCB3.2Sst	100/200	75	2.727203	33.7647	83	-0.039	0.582	atDepth	117.11		
18/02/2025 06:03	-53.7125	-37.9134	050	WCB3.2Sst	100/200		2.714447	33.7653	83	-0.038	0.577	inWater	117.86		
18/02/2025 05:57	-53.7125	-37.9134	049	WCB3.2Sst	100/200		2.706299	33.7645	88	-0.039	0.583	outWater	118.84		Preserved
18/02/2025 05:53	-53.7125	-37.9134	049	WCB3.2Sst	100/200	75	2.706299	33.7645	88	-0.039	0.583	atDepth	118.84		
18/02/2025 05:46	-53.7125	-37.9134	049	WCB3.2Sst	100/200		2.712463	33.7637	84	-0.044	0.582	inWater	117.87		
15/02/2025 03:32	-52.8886	-40.1169	032	P3	100/200		3.790985	33.7827	76	-0.037	0.288	outWater	3794.61		Picked for activity
15/02/2025 03:21	-52.8886	-40.117	032	P3	100/200	200	3.790955	33.7824	78	-0.039	0.287	atDepth	3794.89		
15/02/2025 03:11	-52.8886	-40.117	032	P3	100/200		3.786621	33.7828	79	-0.044	0.293	inWater	3795.2		
15/02/2025 03:05	-52.8886	-40.117	031	P3	100/200		3.784943	33.7824	77	-0.041	0.298	outWater	3795.17		
15/02/2025 02:52	-52.8886	-40.117	031	P3	100/200	200	3.787018	33.7821	76	-0.044	0.296	atDepth	3795.67		
15/02/2025 02:40	-52.8886	-40.117	031	P3	100/200		3.786957	33.7814	78	-0.037	0.309	inWater	3795.12		
15/02/2025 02:35	-54.0516	-39.1289	030	P3	100/200		3.560486	33.795	96	429.51	0.559	outWater	461.63		Picked for: Direct Resp, CHN, CHNT0, and lipids (nmj); zoo phys
15/02/2025 02:19	-52.8886	-40.117	030	P3	100/200	200	3.810242	33.7799	75	-0.037	0.323	atDepth	3795.24		
15/02/2025 02:04	-52.8886	-40.117	030	P3	100/200		3.785034	33.7824	77	-0.038	0.329	inWater	3800.36		
10/02/2025 04:00	-52.8054	-40.1181	011	P3	100/200		4.118011	33.8019	131	-0.038	0.39	outWater	3783.11	test	Picked for zoo phys
10/02/2025 03:54	-52.8053	-40.1181	011	P3	100/200	50	4.119293	33.8018	145	-0.037	0.384	atDepth	3783.19	test	

10/02/2025 03:51	-52.8054	-40.1181	011	P3	100/200		4.119354	33.8016	132	-0.035	0.352	inWater	3783.02	test	

Table 3.4.1.1 Table of Bongo net deployments on SD046

3.4.2 MOCNESS Netting

Author: Geraint Tarling

MOCNESS nets were used to obtain depth discrete catches of the mesozooplankton community from mesopelagic depths to the surface. It was deployed intermittently during the Western Core Box and BIOPOLE phases of SD046.

There were some difficulties with the Biowire and the Down Wire Net Monitor at various points which restricted the deployment of this instrument somewhat. There was also a bucket lost (bucket 9) at E26 at the Eastern Core Box.

The net was paid out at 0.3 m/s and hauled in at 0.3 m/s with a ship speed of ~2 knots.

We applied a specific protocol to the processing of the net buckets once they arrived on deck, as follows: (1) Each cod-end was placed in a bucket and covered immediately with a black plastic bag, (2) all buckets were carried to Controlled temperature room CT1 where red light conditions were maintained (3) cod ends were emptied into buckets and rinsed with filtered seawater, (4) a shallow and deep net transferred under cover to the Dark Lab for further examination and copepods extracted where present (5) all other nets were taken into the Deck Lab and split using a Folsom Splitter (6) one half of the catch was preserved in 4% buffered formaldehyde and the other half used for picking out specimens for physiological experiments (the remainder from this half was not retained) (7) the same protocol was applied to the two samples taken the Dark Lab with the copepods removed added to the sample label (note numbers of copepods extracted presplit must be divided by two for quantitative purposes)

Start, End	Position	Station	Event number	Net	Max wire out	Opening depth (m)	Speed through water (knots)	Comments
16/03/2025 22:02:00	-62.07468, -42.19281	BP2_4	182	9	38.50295	5	2.2	
16/03/2025 21:55:00	-62.07513, -42.18038	BP2_4	182	9	223.0434	5	1.9	
16/03/2025 21:44:28	-62.07568, -42.16514	BP2_4	182	8	449.6231	125	1.8	
16/03/2025 21:31:32	-62.07624, -42.14976	BP2_4	182	7	678.634	250	1.8	
16/03/2025 21:18:28	-62.07674, -42.13555	BP2_4	182	6	889.7427	375	2	
16/03/2025 21:06:25	-62.07729, -42.12055	BP2_4	182	5	1112.627	500	2.1	
16/03/2025 20:53:42	-62.07781, -42.10615	BP2_4	182	4	1326.683	625	2	
16/03/2025 20:41:29	-62.07828, -42.09329	BP2_4	182	3	1517.723	750	1.8	

16/03/2025 20:30:35	-62.07866, -42.08254	BP2_4	182	2	1671.727	875	2	
16/03/2025 20:21:28	-62.08274, -41.97	BP2_4	182	1	0	1000	2.1	
10/03/2025 03:09:00	-61.99465, -47.01647	BP2_6	146	1	0	0	See below	
10/03/2025 01:12:57	-61.96815, -47.05612	BP2_6	146	1	1573.1	1000	2.4 (average)	
10/03/2025 00:08:59	-61.99579, -47.00904	BP2_6	146	1	0	0	See above	Trigger mechanism failed. Net 1 only double oblique Retained for preservation
15/02/2025 01:24:11	-52.88409, -40.11153	P3	29	9	20.64498	5	3.5	
15/02/2025 01:13:28	-52.8793, -40.1057	P3	29	9	229.1903	125	3.7	
15/02/2025 01:06:32	-52.8762, -40.10194	P3	29	8	431.7239	250	3.5	
15/02/2025 00:58:24	-52.87256, -40.09751	P3	29	7	633.5316	375	3.5	
15/02/2025 00:49:36	-52.86863, -40.09273	P3	29	6	874.6124	500	3.5	
15/02/2025 00:42:09	-52.86529, -40.08868	P3	29	5	1092.193	625	3.8	
15/02/2025 00:35:14	-52.86221, -40.08492	P3	29	4	1294.274	750	3.8	
15/02/2025 00:29:02	-52.85941, -40.08153	P3	29	3	1475.36	875	3.5	
15/02/2025 00:24:00	-52.85717, -40.07881	P3	29	2	1604.549	1000	3.5	
14/02/2025 23:12:00	-52.82496, -40.03968	P3	29	1	2.105736	0	3.3	In water
13/02/2025 22:46:59	-54.07847, -36.26125	ECB	26	9	15.46679	5 (closed)	2.8	
13/02/2025 22:42:20	-54.08084, -36.25979	ECB	26	9	41.92614	25	2.8	
13/02/2025 22:40:16	-54.08191, -36.25914	ECB	26	8	78.19274	50	2.8	
13/02/2025 22:38:01	-54.08309, -36.25841	ECB	26	7	117.6103	75	3.1	
13/02/2025 22:35:32	-54.08437, -36.25761	ECB	26	6	161.0483	100	2.9	
13/02/2025 22:33:15	-54.08559, -36.25689	ECB	26	5	200.9299	125	3.2	
13/02/2025 22:30:54	-54.08728, -36.25585	ECB	26	4	258.0577	150	3.5	
13/02/2025 22:28:54	-54.08785, -36.25549	ECB	26	3	274.8781	175	2.7	
13/02/2025 22:26:46	-54.08896, -36.25482	ECB	26	2	298.024	200	2.7	

13/02/2025 22:07:00	-54.09902, -36.24865	ECB	26	1	15.46679	0	1.2	In water

Table 3.4.2.1 Details of MOCNESS deployments on SD046

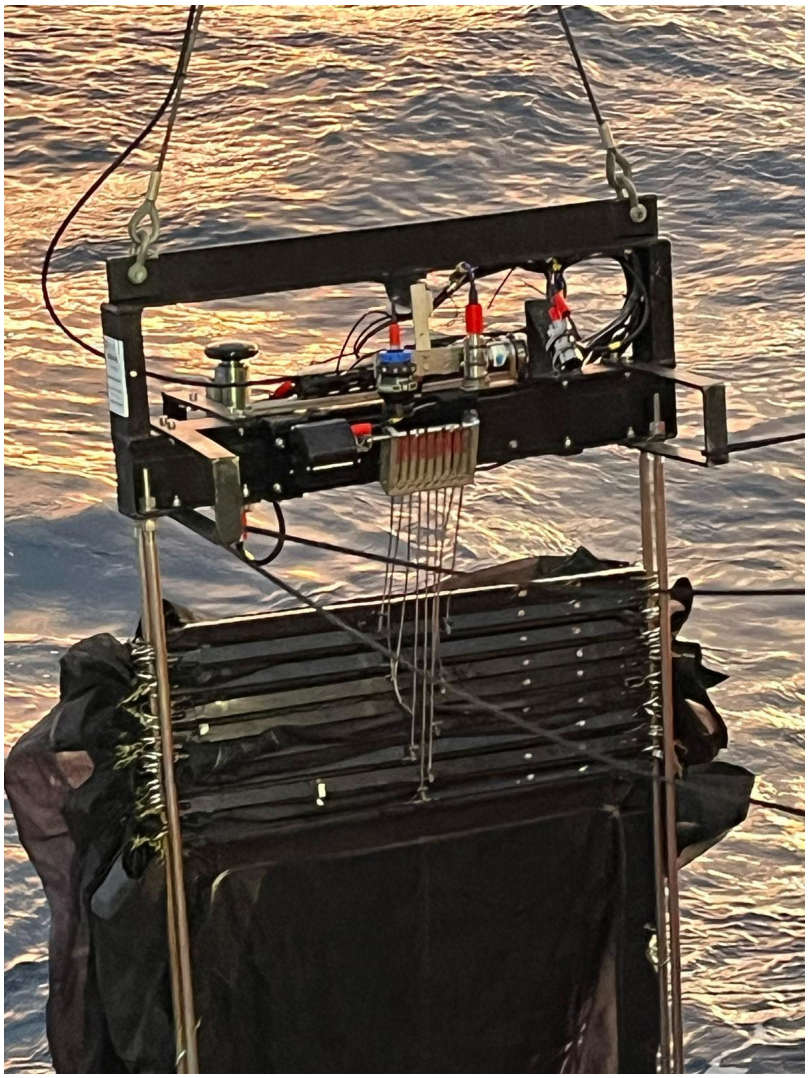


Fig 3.4.2.1 net during deployment showing instruments on top frame

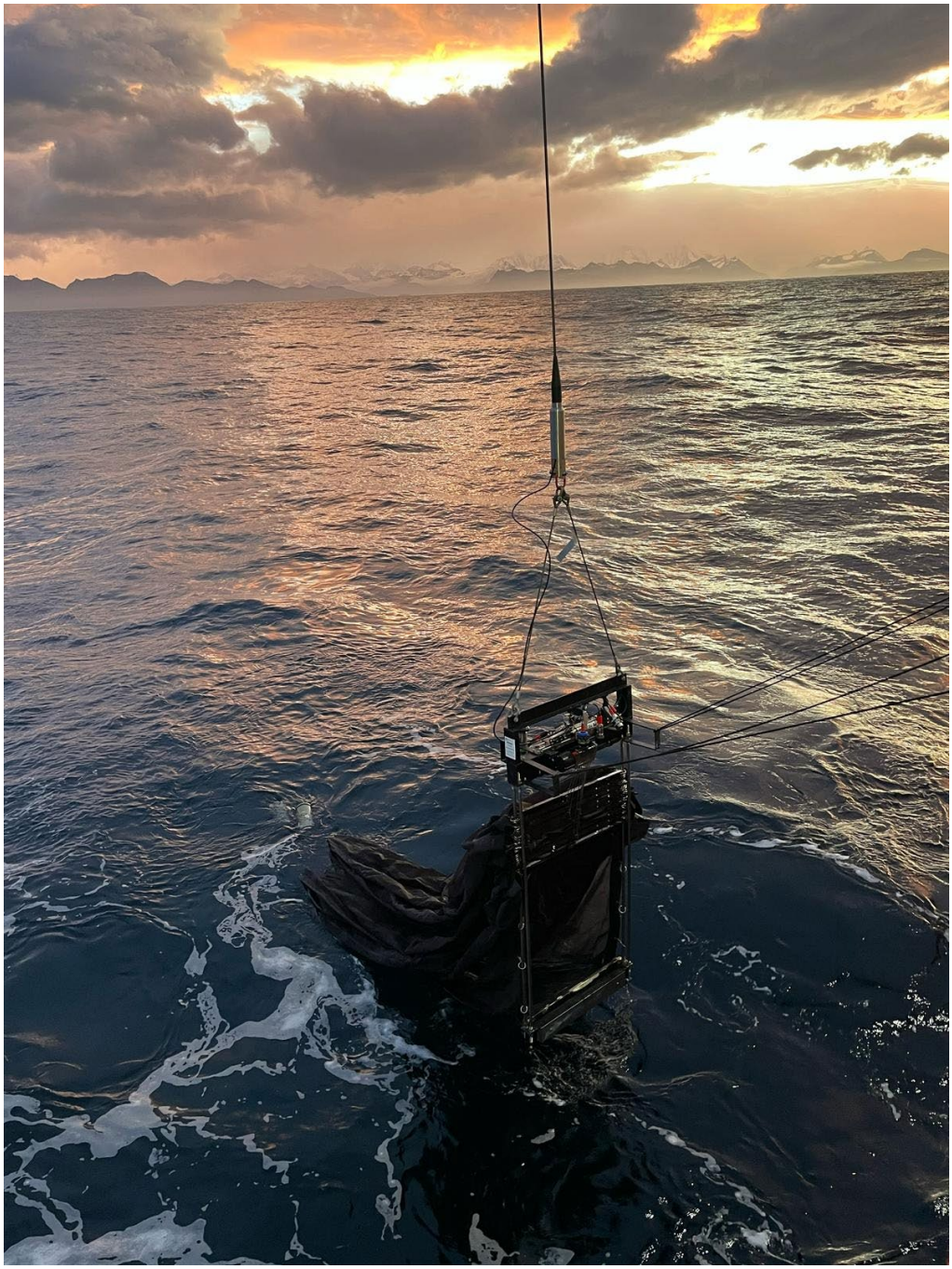


Fig. 3.4.2.2 MOCNESS net during deployment

3.4.3 Mammoth Netting

Author: Geraint Tarling

Mammoth nets were used to obtain depth discrete catches of the mesozooplankton community from mesopelagic depths to the surface. It was mainly deployed during the BIOPOLE phase of SD046, with a test station along the A23 transect and an extra deep deployment to 2000 m at station P3 at the end of the cruise.

The initial strategy was to obtain samples from 1000 m to the surface in 125 m intervals, which occurred at station BP2_3 and BP2_7. We changed this to sample down to 1300 m in all subsequent stations, which meant extending the depth intervals of the deepest two depth intervals to 300 m and 250 m respectively. At P3, the net obtained samples down to 2000 m, with each net interval being 250 m.

The Mammoth net was severely damaged at Station 2_3 as a result of large swell and the pitching of the aft end of the ship over which the net was deployed. Repairs reduced the number of closing bars from 9 to 8 for all subsequent deployments. The majority of further deployments were over the starboard side.

The net was paid out between 0.3 and 0.5 m/s and hauled in at 0.3 m/s

The strategy was to pick for physiological experiments from the nighttime sample. This catch was not subsequently preserved unless it was thought that it was the only catch possible at a station. The catch during the daytime was preserved in 4% buffered formaldehyde intact apart from a small number of copepods removed for respiration experiments (Nadine Johnston) that were logged on the sample labels.

Times	Position (Lat, Long)	Station	Event number	Max wire out	Net depth intervals (m)	Comments
22/03/2025 00:15:00 to 04:02:00	-52.85512, -40.08662	P3	201	2300	2000-1750, 1750-1500, 1500-1250, 1250-1000, 1000-750, 750-500, 500-250, 250-5	Starboard deployment. Catch preserved minus picking for respiration
19/03/2025 07:41:00 to 10:20:00	-60.54716, -40.69362	BP2_1	195	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch preserved minus picking for respiration
19/03/2025 03:46:00 to 06:21:00	-60.54712, -40.69355	BP2_1	193	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Mammoth ran out of battery and released did not function after Net 5. Integrated 500 to surface.

						Catch used for picking
18/03/2025 01:37:00 to 04:27:00	-60.66465, -42.13016	BP2_3/OP2	188	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking
17/03/2025 18:31:00 to 21:12:00	-60.64121, -42.23005	BP2_3/OP2	186	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch preserved minus picking for respiration
16/03/2025 01:08:00 to 04:05:00	-62.08454, -41.96136	BP2_4	175	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking
15/03/2025 21:30:00 to 00:04:00	-62.08435, -41.96215	BP2_4	174	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch preserved minus picking for respiration
10/03/2025 20:58:00 to 23:37:00	-61.99362, -47.02818	BP2_6	155	1550	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch preserved minus picking for respiration
10/03/2025 04:41:00 to 07:16:00	-61.99363, -47.02873	BP2_6	148	1550	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking
10/03/2025 04:25 to 04:32	-61.99364, -47.02871		147			Aborted
08/03/2025 17:24 to 20:02	-62.06793, -50.47511	BP2_8	140	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Aft deployment Starboard deployment. Catch preserved minus picking for respiration
08/03/2025 05:05 to 07:58	-62.06846, -50.47538	BP2_8	135	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking

08/03/2025 01:09:00 to 04:05:00	-62.06877, -50.4752	BP2_8	134	1500	1300-1000, 1000-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking
06/03/2025 02:32:00 to 05:18	-60.54013, -47.65359	BP2_7	122	1300	1000-875, 875-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch preserved minus picking for respiration
05/03/2025 22:44:00 to 01:42:00	-60.54001, -47.65384	BP2_7	121	1300	1000-875, 875-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-5	Starboard deployment. Catch used for picking and then preserved. Only 8 nets after repair
05/03/2025 20:46:00 to 21:26:00	-60.49995, -47.60045	BP2_7	120	250	200-0 in 20 m depth intervals	Test. Catch not retained
02/03/2025 18:55:00 to 21:13:00	-60.66693, -42.25304	BP2_3	103	1300	1000-875, 875-750, 750-625, 625-500, 500-375, 375-250, 250-125, 125-62.5, 62.5-5	Deployed over aft. Nets returned with significant damage. Several cod-ends lost. No sample. Significant swell
28/02/2025 18:21 to 18:58:00	-59.43581, -30.86015	A23-39	97	250	200-0 in 20 m intervals	Test – catch not retained

Table 3.4.3.1: Details of Mammoth deployments on SD046

Fig 3.4.3.1: Starboard deployment of Mammoth net

Fig 3.4.3.2: Starboard deployment of Mammoth once deployed

Fig 3.4.3.3: Aft deployment of Mammoth

Fig 3.4.3.4: Aft deployment of Mammoth once deployed

3.4.4 RMT Netting

Author: Sophie Fielding

WCB stratified stations – nets were deployed at 2 – 2.5 knots. The first net was opened at 10m and wire was paid out until the net reached 200m (or shallower depending on water depth) over the course of 30 minutes. The net was closed and the second net opened. This net was fished from 200m to approximately 10m for 30 minutes. The net open on the way down is preserved, the net fished up is sorted and picked from.

WCB target stations – nets were deployed at 2 – 2.5 knots. A target on the echosounder is identified as the ship is heading downwind. The ship continues a mile and then turns ready to deploy the net. The net is lowered to the target depth. The echosounder, alongside the underwater camera are used to confirm when the net is in a swarm. Depending on swarm thickness the net is fished for 30 seconds to a few minutes.

BP stratified stations – nets were deployed at 2 – 2.5 knots. The net is lowered closed to 500m. Then opened and fished to 250m. The second net is then opened to 10 m. Each net is fished for 30 minutes.

A new down-wire camera system was used to observe whether the nets were firing correctly. The normal colour system worked well, but the lights needed to be turned off except during the closing period. For some nets that auto-fired this was detected by a rapid drop in net depth as the camera was dark at that point. A second UV lamp was tested but picture quality was quite poor.

Station	Event	Date (at depth)	Latitude (at depth)	Longitude (at depth)	Type	Comment	Preserved	Energetics	Length Freq	Joana?
Test	7	08/02/2025	-52.7885	-47.8057	Stratified	Net 2 closed without trigger				
Test	8	08/02/2025	-52.8473	-47.8475	Stratified	Net 2 closed without trigger				
WCB1.2N	36	15/02/2025	-53.4864	-39.2475	Stratified					
WCB1.2S	38	16/02/2025	-53.85933	-39.13359	Stratified					
WCB2.2S	40	16/02/2025	-53.78635	-38.5846	Stratified				X	
	42	17/02/2025	-53.80229	-38.55911	Target				X	
WCB2.2N	43	17/02/2025	-53.43525	-38.6884	Stratified					
	47	18/02/2025	-53.61596	-37.68461	Target				X	
WCB3.2S	48	18/02/2025	-53.69752	-37.88326	Stratified					
	53	19/02/2025	-53.66553	-37.61313	Target				X	
WCB4.2S	54	19/02/2025	-53.68813	-37.64658	Stratified	Net 2 closed at 55m			X	
WCB3.2N	57	19/02/2025	-53.3626	-38.08947	Stratified					
WCB4.2N	59	19/02/2025	-53.33273	-37.7917	Stratified					
ECB	60	19/02/2025	-53.67944	-37.64627	Target				X	
BP2_8	143	09/03/2025	-50.46802	-50.46802	Stratified	500-250-0. Winch stopped variously as wire leading				
BP2_4	184	17/03/2025	-62.05765	-42.30024	Stratified	Nets didn’t open correctly. Closed nets fished through a krill swarm			X	

Table 3.4.4.1 RMT netting on SD046

3.5 Underway sensor data and sampling overview

Authors: Hugh Venables, Sally Thorpe

3.5.1 Underway sensor data

All ship sensors are logged directly into the RVDAS PostgreSQL database. During the cruise, a subset of these, detailed in Section 7.3, were read out and further processed. This involved cleaning data, such as underway oceanographic variables that create bad data around times of low or no flow rate and the EA640 depth data, which can produce very wrong numbers in bad weather, with inappropriate settings or through interference with other acoustic instruments. Efforts have also been made to make data more accessible through averaging and file format conversions, especially during short time periods of interest.

Calibrations have been applied during the cruise to salinity and temperature. The latter will be systematically biased warm due to the position of the sensors, so the calibration could be used with some confidence during cruises without CTD casts. The salinity calibration will not follow on to further cruises. Fluorescence data will be calibrated back in Cambridge.

Processed data are in L:\work\scientific_work_areas\physics\Underway along with the code, as detailed in section 7.3. The full set of sensors and raw data is detailed in Chapter 6.

3.5.2 Underway samples

During SD046, samples of the uncontaminated seawater (UCSW) supply were taken for a variety of measurements at different intervals, summarised in Table 3.5.1. Full details of the samples taken are provided in the underway sample event log.

Table 3.5.1 Daily list of samples taken from the uncontaminated seawater (UCSW) supply during SD046. ● indicates at least one sample was taken on the given day. Nut: nutrients, DOC: dissolved organic carbon, POC/TOC/BSi: particulate organic carbon, total organic carbon, biogenic silica, Chl: chlorophyll *a*/Lugols, Sal: salinity, O18: oxygen isotope, Si: silicon isotope, DIC: dissolved inorganic carbon, BC: black carbon, POM: particulate organic matter, DO: dissolved oxygen (for test purposes). See underway sample event log for full details of all samples taken. No underway samples were taken during 12-13 February 2025 while at Husvik, South Georgia.

Date	Nut	DOC	POC/TOC/ BSi	Chl	Sal	O18	Si	DIC	BC	POM	DO
09/02/2025	●	●	●	●	●						
10/02/2025	●	●	●	●	●	●					
11/02/2025	●			●	●	●					
12/02/2025											
13/02/2025											
14/02/2025	●				●	●					

15/02/2025	●	●	●	●	●	●					
16/02/2025	●	●	●	●	●	●					
17/02/2025	●	●	●		●	●					
18/02/2025	●	●	●		●	●					
19/02/2025	●				●	●					
20/02/2025	●				●	●					
21/02/2025	●	●	●		●	●					
22/02/2025	●	●	●		●	●					
23/02/2025	●	●	●		●	●					
24/02/2025	●				●	●					
25/02/2025	●				●	●					
26/02/2025	●	●	●		●	●					
27/02/2025	●	●	●		●	●					
28/02/2025	●	●	●		●	●					
01/03/2025	●	●	●		●	●					
02/03/2025	●	●	●	●	●	●	●	●			
03/03/2025	●	●	●		●	●	●	●			
04/03/2025	●	●	●	●	●	●	●	●			
05/03/2025	●	●	●	●	●	●	●	●			
06/03/2025	●	●	●	●	●	●	●	●			
07/03/2025	●	●	●	●	●		●	●			
08/03/2025	●				●	●					
09/03/2025	●	●	●	●	●	●	●	●			
10/03/2025	●				●	●					
11/03/2025	●	●	●	●	●	●	●	●			
12/03/2025	●				●	●					
13/03/2025					●						
14/03/2025					●						●
15/03/2025	●	●	●	●	●	●	●	●			
16/03/2025	●				●						●
17/03/2025	●	●	●	●	●	●	●	●			
18/03/2025					●						●
19/03/2025	●	●	●	●	●		●	●			
20/03/2025	●	●	●	●	●	●	●	●			
21/03/2025	●	●	●	●	●	●	●			●	
22/03/2025	●				●						
23/03/2025	●	●	●	●	●	●	●	●	●	●	
24/03/2025	●	●	●	●	●	●		●		●	
25/03/2025	●	●	●	●	●	●				●	
Date	**Nut**	**DOC**	**POC/TOC/ BSi**	**Chl**	**Sal**	**O18**	**Si**	**DIC**	**BC**	**POM**	**DO**

4. Moorings

4.1 Ecosystems moorings

Authors: Sophie Fielding, Simon Wright, Matt Hood

Introduction

Ecosystems had 4 moorings deployed in the Scotia Sea, 3 around South Georgia (P3, WCB and ECB moorings) and 1 near the South Orkneys (BIOPOLE). The three near South Georgia have been deployed annually/bi-annually since ~2005. P3 consists of instruments designed to monitor the carbon cycle, ocean acidification and microplastics. The WCB and ECB moorings consist of instruments designed to monitor krill biomass and distribution and higher predators.

The BIOPOLE mooring has been in place for 2 years (deployed on SD025 in Feb 2023) and is part of the NC-MCS programme BIOPOLE. With two sediment traps, its aim is to look at carbon cycling including over-wintering copepods.

Methodology

P3 mooring

The P3 mooring was deployed during DY158 on 29/12/2022 with the anchor deployed at 52° 51.3'S 40° 05.2'W in 3700m of water, with the expectation of being recovered 2 years later.

The P3 mooring was recovered during SD046 on 09/02/2025. The releases were polled and commanded to release around 16:00 LT. The mooring buoy was not in sight, and a position was received from the iridium beacon.

Download of the CTD on the top buoy indicated the buoy had spent most of its time at 140m, significantly shallower than the desired depth. There were some periods where the top buoy was knocked down to 600m in July 2023.

No CTD was recovered from the lower position, serial number CTD 37 SMP 43742: 4548 from the deployment notes.

An attempt was made to re-deploy the P3 mooring 14/02/2025. The mooring float was deployed into the water, but in the swell the mooring rope jumped a sheeve and got caught in the mooring winch mechanism. The line, part of the long 1700m of rope, was damaged. The mooring buoy was recovered and a decision to defer deployment made.

Due to Polar Ocean's ropes being provided at a longer length than marked, it was possible to use new rope for the entirety of the P3 redeployment. The P3 mooring was redeployed on 22/03/25 as shown in the accompanying drawing. It was trilaterated and the position reported as 52° 51.3767'S, 40° 05.0480'W.

WCB mooring

The WCB mooring was deployed during DY158 on 05/01/2023, with the anchor deployed at 53 47.5'S, 37 23.6 W in approximately 300m water depth.

The WCB mooring was recovered during SD046 on 10/02/2025 as the ship headed into Husvik to calibrate the EK80. Prior to release the mooring was identified on the EK80, allowing the ship to be quite close by for recovery. The buoy and instruments were heavily bio-fouled.

The mooring buoy and instruments were cleaned and data downloaded. The CTD had only worked for one year. The CTD was re-used. The ADCP from P3 was used for deployment, a new WBAT was fitted and new beacons were fitted (new iridium and old Argos from P3). A UVP was suspended 25m below the buoy. Below this a sediment trap and aquadopp current meter were placed and finally a sonovault (25m above the releases)

The WCB mooring was deployed on 18/03/2025, after deployment the ship went over the mooring release position to detect it in the EK80. It was located in the echosounder beams at 53° 47.74'S, 37° 56.58'W (53.7956S, 37.94293W). The deployed arrangement is shown in the accompanying drawing

ECB mooring

The ECB mooring was deployed during DY158 on 06/01/2023 with the anchor deployed at 54° 06.20'S 36° 14.81'W in approximately 275m of water.

The ECB mooring was recovered during SD046 on 13/02/2025. Prior to release the mooring was identified on the EK80, allowing the ship to be close by for recovery. This was fortunate, as on recovery it was evident that both the iridium and VHF beacon had suffered considerable damage and were not working. Similar to the WCB and P3 mooring, there was significant biofouling over both the mooring buoy and instruments.

All the instruments were cleaned and data downloaded. The buoy had sat at ~170m water depth. The shallow CTD (350m depth rating) from P3 was deployed, the ADCP was re-used, and a new WBAT was mounted. The two old iridium beacons (previously deployed on P3 and WCB mooring) were deployed since both beacons previously on the mooring buoy were beyond repair.

The ECB mooring was deployed on 20/03/2025, after deployment the ship went over the mooring release position to detect it in the EK80. It was located in the echosounder beams at 54° 06.21'S, 36° 14.41'W (54.10351S, 36.24010W). The deployed arrangement is shown in the accompanying drawing

BIOPOLE mooring

The BIOPOLE mooring was originally deployed on SD025 (2022). It was recovered on SD034 after concerns that the megaberg A23a would take it away. It was then subsequently re-deployed during SD035 on 05/03/2025 in 3438. The second deployment was in a slightly different location, based on the time constraints of SD035.

The BIOPOLE mooring was recovered on 08/03/2025.

Mooring instrument data tables

All data was downloaded to the working drives \work\scientific_work_areas\Moorings and recorded to individual folders with folder or file numbers including the serial numbers of the instruments.

P3 mooring

P3 instruments and data as recovered 09/02/2025

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
3521	179	Iridium beacon IMEI 300434060651120 (SN M015U5)				
3521	179	Argos Beacon (SN 280, ID 60210)				
3521	179	ADCP WHS-300-I-UG64 (SN15548)	U, V, W	15	29/12/2022 18:00:00 12/04/2024 08:00:00	
3521	179	SBE SMP37 CTD (SN 37-11807)	T,C,P	15	29/12/2022 18:00:01 09/02/2025 21:00:01	Whole dataset recovered. Actual depth ~140 m
3496	204	OPIC	Plastic degradation		29/12/2022 09/02/2025	Dismantled due to heavy corrosion. The upper steel plate was missing, and the motor was detached and sat lose in the frame. Of nine sample tubes, only 3 remained.
1736	1964	Trimsyn buoys (4)				
1716	1984	Sediment Trap (SN 13136-01)	Falling particulate matter	2-4 weeks	01/01/2023 01/03/2024	All samples recovered
1715	1985	Seaguard (SN1309) Current Meter (SN851) and DO (SN 1561)	U,V,W, DO	120	29/12/2022 20:00:00 09/02/2025 22:00:00	Whole dataset recovered
15	3685	Acoustic Release SN 93				

15	3685	Acoustic Release SN 2060				

P3 instruments and data as deployed

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
3496	205	Iridium beacon IMEI 301434061312050 (SN M21UC4)				
3496	205	Argos Beacon 280 (ID – 60210)				
3496	205	ADCP WHS-300-I-UG64 (SN 24636)	U, V, W	15		
3496	205	SBE SMP37 CTD (SN 37-13719)	T,C,P	15		
3471	229	PPS				
1731	1969	Trimsyn buoys (4)				
1711	1989	Sediment Trap (SN 15789-01)	Falling particulate matter	2 -4 weeks	01/04/2025 00:00:01 01/10/2026 00:00:01	
1710	1990	Seaguard (1184) Current Meter and DO	U,V,W, DO	120		
15	3685	Acoustic Release SN 22060086				
15	3685	Acoustic Release SN 22060087				

WCB instruments and data as recovered 10/02/2025

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
92	208	Iridium beacon IMEI 3002340605535030				
92	208	Argos Beacon (SN 251, ID 35520)				
92	208	ADCP WHS-300-I-UG64 (SN7522)	U, V, W	15	06/01/2023 09:00 10/02/2025 18:00	Whole dataset recovered
92	208	SBE SMP37 CTD (SN 37-4852)	T,C,P	15	05/01/2023 09:00:02 22/12/2023 02:45	Partial dataset recovered. Buoy at 180m
92	208	Simrad WBAT echosounder + 120 kHz transducer (SN 279949 + SN147)	Acoustic backscatter (Sv)	60	07/01/2023 01:00 01/02/2024 01:00	Whole dataset recovered
42	258	Sediment Trap (SN 13136-02)	Falling particulate matter	2-4 weeks	06/01/2023 01/03/2024	Whole dataset recovered
41	259	Aquadopp (SN 47547-993), head (SN A6P 11739)	U, V, W, T, P	10	05/01/2023 09:00 10/02/2025 18:00	Whole dataset recovered
40	260	Sonovault passive acoustic hydrophone (SN 25161)	Sound			32 out of 35 SD cards contained data files
15	285	Acoustic Release SN 21020005				
15	285	Acoustic Release SN 21020004				

WCB instruments and data as deployed 18/02/2025 at 53° 47.74'S, 37° 56.58'W (53.7956S, 37.94293W) in 311 m of water

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
		Iridium beacon IMEI 301434061315010 (SN M21UCS)				
		Argos Beacon (SN 251, ID 35520)				
		ADCP WHS-300-I-UG64 (SN15548)	U, V, W	15	In water	
		SBE SMP37 CTD (SN 37-4852)	T,C,P	15		
		Simrad WBAT echosounder + 120 kHz transducer (SN 267815 + SN147)	Acoustic backscatter (Sv)	60	19/02/2025 03:00:00 01/04/2026 00:00:00	
		Underwater Vision Profiler (UVP)	Images of plankton and particulates	0.1 Hz	00:00 19/02/2025	At 0.1 Hz (this is what it is set to) it should acquire images every 10 seconds and run for 714 days.
		Sediment Trap (SN 13176-01)	Sediment	2-4 weeks	20/02/2025 01/07/2026	
		Aquadopp (SN 47547-993), head (SN A6P 11739)	U, V, W, T, P	15	19/02/2025 12:00:01	

		Sonovault passive acoustic hydrophone (SN 25161)	Sound			Sonovault and SD cards were refurbished on the cruise
15	285	Acoustic Release SN 21020005				
15	285	Acoustic Release SN 21020004				

ECB instruments and data as recovered

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
92	208	Iridium beacon IMEI 3002340605535030				
92	208	Argos Beacon (SN 251, ID 35520)				
92	208	ADCP WHS-300-I-UG64 (SN7522)	U, V, W	15	06/01/2023 09:00 10/02/2025 18:00	
92	208	SBE SMP37 CTD (SN 37-4855)	T,C,P	15	05/01/2023 09:00:02 06/03/2024 03:30	Partial dataset recovered. Buoy at 170m
92	208	Simrad WBAT echosounder + 120 kHz transducer (SN 279949 + SN147)	Acoustic backscatter (Sv)	60	07/01/2023 01:00 01/02/2024 01:00	Whole dataset recovered
41	259	Aquadopp (SN 47547-993), head (SN A6P 11739)	U, V, W, T, P	10	05/01/2023 09:00 10/02/2025 18:00	Whole dataset recovered
40	260	Sonovault passive acoustic hydrophone (SN 25228)	Sound			Only 3 SD cards contained data files. The 4th SD card was corrupted and prevented the rest

						of the cards from recording. The instrument was sent back to Cambridge to be serviced
15	285	Acoustic Release SN 21020005				
15	285	Acoustic Release SN 21020004				

ECB instruments and data as deployed 20/03/2025 at 54° 06.21'S, 36° 14.41'W (54.10351S, 36.24010W) in 272 m of water

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
		Iridium beacon IMEI 300034012098770				
		Iridium beacon IMEI 300034013901110				
		ADCP WHS-300-I-UG64 (SN unknown)	U, V, W	15	In water	White plastic ADCP – no serial number
		SBE SMP37 CTD (SN 37-11807)	T,C,P	15		350 m rated CTD
		Simrad WBAT echosounder + 120 kHz transducer (SN 240809 + SN132)	Acoustic backscatter (Sv)	60	21/02/2025 03:00:00 01/04/2026 00:00:00	
		Sonovault passive acoustic hydrophone (SN 1119)	Sound			The instrument was sent refurbished from Cambridge

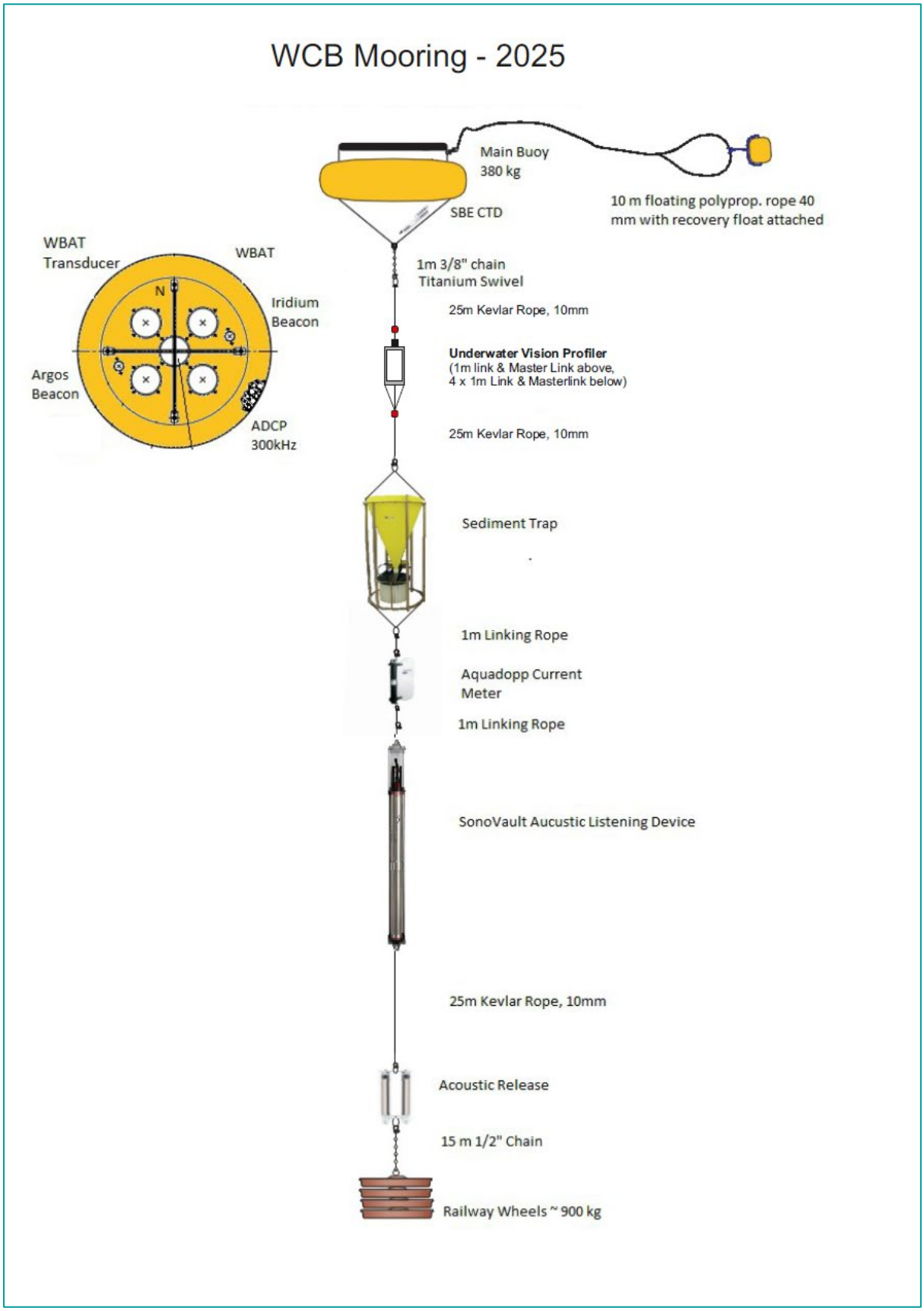
15	285	Acoustic Release SN 093				
15	285	Acoustic Release SN 2060				

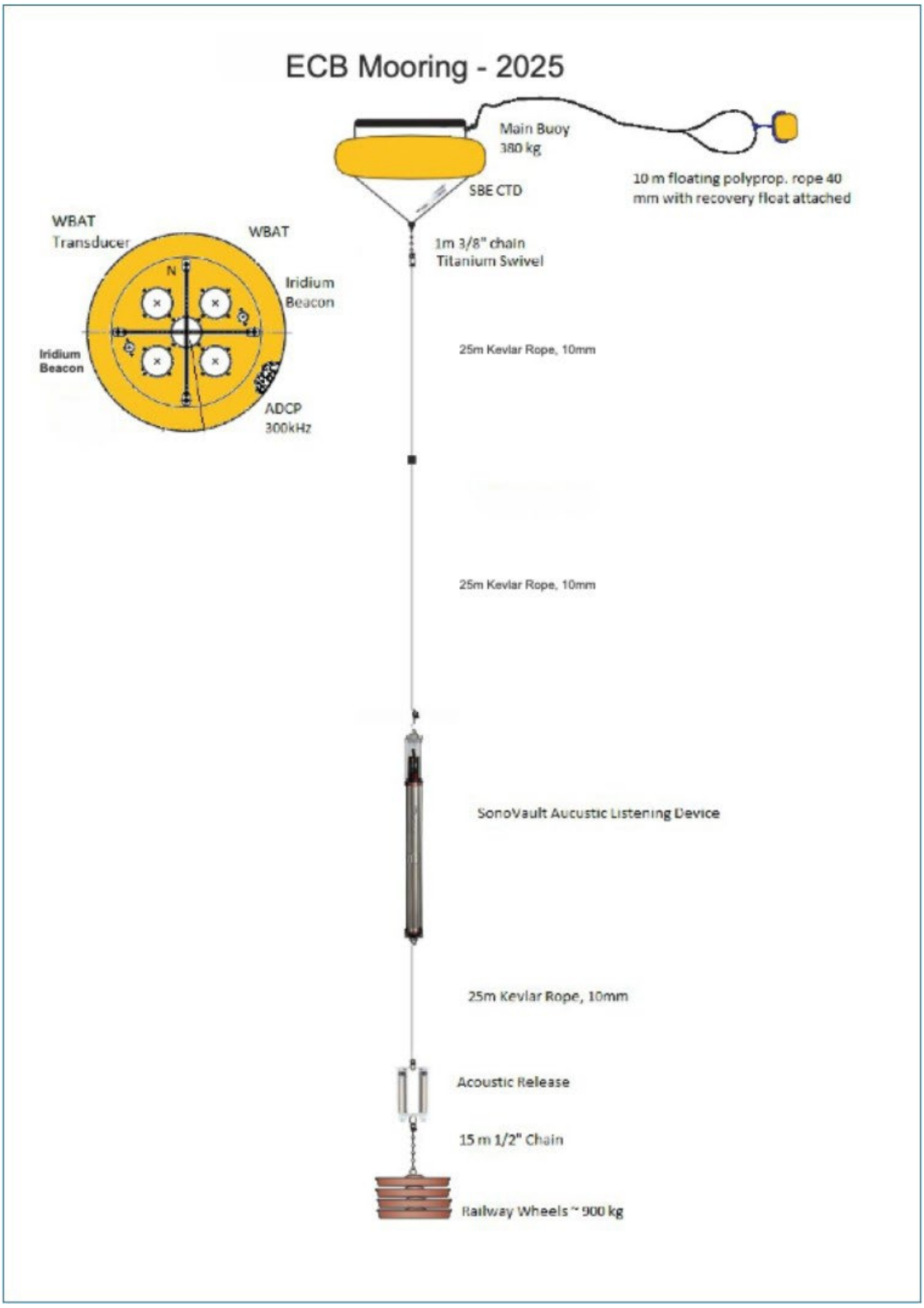
Biopole instruments and data as recovered 08/03/2025

Height above bottom (m)	Nominal Depth (m)	Instrument/SN	Parameters measured	Sample Interval (mins)	Start/stop time UTC (dd/mm/yyyy hh:mm:ss)	Comments
92	208	Argos Beacon (K03-047)				Aerial broken off
92	208	VHF flasher Beacon (SN D07-017)				Didn't appear to work although intact. Plastic cover requires replacement
92	208	ADCP WHS-300-I-UG64 (SN 24636)	U, V, W	60	06/03/2024 16:39 08/03/2025 18:00	Whole dataset recovered
92	208	SBE SMP37 CTD (SN 13719)	T,C,P	60	08/03/2024 00:00:01 08/03/2025 18:00:01	Whole dataset recovered. Surface buoy sat around 110m
92	208	Sediment Trap (SN 15789-01)	Sediment trap	2-4 weeks	06/03/2024 00:00:01 01/04/2025 00:00:01	6 bottles recovered
		Trimsyn Buoys (4)				
42	258	Sediment Trap (SN ML15559-01)	Sediment	2-4 weeks	06/03/2024 00:00:01 01/04/2025 00:00:01	Whole dataset recovered
41	259	Seaguard Current Meter, pressure, turbidity, DO (SN 1184)	U, V, W, T, P, DO	10	08/03/2024 00:10:00 08/03/2025 18:00:00	Whole dataset recovered

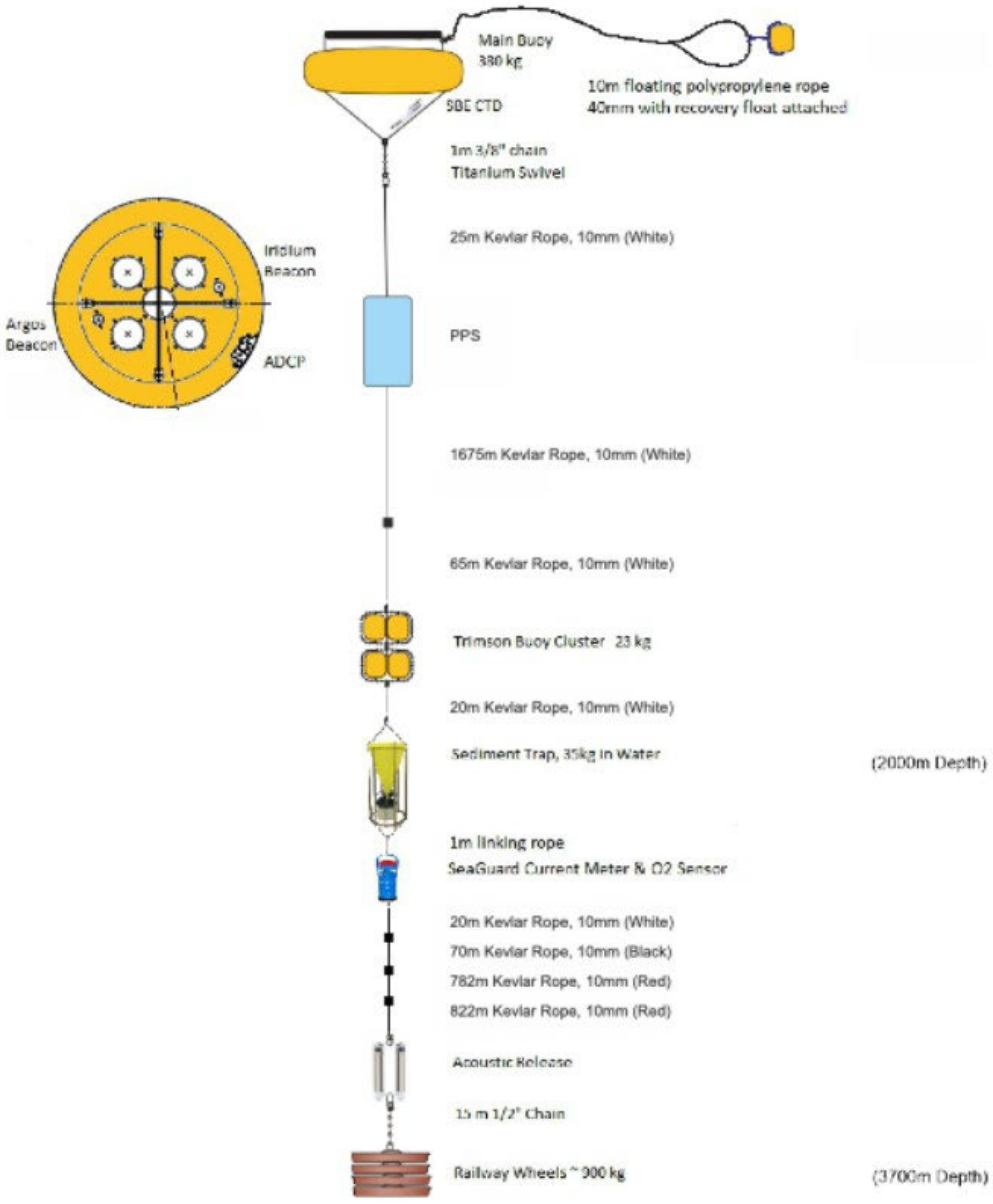
15	285	Acoustic Release SN 2061				
15	285	Acoustic Release SN 513				

Deployed mooring arrangements - Ecosystems




ECB Mooring - 2025
Main Buoy
380 kg
10 m floating polyprop. rope 40 mm with recovery float attached
SBE CTD
WBAT
Transducer
WBAT
1m 3/8" chain
Titanium Swivel
N
Iridium
Beacon
Iridium
Beacon
25m Kevlar Rope, 10mm
ADCP
300kHz
25m Kevlar Rope, 10mm
SonoVault Aucustic Listening Device
25m Kevlar Rope, 10mm
Acoustic Release
15 m 1/2" Chain
Railway Wheels ~ 900 kg

P3 Mooring - 2025



Recommendations

More links!

References

Cardinale BJ, Srivastava DS, Duffy JE, Wright JP, Downing AL, Sankaran M, Jouseau C (2006) Effects of biodiversity on the functioning of trophic groups and ecosystems. Nature 443:989–992.

Maynard AE, Greenfield PM (2005) An Ethnomodel of Teaching and Learning. In: *Learning in Cultural Context: Family, Peers, and School*. International and Cultural Psychology Series, Martini MI (ed) Springer US, Boston, MA, p 75–103

4.1.1 WBATs

Author: Sophie Fielding

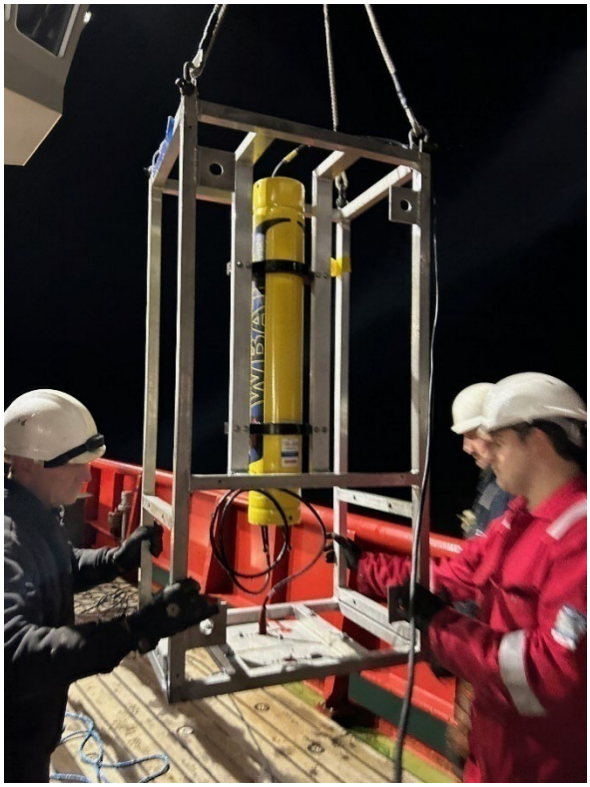
Introduction

Wide Band Acoustic Transceivers (WBATs) are used on the ECB and WCB moorings to collect information on the presence/absence and aggregation type of Antarctic krill. Where possible the 120 kHz transducers attached to these autonomous echosounders are calibrated prior to deployment.

Methodology

The WCB and ECB WBATS deployed from DY158 both worked successfully over the full deployment. Data were retrieved off the memory sticks and placed on the working drive for storage.

Two new WBATS were deployed on the ECB (SN 240809) and WCB (SN 267815) moorings with 120 kHz transducers (SN132 on the ECB and SN 147 on the WCB). Prior to deployment an attempt was made to calibrate each system whilst the ship was in Husvik, by deploying over the side in a bespoke frame and dangling a 38.1 mm sphere under each transducer. This was somewhat challenging as the wind in Husvik made it hard to place the sphere with reliability under the transducer.



Data from the two calibrations was placed in the folder
/working/science_work_area\acoustics\WBAT

Recommendations

Need to consider how to calibrate. The setup, despite working out of the boat access point, was very difficult to know that the sphere was found. Need more consideration regarding how to lower and identify sphere below the transducer.

4.1.2 OPIC, Sediment traps and PPS

Author: Emily Rowlands

Ocean Plastic Incubation Chamber

OPIC, designed to monitor in situ plastic degradation at sea, was deployed as part of the P3 mooring at a depth of 200 m for the first time on 29 December 2022. Upon recovery (10/02/2025 00:40), the OPIC was dismantled due to heavy corrosion. The upper steel plate was missing, and the motor was detached and sat lose in the frame. Of nine sample tubes, only 3 remained. Missing pieces were reported to the SDA safety officer. In the three remaining sample tubes, polymers were removed from the wire and stored at room temperature for analyses in Cambridge. Analyses will include macroscopic measurements of weight loss, changes in size, colour and opacity whilst changes in plastic mechanical properties such as polymer density can be determined through sinking experiments. Surface alteration and erosion will be assessed with a scanning electron microscope (SEM), whilst changes in polymer chemical bond structures will be assessed using Fourier-transform infrared (FTIR) spectroscopy.

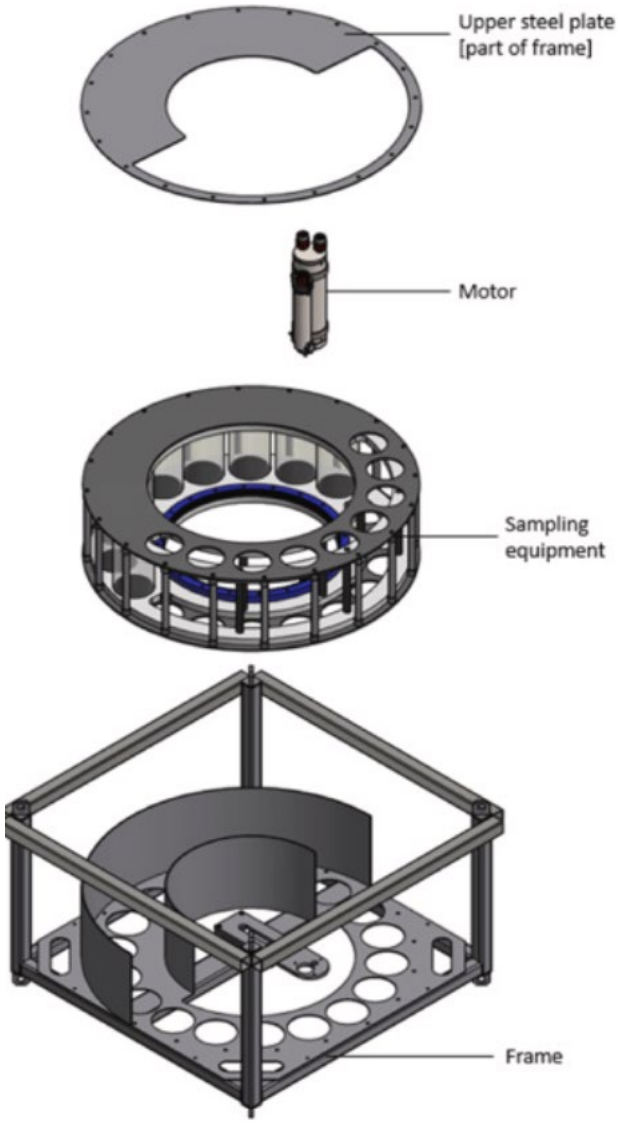


Figure 4.1.2.1: OPIC schematic

Sediment trap

One sediment trap was recovered as part of the P3 mooring since the shallow sediment trap had not been redeployed previously. The recovered trap was situated at 2000 m and programmed to rotate every 15 – 30 days. Upon recovery, all of the bottles had rotated as expected. Bottles were stored at room temperature in vermiculite for analyses back in Cambridge.

Each event number represents 1 increment of rotation, therefore sampling began after event 01 when the first bottle is moved underneath the sampling funnel.

Event 1 of 22 = 01/01/2023 00:00:00

Event 2 of 22 = 15/01/2023 00:00:00

Event 3 of 22 = 01/02/2023 00:00:00

Event 4 of 22 = 15/02/2023 00:00:00

Event 5 of 22 = 01/03/2023 00:00:00

Event 6 of 22 = 15/03/2023 00:00:00

Event 7 of 22 = 01/04/2023 00:00:00

Event 8 of 22 = 01/05/2023 00:00:00

Event 9 of 22 = 01/06/2023 00:00:00

Event 10 of 22 = 01/07/2023 00:00:00

Event 11 of 22 = 01/08/2023 00:00:00

Event 12 of 22 = 01/09/2023 00:00:00

Event 13 of 22 = 01/10/2023 00:00:00

Event 14 of 22 = 01/11/2023 00:00:00

Event 15 of 22 = 15/11/2023 00:00:00

Event 16 of 22 = 01/12/2023 00:00:00

Event 17 of 22 = 15/12/2023 00:00:00

Event 18 of 22 = 01/01/2024 00:00:00

Event 19 of 22 = 15/01/2024 00:00:00

Event 20 of 22 = 01/02/2024 00:00:00

Event 21 of 22 = 15/02/2024 00:00:00

Event 22 of 22 = 01/03/2024 00:00:00

Western core box mooring recovery

One sediment trap was recovered as part of the WCB mooring which was situated at 200 m and programmed to rotate every 15 – 30 days. Upon recovery, all of the bottles had rotated as expected. Samples were stored in vermiculite for analyses in Cambridge.

Each event number represents 1 increment of rotation, therefore sampling began after event 01 when the first bottle is moved underneath the sampling funnel.

Event 1 of 22 = 06/01/2023 00:00:00

Event 2 of 22 = 15/01/2023 00:00:00

Event 3 of 22 = 01/02/2023 00:00:00

Event 4 of 22 = 15/02/2023 00:00:00

Event 5 of 22 = 01/03/2023 00:00:00

Event 6 of 22 = 15/03/2023 00:00:00

Event 7 of 22 = 01/04/2023 00:00:00

Event 8 of 22 = 01/05/2023 00:00:00

Event 9 of 22 = 01/06/2023 00:00:00

Event 10 of 22 = 01/07/2023 00:00:00

Event 11 of 22 = 01/08/2023 00:00:00

Event 12 of 22 = 01/09/2023 00:00:00

Event 13 of 22 = 01/10/2023 00:00:00

Event 14 of 22 = 01/11/2023 00:00:00

Event 15 of 22 = 15/11/2023 00:00:00

Event 16 of 22 = 01/12/2023 00:00:00

Event 17 of 22 = 15/12/2023 00:00:00

Event 18 of 22 = 01/01/2024 00:00:00

Event 19 of 22 = 15/01/2024 00:00:00

Event 20 of 22 = 01/02/2024 00:00:00

Event 21 of 22 = 15/02/2024 00:00:00

Event 22 of 22 = 01/03/2024 00:00:00

Biopole mooring recovery

Two sediment traps were recovered as part of the Biopole mooring deployed 05 March 2024 in 3438 water depth. The sediment traps were situated at 400 m and 2000 m water depth and programmed to rotate every 15 – 30 days. Upon recovery, all of the bottles from the deep trap had rotated as expected. As for the shallow trap, only 6 bottle rotations occurred. The batteries were tested and were flat, with new batteries the carousel was still able to rotate so it is unlikely it was previously jammed. Samples were stored in vermiculite for analyses in Cambridge.

Event 1 of 22 = 06/03/2024 00:00:01

Event 2 of 22 = 11/03/2024 00:00:01

Event 3 of 22 = 21/03/2024 00:00:01

Event 4 of 22 = 01/04/2024 00:00:01

Event 5 of 22 = 01/05/2024 00:00:01

Event 6 of 22 = 01/06/2024 00:00:01

Event 7 of 22 = 01/07/2024 00:00:01

Event 8 of 22 = 01/08/2024 00:00:01

Event 9 of 22 = 01/09/2024 00:00:01

Event 10 of 22 = 01/10/2024 00:00:01

Event 11 of 22 = 01/11/2024 00:00:01

Event 12 of 22 = 16/11/2024 00:00:01

Event 13 of 22 = 01/12/2024 00:00:01

Event 14 of 22 = 16/12/2024 00:00:01

Event 15 of 22 = 01/01/2025 00:00:01

Event 16 of 22 = 16/01/2025 00:00:01

Event 17 of 22 = 01/02/2025 00:00:01

Event 18 of 22 = 15/02/2025 00:00:01

Event 19 of 22 = 01/03/2025 00:00:01

Event 20 of 22 = 11/03/2025 00:00:01

Event 21 of 22 = 21/03/2025 00:00:01

Event 22 of 22 = 22/04/2025 00:00:01

P3 mooring redeployment

PPS

The phytoplankton and particle sampler (PPS) was deployed on the p3 mooring at a depth of 230 m. Prior to deployment, the plumbing of the PPS requires priming with Milli-Q. This was done through the multi-port valve after disconnecting all of the bottom tubing from all filter bodies and filling both the top and bottom of the filter housing with milli-q, ensuring air is purged from the system. During this process 3 of the spigots snapped whilst removing tubing but were placed with substitute parts from uncontaminated seawater spare parts on the ship, since these filters no longer fitted in the holders they were secured to the frame with wire ties. The PPS is equipped with a fixative valve and reservoir used for preserving samples in situ. The fixative reservoir was activated prior to deployment.

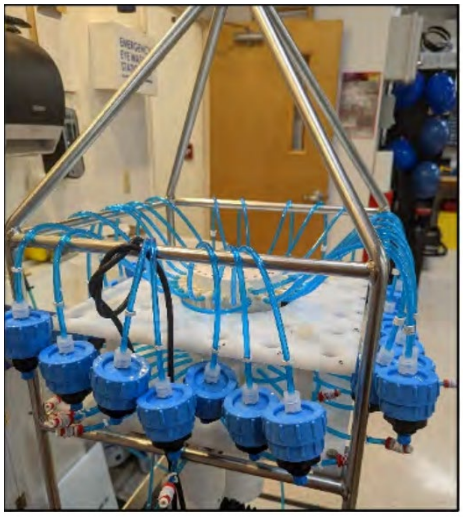


Table 4.1.2.1: Deployment schedule for the P3 PPS

	Flush Vol	Time Limit	Sample Vol	Flow Rate	Min Rate	Time Limit	Fixative Vol	Flow Rate	Min Rate	Time Limit
Event 1: 04/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 2: 05/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 3: 06/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 4: 07/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 5: 08/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 6: 09/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 7: 10/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 8: 11/01/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 9: 11/08/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 10: 11/15/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 11: 11/22/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 12: 11/29/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 13: 12/06/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 14: 12/13/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 15: 12/20/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 16: 12/27/25 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 17: 01/03/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 18: 01/10/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 19: 01/17/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 20: 01/24/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 21: 01/31/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 22: 02/07/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 23: 02/14/26 00:00:01	100	3	1000	100	50	21	40	100	75	1
Event 24: 02/21/26 00:00:01	100	3	1000	100	50	21	40	100	75	1

Sediment trap

Each of the trap bottles contain a solution of 1 L of 37% formalin was buffered with 5 g of sodium tetraborate (BORAX) and left to dissolve for 24 hours. 100 g of sodium chloride was added to 19 L of filtered seawater and left to dissolve for 24 hours. The buffered formalin and sea water were then mixed to create 20 L of 4% formalin solution. The solution was pre-prepared in Cambridge into sediment trap bottles which were loaded onto the trap onboard. The remaining bottles required were reused from the recovered shallow biopole mooring. The solution had previously been made up using the same method. The schedule for the deployed trap is as follows:

Event 1 of 22 = 01/04/2025 00:00:01

Event 2 of 22 = 01/05/2025 00:00:01

Event 3 of 22 = 01/06/2025 00:00:01

Event 4 of 22 = 01/06/2025 00:00:01

Event 5 of 22 = 01/07/2025 00:00:01

Event 6 of 22 = 01/08/2025 00:00:01

Event 7 of 22 = 01/09/2025 00:00:01

Event 8 of 22 = 01/10/2025 00:00:01

Event 9 of 22 = 01/11/2025 00:00:01

Event 10 of 22 = 15/11/2025 00:00:01

Event 11 of 22 = 01/12/2025 00:00:01

Event 12 of 22 = 01/01/2026 00:00:01

Event 13 of 22 = 01/02/2026 00:00:01

Event 14 of 22 = 15/02/2026 00:00:01

Event 15 of 22 = 01/03/2026 00:00:01

Event 16 of 22 = 01/04/2026 00:00:01

Event 17 of 22 = 01/05/2026 00:00:01

Event 18 of 22 = 01/06/2026 00:00:01

Event 19 of 22 = 01/07/2026 00:00:01

Event 20 of 22 = 01/08/2026 00:00:01

Event 21 of 22 = 01/09/2026 00:00:01

Event 22 of 22 = 01/10/2026 00:00:01

Western Core Box

Each of the trap bottles contain a solution of 1 L of 37% formalin was buffered with 5 g of sodium tetraborate (BORAX) and left to dissolve for 24 hours. 100 g of sodium chloride was added to 19 L of filtered seawater and left to dissolve for 24 hours. The buffered formalin and sea water were then mixed to create 20 L of 4% formalin solution. The solution was pre-prepared in Cambridge into sediment trap bottles which were loaded onto the trap onboard.

Sediment trap

Event 1 of 22 = 20/02/2025 00:00:00

Event 2 of 22 = 01/03/2025 00:00:00

Event 3 of 22 = 01/04/2025 00:00:00

Event 4 of 22 = 01/05/2025 00:00:00

Event 5 of 22 = 01/06/2025 00:00:00

Event 6 of 22 = 01/07/2025 00:00:00

Event 7 of 22 = 01/08/2025 00:00:00

Event 8 of 22 = 01/09/2025 00:00:00

Event 9 of 22 = 01/10/2025 00:00:00

Event 10 of 22 = 01/11/2025 00:00:00

Event 11 of 22 = 15/11/2025 00:00:00

Event 12 of 22 = 01/12/2025 00:00:00

Event 13 of 22 = 15/12/2025 00:00:00

Event 14 of 22 = 01/01/2026 00:00:00

Event 15 of 22 = 15/01/2026 00:00:00

Event 16 of 22 = 01/02/2026 00:00:00

Event 17 of 22 = 15/02/2026 00:00:00

Event 18 of 22 = 01/03/2026 00:00:00

Event 19 of 22 = 01/04/2026 00:00:00

Event 20 of 22 = 01/05/2026 00:00:00

Event 21 of 22 = 01/06/2026 00:00:00

Event 22 of 22 = 01/07/2026 00:00:00

4.1.3 Sonovaults

Authors: Gabriele Stowasser, Ryan Saunders and Jennifer Jackson

Deployment of new sonovaults

In order to monitor whale seasonal occurrence in South Georgia waters two Sonovaults (instruments that are designed for long-term recording and monitoring of marine acoustic emissions) were deployed during cruise SD046 on the Western Core Box Mooring (Hydrophone number S/N 25161, Instrument number: SN1394) and the Eastern Core Box Mooring (Hydrophone number: unknown, Instrument number: SN1119) respectively. The instrument deployed on the WCB was recovered during SD046 and re-furbished on the cruise. The Sonovault deployed on the ECB had been programmed and SD cards formatted and installed with the manufacturer.

QUICK GUIDE: SONOVAULT DEPLOYMENT AND RETRIEVAL

Please note, this manual assumes all sonovault programming has been done at BAS prior to deployment, and that SD cards are formatted and ready to deploy.

Fig 4.1.3.1. Develogic Sonovault in housing, installed in a mooring frame

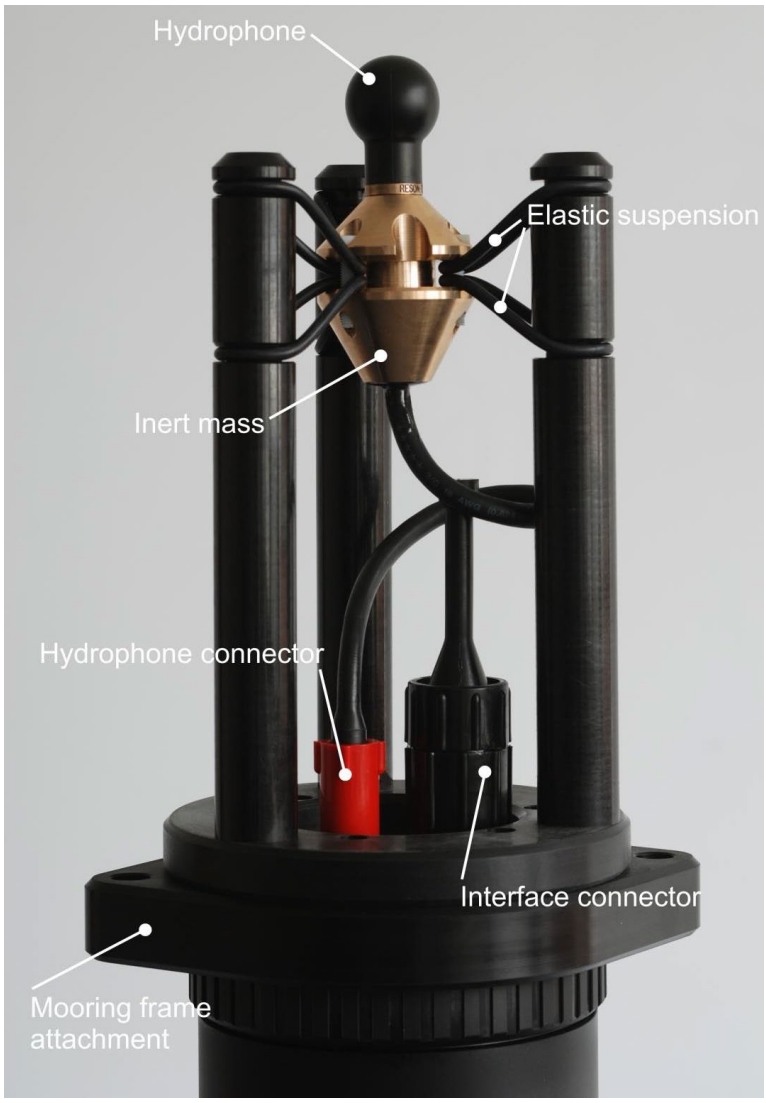


Fig 4.1.3.2. Top section of sonovault, showing hydrophone. Batteries are stored beneath this.

Battery filling and replacement

Work in a dry area. If just retrieved, carefully dry down the sonovault with a towel prior to opening it up, ensure water cannot get into the interior.

1. Remove the top lid from the housing by screwing the outer ring counter-clockwise (the top section contains the hydrophone and memory storage modules). Take care to disconnect the power supply cable carefully from either the battery housing or system electronics to avoid any stress or damage
2. The battery container (Fig 3) and its top lid with 3 screws will become visible. Remove the three screws with an Allen key (Fig 4). NOTE: the battery container lid might be under pressure in case it is already filled with batteries pushing against the springs inside the lid.
3. Carefully remove the top lid of the battery container. Remove batteries if they have to be replaced.
4. Install new batteries into battery container (Fig 5). These are lithium size D (ideally 19Ah), installed in sets of 91 (7 x 13).
5. Reinstall the battery cap lid. This cap only fits in one way. Push the cap down against the spring friction and screw the 3 Allen screws back into their positions
6. Check that the O-rings inside the housing lid are in good shape. Re-connect the power supply cables between the housing lid and battery container.
7. Screw the lid back onto the housing by rotating the ring clockwise. Through a hole in the side of the ring, proper closure of the housing can be checked. There should be NO space left between lid and housing.

Fig 4.1.3.3. Battery container within sonovault

Fig 4.1.3.4. Top view onto battery container.

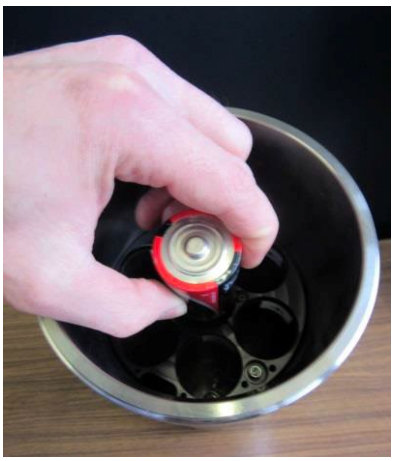


Fig 4.1.3.5. Installing batteries into a battery container

Recommendations

Care has to be taken that the batteries have the right sized (in diameter) plus pole battery terminal. If the terminal is too small the batteries will not connect to the top lid and no charge will be created. If the terminal is small a metal washer needs to be added in order to make the connection.

1. Switching on the system

A Smart Power Switch system controls the power supply, and is connected to a magnet starter plug mounted on the cap of the housing (Fig 6). This plug includes a bi-colour LED which signals a switching operation.

Fig 4.1.3.6. Close up of the power switch from above.

The LED light is visible within the power switch (marked with ON/OFF)

A Hall Effect sensor is mounted within the plug and can detect a magnet and its polarity. The unmarked North Pole of the magnet (black) is used to turn the switch on (Fig 7). The South Pole of the magnet is marked red and is used to turn the switch off. To turn the Smart Power Switch on (Fig 8) and off (Fig 9), the magnet has to touch the Magnet Starter plug for > 3 seconds.

Fig 4.1.3.7. Magnet Starter plug and included magnet

Fig 4.1.3.8. Switching ON the sonovault using the magnet

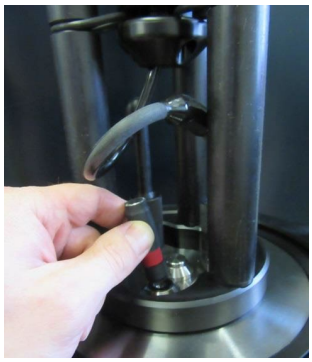


Fig 4.1.3.9. Switching OFF the sonovault using the magnet starter plug (red South pole)

Immediately after the magnet has been used, the LED system will confirm if the power is on or off:

A “switch on” operation is confirmed by the green LED on for 5 seconds. After a 2 second pause, successive blinking indicates the battery voltage.

1 red > 1 green per ten volts > 1 red > 1 green per unit volt > 1 red -> 1 green per 0.1 volts

e.g. 1 red > 3 green > 1 red > 0 green > 1 red > 2 green = 30.2V

A “switch off” operation is confirmed by the red LED on for 5 seconds.

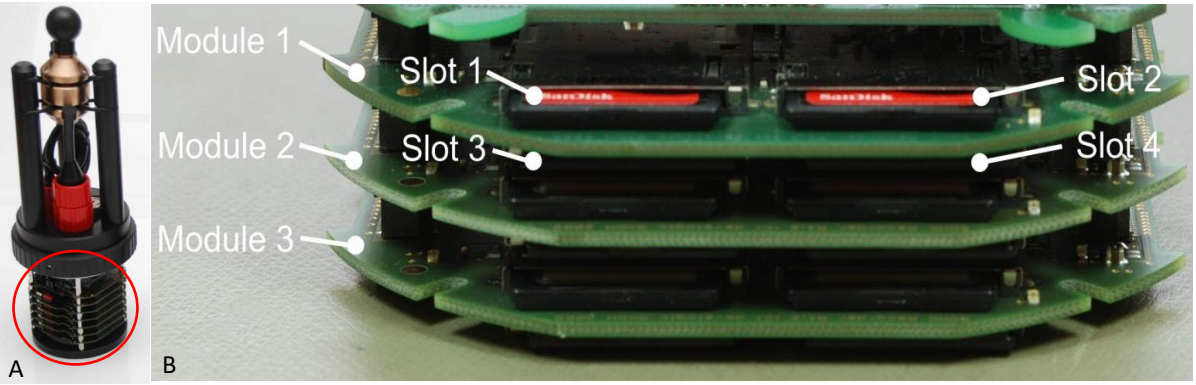
If during operations a fuse is triggered, this is indicated by a red blinking sequence. This indication ceases after 60 seconds and the device is switched off. The number of red blinks corresponds to different fuse trigger indications: 2 = current, 3 = voltage, 4 = pressure, 5 = temperature.

For further troubleshooting of these, check manual. Voltage errors may be caused by insufficient power delivery to the unit, so it is worth checking batteries are working OK.

Once the instrument is switched on, it is ready for immediate deployment.

2. Retrieving / installing SD cards

SD cards are located in stacked storage modules beneath the hydrophone (Fig 10).



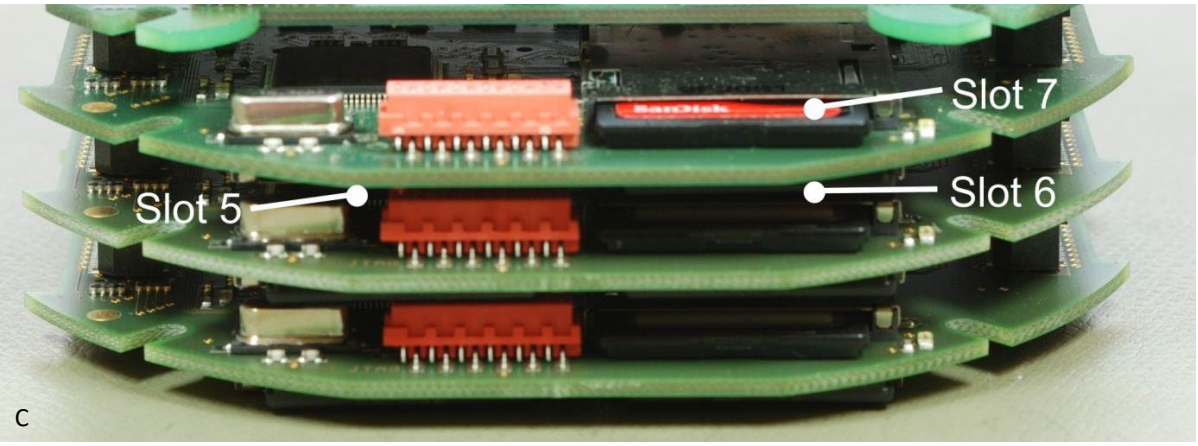


Fig 4.1.3.10. A. Top of sonovault (left), showing location of storage modules (red circle) beneath hydrophone. B & C Detail of storage modules, showing positioning of SD cards within modules: (B) from the front; (C) from the back.

Each module provides seven slots, and there are 5 storage modules in each sonovault (35 SD cards total). Modules and cards are used sequentially. Slot 1, module 1 must always be fitted with the SD card that contains the configuration file (the sonovault programming file). This should be labelled prior to deployment. Aside from this slot, the order of additional SD cards is not important when installing them.

When removing SD cards, it is helpful to keep them in order if possible, for example labelling them by sequential position (module 1:1-7, module 2:1-7 etc).

Retrieval of two sonovaults deployed on DY158

Two sonovaults (Hydrophone number S/N 25161, Instrument number: SN1394were recovered on SD046 from the WCB Mooring and the ECB Mooring (Hydrophone number: S/N 25228, Instrument number: unkown) deployed on DY158 in 2024. The instruments were cleaned, the batteries removed and SD cards removed. The instrument deployed on the WCB was refurbished to be re-deployed on SD046. The majority of SD cards contained data files and all data was downloaded onto an external hard-drive and backed up to the cruise Leg drive. All data files were then wiped off the SD cards and only the SD card in slot 1 (according to manufacturer instructions, see above) remained, containing the configuration file.

During the ECB sonovault deployment very little data was recorded and only 3 SD cards contained data files. The 4th SD card was corrupted after which no more data was recorded. The instrument will be returned to Cambridge and serviced for the next season.

Retrieval of the SD cards on SD046:

The SD cards were removed in the wrong order and were slotted into an SD card holder into positions 1 to 35. The order was as follows: Going from left to right downwards starting at perceived position 1 as indicated below (Fig 4.1.3.11). The same applied to the back of the SD stack. The SD card containing the calibration file was slotted in at position 20 according to this system. For the new deployments the cards were re-inserted in the correct order as indicated by the manufacturer.

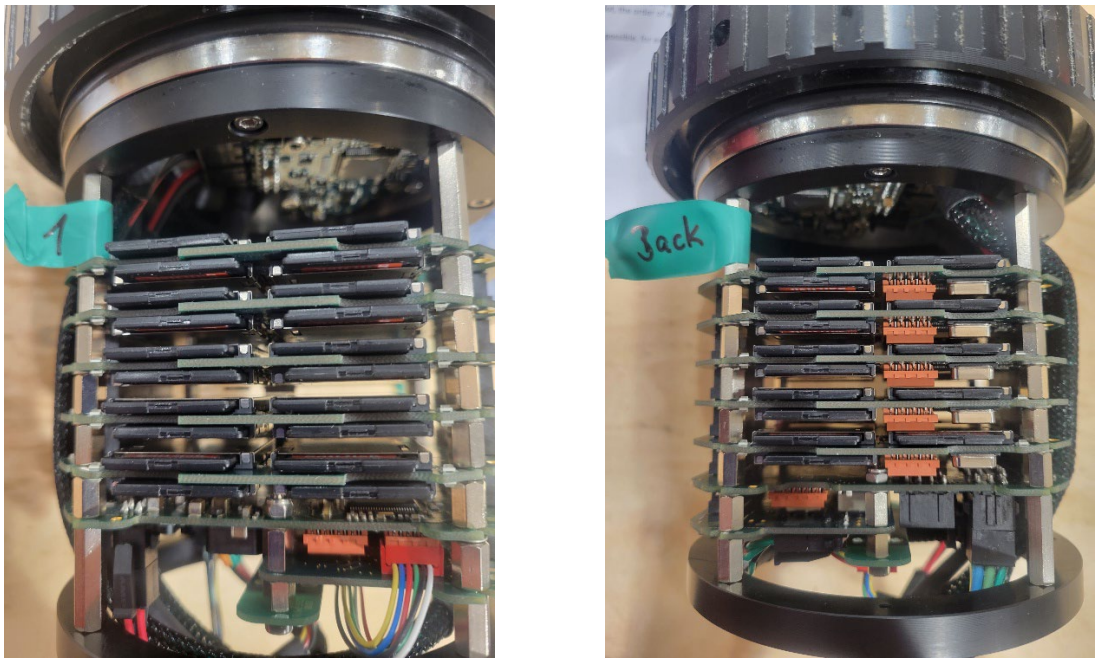


Fig 4.1.3.11. Sonovaults during retrieval process

4.1.4 Underwater vision profiler

Authors: Geraint Tarling and Sally Thorpe

The Underwater Vision Profiler (UVP) was deployed on the WCB mooring on 10th March 2025. The setup was already preprogrammed by Cecilia Liszka before dispatch to the present cruise. The instrument was turned on using a magnet with the correct number of subsequent flashes indicating that it was switched on and at a full battery level.

As shown in the following figures, it was set up in a vertical position (the frame was inverted 180 degrees prior to deployment so that the sensors were pointing downwards). The end caps were removed prior to deployment

Fig 4.1.4.1 UVP prior to deployment on WCB mooring (instrument is rotated 180° to final deployment orientation. The caps linked with orange string were removed prior to deployment)

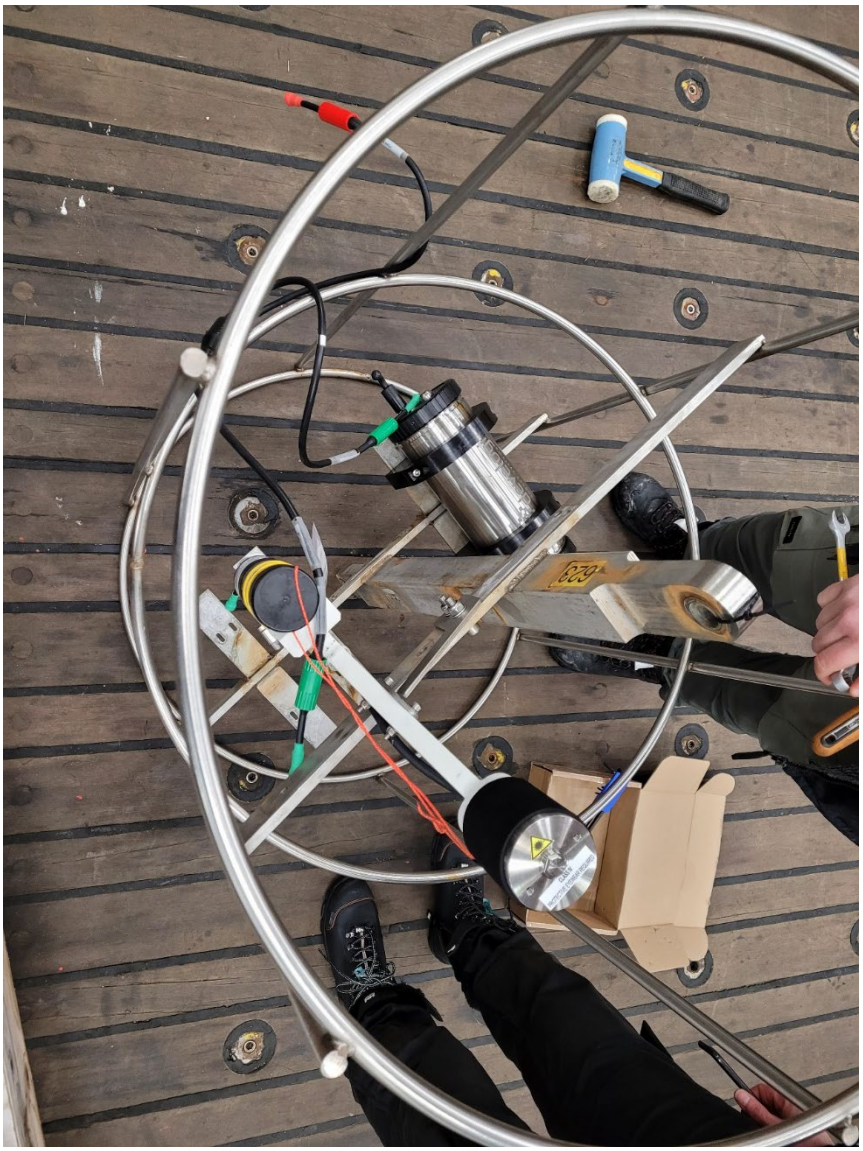


Fig 4.1.4.2 UVP prior to deployment on WCB mooring (looking from above – note the instrument is rotated 180° so this orientation will be facing downwards towards the seabed when in final deployment orientation. The caps linked with orange string were removed prior to deployment)

4.2 Physical Oceanography Moorings

Authors: Rachael Sanders, Sally Thorpe, Simon Wright

Introduction

Eight physical oceanography moorings were planned to be recovered during SD046 – two in the South Sandwich Trench (SST C, SST W), and six in and around the Orkney Passage (OP1, OP2, OP3, OP5, M2, M3). The six Orkney Passage moorings were then to be turned around and redeployed. Unfortunately, it was only possible to recover four complete moorings – SST C, OP3, OP5, M3 – as well as two instruments from the western South Sandwich Trench mooring and only the acoustic releases from OP2. Because not all moorings could be recovered, there were not enough top floats or instruments to redeploy all six moorings as planned, and therefore only OP1, OP2, OP5 and M3 were redeployed.

South Sandwich Trench Moorings Recovery

The central and western South Sandwich Trench mooring (SST C and SST W) were deployed from the FV Argos Georgia on cruise SS24 on 16th February 2024. The anchor drop position for SST C was 60° 13.220' S, 025° 07.897' W with an approximate depth of 5964 m, and the anchor drop position for SST W was 60° 06.583'S, 025° 18.728'W with an approximate depth of 3958 m. Neither mooring was trilaterated after deployment, so on arrival at the South Sandwich Trench, the releases of each mooring were trilaterated. The position was determined as 60°12.8505’ S, 25°7.3560’ W for SST C and 60°06.49’ S, 25°18.542’ W for SST W. Due to low visibility in the area, and because the moorings had only a light beacon, the ship’s acoustic EK80 system was also used to attempt to identify the position of the top buoy of each mooring so the ship could be as close as possible during release. While the top buoy was identified for SST C, the buoy could not be seen in the acoustics for the western mooring, raising suspicions that the top buoy was not attached anymore.

On 24th February, when visibility was considered good enough, the central, deepest mooring was released, and both sets of buoys were spotted at the surface. All nine instruments and the acoustic releases were successfully recovered, starting with the surface buoy. The instruments are listed in Table 4.2.1.

The shallower, western mooring was then released on 25th February, and the three deeper floats were spotted on the surface. Unfortunately, only two instruments were recovered – a SBE39 temperature sensor, and an Aquadopp Acoustic Doppler Current Profiler (ADCP) – along with the acoustic releases and lower floats. The instruments, as well as those that were lost, are listed in Table 4.2.2. The rope had snapped just above the SBE39, near to a piece of tape that had been placed there to protect the rope from the instrument clamp (Figure 4.2.1).

Figure 4.2.1 The snapped rope from SST W. Black tape that was placed to protect the rope from the instruments can be seen on the left of the image.

For both moorings, all instruments were cleaned in freshwater and the sensors with Milli-Q, and the data downloaded. A CTD was deployed close to each of the mooring sites to calibrate the mooring instruments. The CTD cast associated with each mooring is listed in Table 7.16.

Orkney Passage Moorings Recovery

Moorings OP1, OP2, OP3 and OP5 were deployed from the RRS Discovery on Cruise DY158 in 2023. Mooring OP3 was successfully released and recovered on 3rd March 2025. The recovered instruments and equipment are listed in Table 4.2.3. All data was downloaded and a CTD cast was done for calibration purposes.

On 3rd March 2025, an attempt was also made to recover both the OP1 and OP2 moorings. While it was possible to communicate with the OP1 acoustic releases, the response showed that the releases were still there, but horizontal, suggesting that the rest of the mooring had come apart at some point. There was also no sign of the mooring on the EK80. A CTD was still deployed at the mooring site to continue the time series. Details of the instruments and equipment lost from OP1 can be found in the DY158 cruise report (https://www.bodc.ac.uk/data/documents/cruise/18119/).

Mooring OP2 was also released on 3rd March, but only the bottom buoys surfaced with the acoustic releases. These were recovered and the wire was found to have snapped immediately above (Figure 4.2.2). The details of the releases and the lost instruments are in Table 4.2.4.

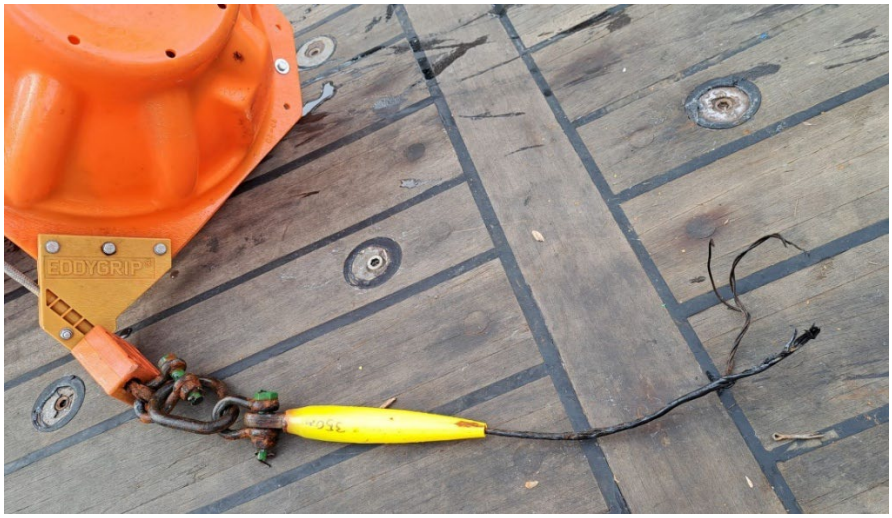


Figure 4.2.2 The broken wire immediately above the bottom buoys on OP2.

OP5 was successfully recovered on 4th March 2025. One of the SBE37 Microcats (serial number 2956) had a missing sensor cover, with one of the bolts holding it in place sheared. The downloaded data looked OK, and a cover was removed from another Microcat to use during the CTD calibration cast. The data from the calibration cast showed little difference to the unbroken Microcats.

M2 & M3 Mooring Recovery

Mooring M2 was deployed from the RRS Discovery Cruise DY158 on 20th January 2023 at 62° 36.925' S, 043° 14.526' W. An attempt to release the mooring was made on 11th March 2025. While the releases were communicating, when the release signal was sent, no confirmation was received and the distance to the releases did not decrease. This was tried multiple times with no success. An initial idea to trawl for the mooring releases, using the same methods as used during the recovery of M2 during Cruise DY158. This was however deemed impossible due to the lack of equipment on board, namely sacrificial rope and specialised grappling devices. The ship remained close to the mooring site to complete a CTD, and the releases communicated with a further three times, each with the same result. The ship diverted back to the M2 site on 15th March to do a final check, and the releases were still communicating and vertical. The releases were then deactivated. It is hoped that the mooring can be trawled for on a later cruise when the right equipment is available. Information about the instruments on M2 can be found in the DY158 cruise report (https://www.bodc.ac.uk/data/documents/cruise/18119/).

The M3 mooring was last deployed on 10th March 2023 on Cruise SD025. The mooring was both successfully recovered and redeployed with different instruments on 14th March 2025. A SBE37 Microcat (serial number 10172) had an open end cap during recovery so had water inside. Battery acid started leaking from it after recovery, and the instrument began to warm when checked with a thermal lens. The instrument was kept in water and monitored overnight. Once deemed to be stable, the instrument was opened and the corroded batteries removed. It was noted that one of the bolts holding the cap on the Microcat had a very worn thread (it was not possible to remove it with an Allen key and instead had to be drilled into). The data was not recovered from the instrument.

New instruments

Four SBE-37 SM Microcats were brought to replace instruments on the moorings that had been deployed for two years or more, as well as two SBE-37 SMP Microcats from LDEO, Columbia University. Each instrument, along with those recovered from the moorings, was set up with a sampling rate of 10 seconds and attached to the CTD rosette using jubilee clips prior to deployment for a calibration cast. The details of these casts are in Table 4.2.10. When the data was checked, one of the LDEO instruments (serial number 14763) was found to have a broken conductivity cell and was therefore not deployed on any mooring.

Deployed mooring arrangements – Polar Oceans

With only four surface buoys available, a decision was made to redeploy only M3, OP1, OP2 and OP5. All moorings except OP2 were changed from wire to rope, meaning that the clamps on the instruments had to be replaced. Spare clamps with larger connections for the rope were brought for the Aquadopps and some SBE37s, while others had to have their original clamps drilled with larger holes. This was sometimes difficult for the SBE39s, which had very short threads on the bolts, and two were modified to have longer bolts. When instruments were deployed on rope, silicone tubing was put between the clamp and the rope to protect the rope. When instruments were deployed on wire, tape was wrapped around the wire under the clamps instead.

New lengths of rope were brought for the moorings, and when measured on deck, two of the ropes labelled as 500 m were found to be different lengths and both over 100 m too long. Luckily, because we were not able to deploy all instruments, these did not have to be used and the correctly measured lengths were used instead.

Prior to deployment, new batteries were put into each instrument, which were each then set up with a sampling frequency of 600 seconds, except for the RBRSoloTs, which were instead set up with a sampling frequency of 60 seconds due to their high battery life and memory. Information about the instruments and releases deployed on each mooring is listed in Table 4.2.7-4.2.10. Just before deployment of OP1, a scratch was noticed on one of the transducers of an Aquadopp 6k (serial number 2317). Instead of not deploying it, it was deployed higher up on the rope than planned to a position deemed less important, in case the instrument does not function properly.

Each mooring was deployed from the aft deck with the top buoy deployed first. Each is fitted with a light and radio beacon. After deployment, the moorings were trilaterated to determine the exact position, which are listed in Tables 4.2.12-4.2.15. Close to each mooring site, a CTD cast was done for calibration. The event and cast numbers of these CTDs are listed in Table 4.2.16.

Recommendations

Since this is the second time that the M2 mooring has not released properly, and will have to be trawled for, it would be useful in future to ensure the right equipment for trawling are available for recoveries in future.

Height above seafloor (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started and stopped logging (UTC)	Time difference: actual time-instrument time (s)	Comments
4546	1418	ST-400A Xenon flasher	Z03-086	-	-	-	-	
4509	1454	Aquadopp 6k	12020	u, v, z, pressure, temperature, sound speed	600	15-02-24 00:00 26-02-25 05:47	-39	
4508	1455	SBE37-SM	7386	Temperature, salinity, pressure	600	15-02-24 00:00 25-02-25 22:57	16	
3764	2119	RBRsoloT	206995	Temperature	60	15-02-24 00:00 26-02-25 17:55	1	
3012	2952	Aquadopp 6k	12016	u, v, z, pressure, temperature, sound speed	600	15-02-24 00:00 26-02-25 05:47	-39	
2264	3700	RBRsoloT	206994	Temperature	60	15-02-24 00:00 26-02-25 19:53	0	
1512	4452	Aquadopp 6k	17261	u, v, z, pressure, temperature, sound speed	600	15-02-24 00:00 26-02-25 06:10	-80	
764	5200	RBRsoloT	206993	Temperature	60	15-02-24 00:00 26-02-25 20:15	-22	
20	5944	Aquadopp 6k	17288	u, v, z, pressure, temperature, sound speed	600	15-02-24 00:00 26-02-25 05:32	-56	
19	5945	SBE37-SM	7387	Temperature, salinity, pressure	600	15-02-24 00:00 25-02-25 22:03	8	
9	5955	AR861 acoustic release	565	-	-	-	-	
9	5955	AR861 acoustic release	1618	-	-	-	-	

Table 4.2.1 Instruments and equipment recovered from the central South Sandwich Trench Mooring (SST C).

Height above seafloor (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started and stopped logging (UTC)	Actual time-instrument time (s)	Comments
2540	1417	ST-400A Xenon flasher	Y07-012	-	-	-	-	Not recovered
2510	1448	Aquadopp 6k	12010	-	-	-	-	Not recovered
1764	2194	SBE39	4413	-	-	-	-	Not recovered
1012	2946	Aquadopp 6k	12053	-	-	-	-	Not recovered
1011	2947	SBE37-SM	7385	-	-	-	-	Not recovered
514	3444	SBE39	4716	Temperature (no pressure)	600	15/02/2024 00:00 25/02/2025 18:24	-60	
19	3939	Aquadopp 6k	6263	u, v, w, pressure, temperature, sound speed	600	15/02/2024 00:00 25/02/2025 18:47	-28	
9	3949	AR861 acoustic release	564	-	-	-	-	
9	3949	AR861 acoustic release	1615	-	-	-	-	

Table 4.2.2 Instruments and equipment on the western South Sandwich Trench Mooring (SST W). Only two instruments and the acoustic releases were recovered.

Height above seafloor (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started and stopped logging (UTC)	Actual time-instrument time (s)	Comments
534	1235	ST-400A Xenon flasher	W02-088	-	-	-	-	
534	1235	RF-700A1 Radio beacon	W02-084 (154.585 MHz)	-	-	-	-	
512	1257	SBE39	1239	Temperature	600	22/01/23 16:00 05/03/25 17:42	171	
300	1469	Aquadopp 6k	9250	u, v, w, pressure, temperature, sound speed	600	22/01/23 16:00 05/03/25 14:00	-121	
299	1470	SBE37-SM	7380	Temperature, salinity, pressure	600	22/01/23 16:00 04/03/25 23:57	0	
47	1723	Aquadopp 6k	9264	u,v,w,pressure, temperature, sound speed	600	22/01/23 16:00 05/03/25 13:42	-102	
19	1751	SBE37-SM	8267	Temperature, salinity, pressure	600	22/01/203 16:00 04/03/25 23:33	48	
7	1762	AR861 acoustic release	1356	-	-	-	-	
7	1762	AR861 acoustic release	3045	-	-	-	-	

Table 4.2.3 Instruments and equipment recovered from the OP3 mooring.

Height above seafloor (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started and stopped logging (UTC)	Actual time-instrument time (s)	Comments
424	2985	ST-400A Xenon flasher	W02-087	-	-	-	-	
424	2985	RF-700A1 Radio beacon	W02-085 (159.480 MHz)	-	-	-	-	
400	3009	Aquadopp 6k	8556	u,v,w, pressure, temperature, sound speed	600	23/01/23 09:00 05/03/25 16:29	-137	
399	3010	SBE39	83	Temperature (no pressure)	600	23/01/23 15:30 05/03/25 16:45	139	
46	3363	Aquadopp 6k	5424	u,v,w, pressure, temperature, sound speed	600	23/01/23 15:30 05/03/25 16:12	-76	
18	3391	SBE37-SM	2956	Temprature, salinity, pressure	600	23/01/23 09:00 05/03/25 00:20	303	Sensor cover broken off
7	3402	AR861 acoustic release	1942	-	-	-	-	

Table 4.2.4 Instruments and equipment recovered from the OP5 mooring.

Height above seabed (m)	Nominal depth (m)	Model	Serial Number	Comments
1542	1570	ST-400A	W02-089	Not recovered
1520	1593	SBE-37	2707	Not recovered
1414	1698	Aquadopp	6198	Not recovered
1120	1992	SBE-39	4713	Not recovered
727	2386	Aquadopp	6226	Not recovered
726	2387	SBE-37	22337	Not recovered
65	3048	Aquadopp	6263	Not recovered
21	3092	SBE-37	22338	Not recovered
8	3105	8242 acoustic release	33147	
8	3105	8242 acoustic release	33614	

Table 4.2.5 Instruments and equipment lost from the OP2 mooring, and the releases that were recovered.

Nominal Depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started and stopped logging (UTC)	Actual time-instrument time (s)	Comments
4085	Strobe beacon	159.48MHz	-	-	-	-	
4085	Radio beacon		-	-	-	-	
4604	Aquadopp 6k	1752	u,v,w,pressure, temperature, sound speed	900	10/03/23 11:00 14/03/25 15:55	-213	
4103	Aquadopp 6k	2317	u,v,w,pressure, temperature, sound speed	1800	09/03/23 21:38 14/03/25 14:03	-128	
4223	SBE39	1826	Temperature, pressure	900	10/03/23 11:00 14/03/25 15:04	-119	
4478	SBE39	1310	Temperature, pressure	900	10/03/23 11:00 14/03/25 15:19	-188	
4356	SBE39	1247	Temperature, pressure	900	10/03/23 11:00 14/03/25 15:43	0	
4148	SBE37-SMP	10172	-	-	-	-	Batteries corroded, data not accessed
4598	SBE37-SMP	16961	Temperature, salinity, pressure	900	09/03/23 22:30 14/03/25 15:35	13	

Table 4.2.6 Instruments and equipment recovered from the OP5 mooring.

Height above seabed (m)	Nominal Depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started logging (UTC)	Comments
531	4069	ST-400A Novatech Xenon flasher	Z03-086	-	-	-	Auto 'Daylight Off' disabled
531	4069	RF-700A1 Radio beacon	W02-85	-	-	-	Frequency: 159.48000 Mhz Channel: B
509	4091	Aquadopp 6k	5424	u, v, w, Pressure, temperature, speed sound	600	14/03/25 12:00	
464	4136	SBE37-SMP	14764	Temperature, Salinity, Pressure	60	14/03/25 12:00	
364	4236	SBE39-SM	0083	u, v, w, Pressure, temperature, sound speed	600	14/03/25 12:00	
264	4336	SBE39-SM	1239	Temperature, Pressure	600	14/03/25 12:00	
114	4486	SBE39-SM	4716	Temperature (no pressure)	600	14/03/25 12:00	
19	4581	SBE37-SM	7386	Temperature, Salinity, Pressure	600	14/03/25 12:00	
17	4583	Aquadopp 6k	8556	u, v, w, Pressure, temperature, sound speed	600	14/03/25 12:00	
7	4593	Edgetech release	33614	-	-	-	
7	4593	Edgetech release	33147	-	-	-	

Table 4.2.7 Instruments and equipment deployed on the M3 mooring.

Height above seabed (m)	Nominal Depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started logging (UTC)	Comments
1541	1572	ST-400A Novatech Xenon flasher	V08-057	-	-	-	Auto 'Daylight Off' disabled
1541	1572	RF-700A1 Radio beacon	W08-053	-	-	-	Frequency: 159.48000 Mhz Channel: B
1518	1595	SBE37-SM	26083	Temperature, salinity, pressure	600	17/03/25 09:00	
1413	1700	Aquadopp 6k	12016	u, v, w, pressure, temperature, sound speed	600	17/03/25 09:00	
1412	1701	RBRsoloT 10k	206994	Temperature	60	17/03/25 09:00	
1067	2046	SBE39	1310	Temperature, pressure	600	17/03/25 09:00	Accidentally put on wrong side of shackle
709	2404	Aquadopp 6k	17261	u, v, w, pressure, temperature, sound speed	600	17/03/25 09:00	
708	2405	SBE37-SM	26066	Temperature, salinity, pressure	600	17/03/25 09:00	
365	2748	SBE39	1826	Temperature	600	17/03/25 09:00	Thread on connector partly stripped – drilled for bigger bolts
50	3063	Aquadopp 6k	12020	u, v, w, pressure, temperature, sound speed	600	17/03/25 09:00	
20	3093	SBE37-SM	26084	Temperature, salinity, pressure	600	17/03/25 09:00	
7	3106	Edgetech release	32131	-	-	-	
7	3106	Edgetech release	49027	-	-	-	

Table 4.2.8 Instruments and equipment deployed on the OP2 mooring.

Height above seabed (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started logging (UTC)	Comments
1833	1806	ST-400A Novatech Xenon flasher	W02-087	-	-	-	Auto 'Daylight Off' disabled
1833	1806	RF-700A1 Radio beacon	W02-084	-	-	-	Frequency: 154.58500 Mhz Channel: A
1811	1828	Aquadopp 6k	1752	u, v, w, pressure, temperature, sound speed	600	18/03/25 09:00	
1810	1829	RBRSoloT	206993	Temperature	600	18/03/25 09:00	
1455	2184	Aquadopp 6k	2317	u, v, w, pressure, temperature, sound speed	60	18/03/25 09:00	Scratch on transducer
1454	2185	SBE37-SM	7387	Temperature, salinity, pressure	600	18/03/25 09:00	
1061	2578	SBE39	1247	Temperature, pressure	600	18/03/25 09:00	Connector adapted with bigger bolts
701	2938	Aquadopp 6k	17288	u, v, w, pressure, temperature, sound speed	600	18/03/25 09:00	
700	2939	SBE37-SM	26085	Temperature, salinity, pressure	600	18/03/25 09:00	
48	3591	Aquadopp 6k	6263	u, v, w, pressure, temperature, sound speed	600	18/03/25 09:00	
20	3619	SBE37-SM	8267	Temperature, salinity (no pressure)	600	18/03/25 09:00	Reference pressure set to 3700 dbar
9	3630	Xisea Oceano 2500S (AR861B2S Series)	565	-	-	-	-
9	3630	Xisea Oceano 2500S (AR861B2S Series)	1618	-	-	-	-

Table 4.2.9 Instruments and equipment deployed on the OP1 mooring.

Height above seabed (m)	Nominal depth (m)	Model	Serial Number	Parameters measured	Sampling frequency (s)	Time started logging (UTC)	Comments
430	2979	ST-400A Xenon flasher	W02-088	-	-	-	Auto 'Daylight Off' disabled
430	2979	RF-700A1 Radio beacon	Y07-010	-	-	-	Frequency: 160.725 Mhz Channel: C
407	3002	Aquadopp 6k	9250	u, v, w, pressure, temperature, sound speed	600	17/03/25 12:00	
406	3003	RBRsoloT 10k	206995	Temperature	60	17/03/25 12:00	
50	3359	Aquadopp 6k	9264	u, v, w, pressure, temperature, sound speed	600	17/03/25 12:00	
19	3390	SBE37-SMP	16961	Temperature, salinity, pressure	600	17/03/25 12:00	
8	3401	Xisea Oceano 2500S (AR861B2S Series)	564				
8	3401	Xisea Oceano 2500S (AR861B2S Series)	1615				

Table 4.2.10 Instruments and equipment deployed on the OP5 mooring.

Model	Serial number	Mooring recovered from	Test cast	Mooring deployed on	Comments
SBE37-SM	2956	OP5	Event 152, CTD Cast 050	-	Broken sensor cover – returned to Cambridge
SBE37-SM	7380	OP3	Event 152, CTD Cast 050	-	Returned to Cambridge
SBE37-SM	7386	SST_C	Event 094, CTD case 034	M3	
SBE37-SM	7387	SST_C	Event 094, CTD case 034	OP1	
SBE37-SM	8267	OP3	Event 152, CTD Cast 050	OP1	Instrument has no pressure sensor
SBE37-SMP	14763	-	Event 094, CTD case 034	-	Broken conductivity cell – returned to Cambridge
SBE37-SMP	14764	-	Event 094, CTD case 034	M3	
SBE37-SMP	16961	M3	Event 179, CTD case 058	OP5	
SBE37-SM	26066	-	Event 094, CTD case 034	OP2	
SBE37-SM	26083	-	Event 094, CTD case 034	OP2	
SBE37-SM	26084	-	Event 094, CTD case 034	OP2	
SBE37-SM	26085	-	Event 094, CTD case 034	OP1	

Table 4.2.11 Details of the calibration casts of the SBE37 Microcats.

	Latitude (°S)	Longitude (°W)	Range (m)	Seabed depth (m)	Distance (m)
Position 1	63° 32.300’	41° 43.150’	5306		2645
Position 2	63° 33.610’	41° 49.760’	6269		4259
Position 3	63° 29.900’	41° 47.880’	6076		3970
Mooring position:	63° 31.920’	41° 46.247’		4600	

Table 4.2.12 Trilateration information for M3, deployed on 14th March 2025.

	Latitude (°S)	Longitude (°W)	Range (m)	Seabed depth (m)	Distance (m)
Pos1	60° 38.470’	42° 13.800’	4290		2952
Pos2	60° 39.880’	42° 07.780’	4948		3846
Pos3	60° 37.040’	42° 08.030’	4674		3486
Mooring position:	60° 38.388’	42° 10.557’		3113	

Table 4.2.13 Trilateration information for OP2, deployed on 17th March 2025.

	Latitude (°S)	Longitude (°W)	Range (m)	Seabed depth (m)	Distance (m)
Pos1	60° 37.040’	42° 02.120	4898		3278
Pos2	60° 39.120’	42° 07.740	5167		3668
Pos3	60° 36.840’	42° 07.580	4571		2766
Mooring position:	60° 37.380’	42° 05.700		3639	

Table 4.2.14 Trilateration information for OP1, deployed on 18th March 2025.

	Latitude (°S)	Longitude (°W)	Range (m)	Seabed depth (m)	Distance (m)
Pos1	60° 35.250’	41° 55.580’	5421		4215
Pos2	60° 38.350’	41° 55.580’	5175		3894
Pos3	60° 37.030’	42° 02.120’	4724		3270
Mooring position:	60° 36.960’	41° 58.620’		3409	

Table 4.2.15 Trilateration information for OP5, deployed on 18th March 2025.

Mooring	Recovery CTD calibration cast			Deployment CTD calibration cast		
	Date	Event number	CTD cast number	Date	Event number	CTD cast number
SST C	24/02/2025	084	027	-	-	-
SST W	25/02/2025	085	028	-	-	-
OP1	03/03/2025	113	040	18/03/2025	189	061
OP2	04/03/2025	114	041	18/03/2025	187	060
OP3	04/03/2025	115	042	-	-	-
OP5	04/03/2025	118	043	18/03/2025	191	062
M2	11/03/2025	159	051	-	-	-
M3	14/03/2025	163	055	-	-	

Table 4.2.16 Information about the CTD casts done for calibration of each mooring. One CTD was done at M3 for calibration of both the recovered and deployed mooring. CTDs were also done at the sites of the unrecovered moorings, and repeated later when the mooring was redeployed.

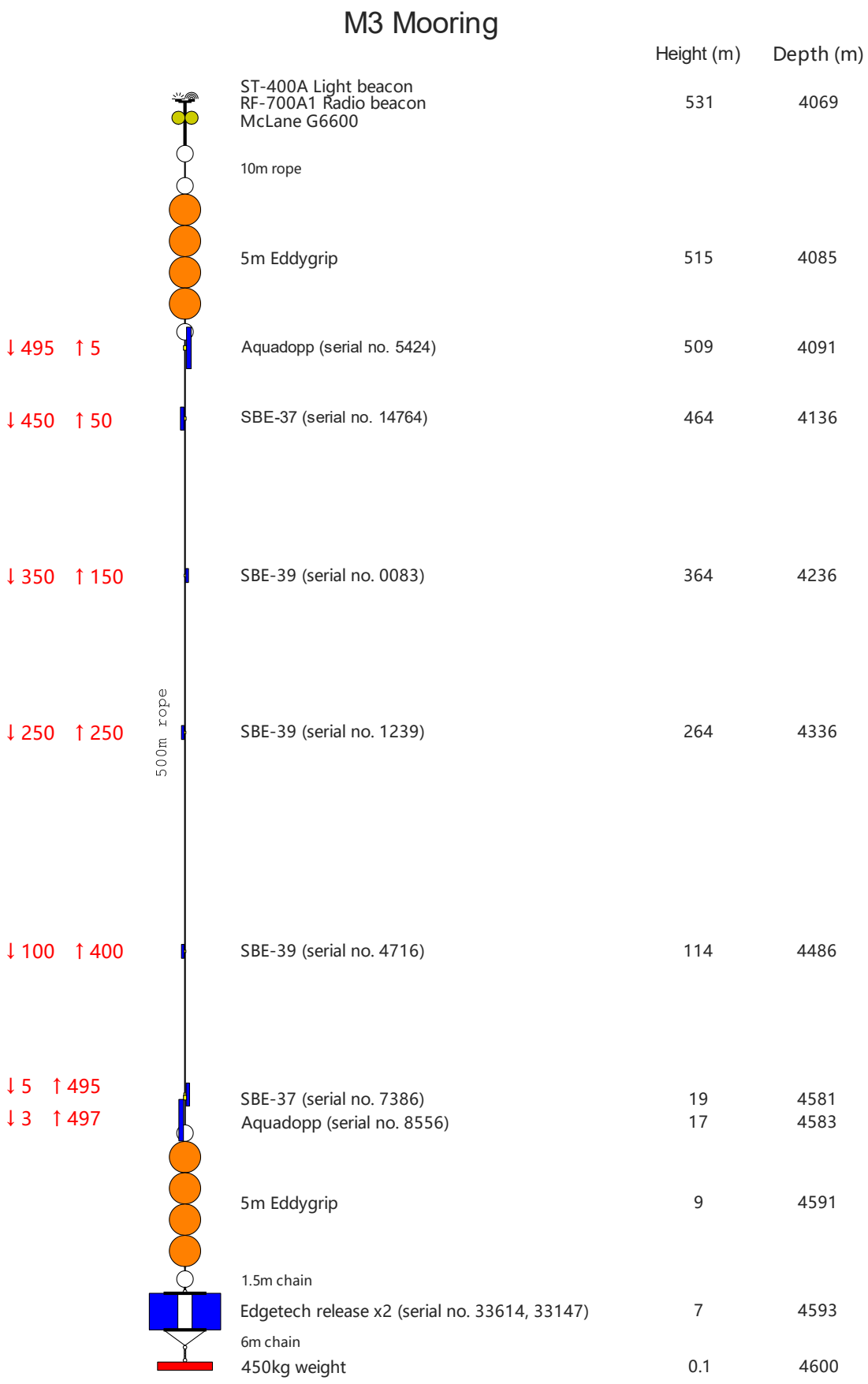


Figure 4.2.3 Diagram of the M3 mooring, deployed on 15th March 2025.

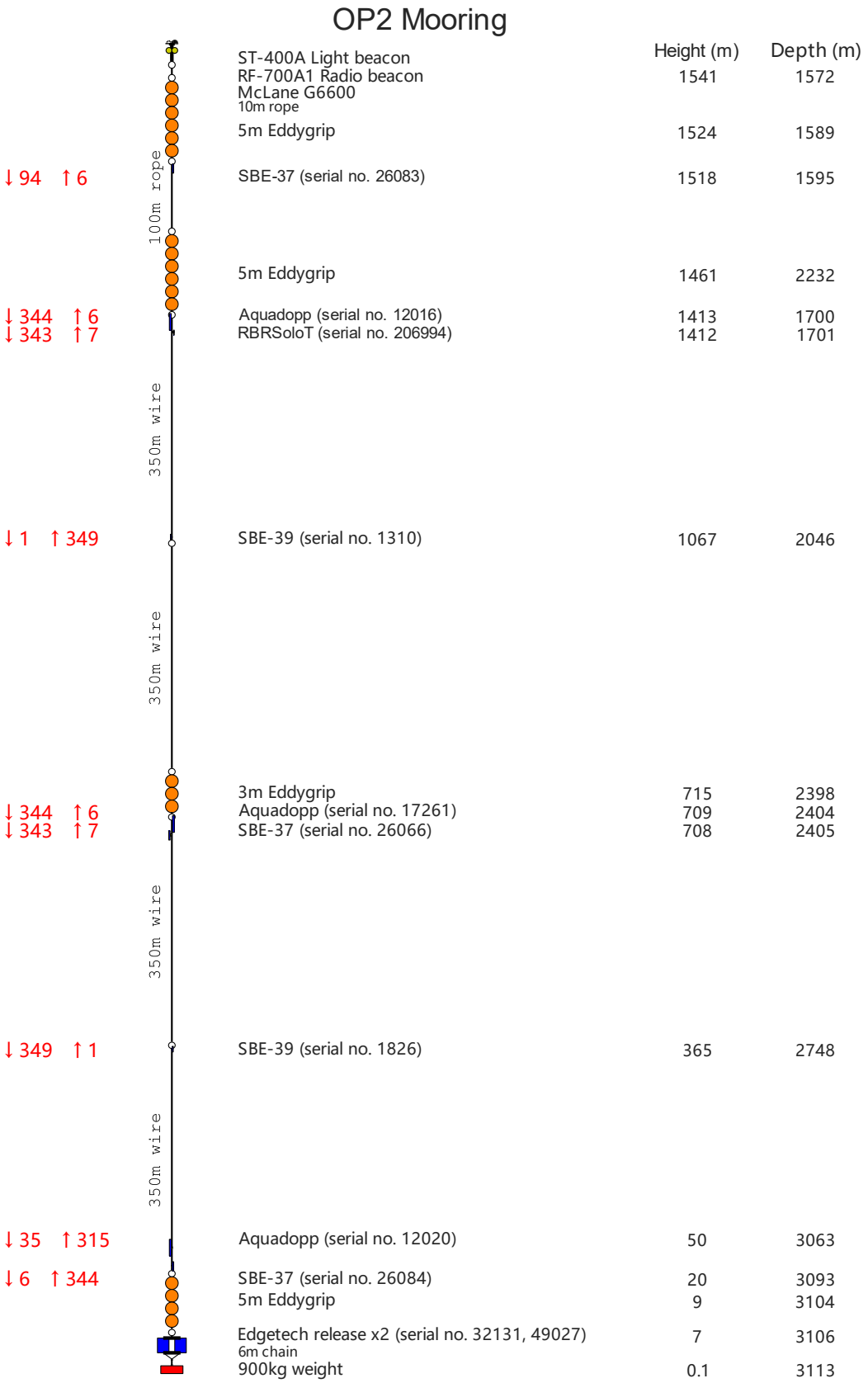


Figure 4.2.4 Diagram of the OP2 deployment, deployed on 17th March 2025

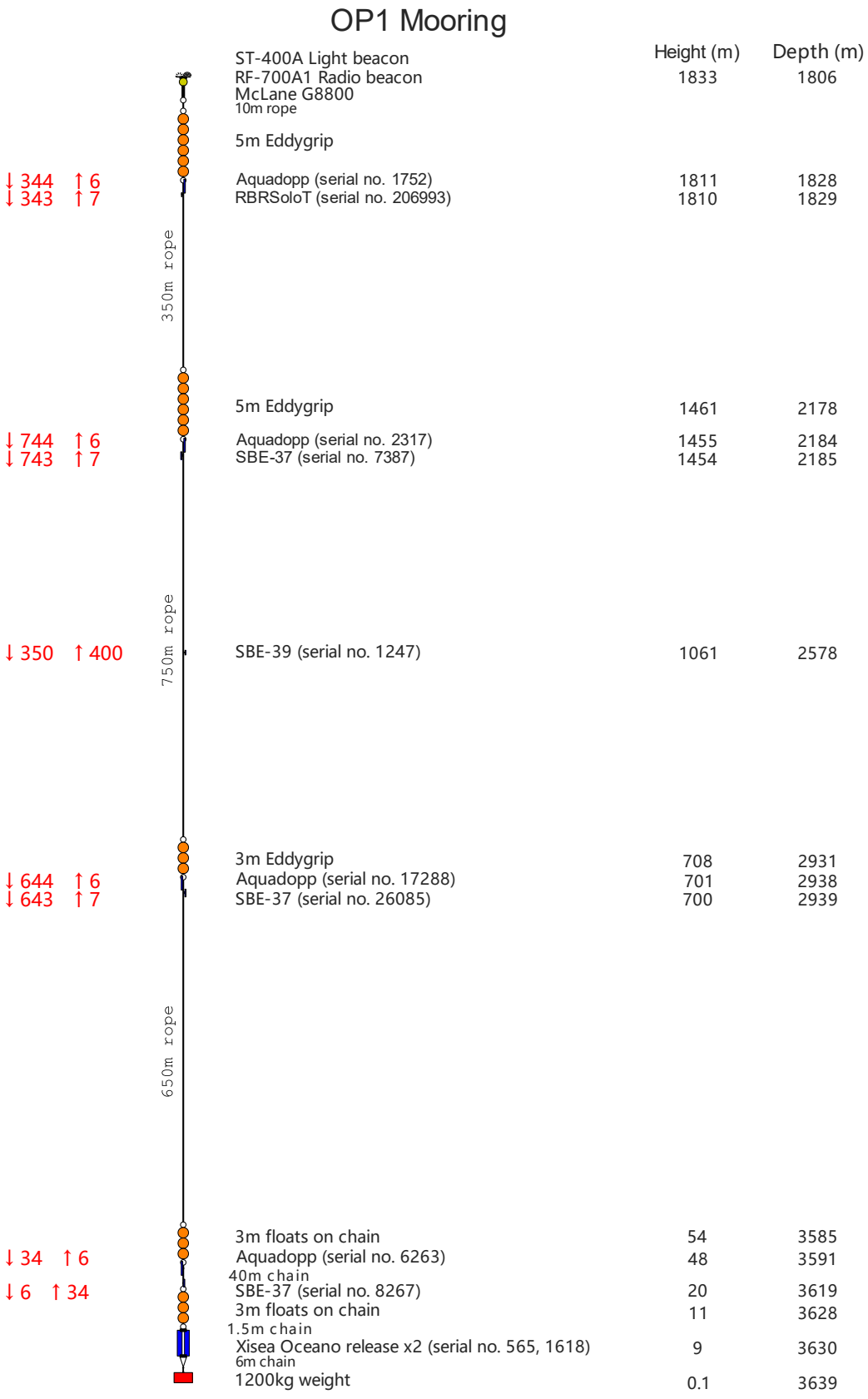


Figure 4.2.5 Diagram of the OP1 deployment, deployed on 18th March 2025

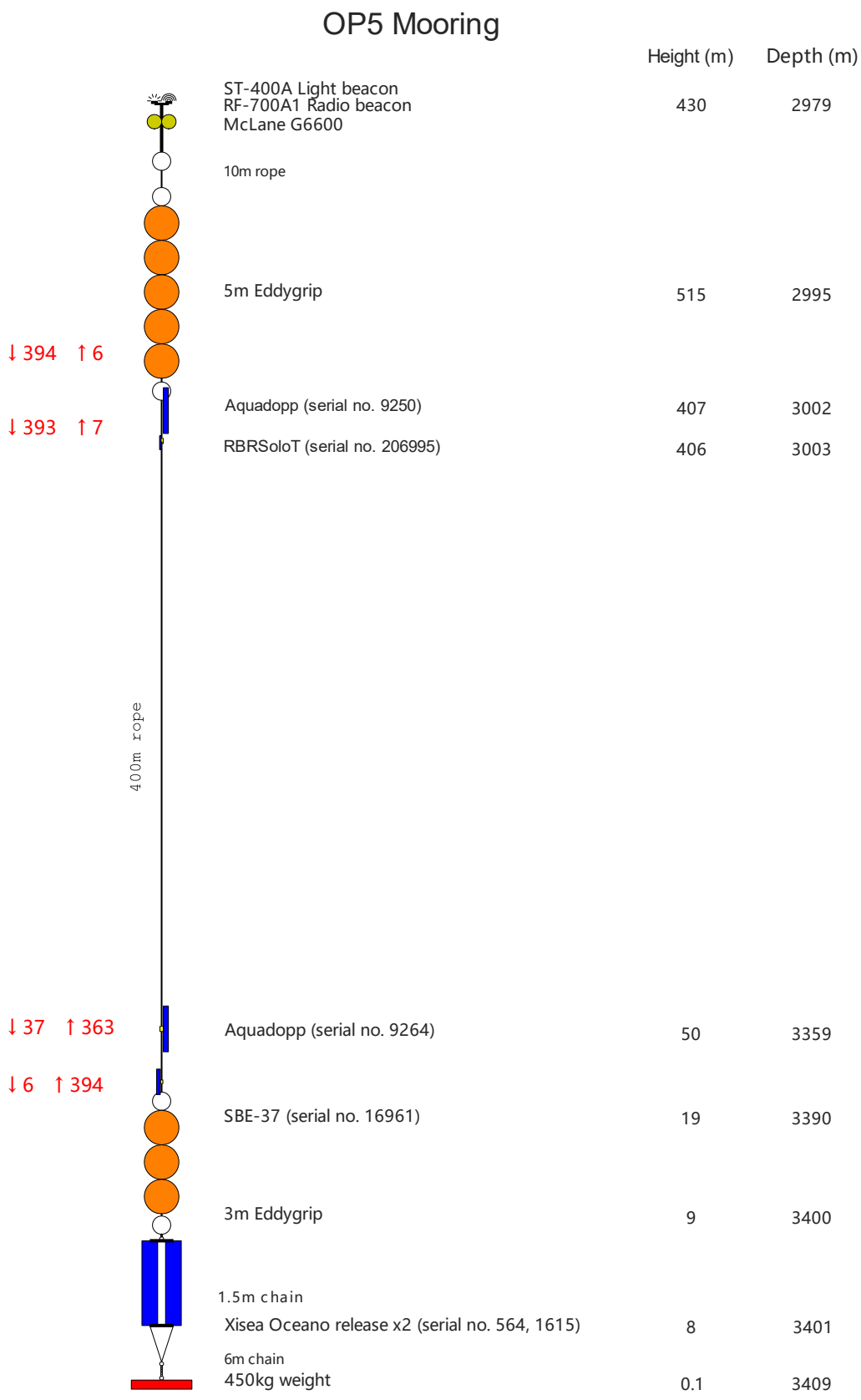


Figure 4.2.6 Diagram of the OP5 deployment, deployed on 18th March 2025

5. AME
5.1 AME Mechanical

5.1.1 Moorings

Note: Mooring release codes are not included in this synthesised report but are available in the original separate report available on request

Introduction

During SD046 the intention was to recover 12 moorings and redeploy 9. Four of them were for Ecosystems (P3, WCB, ECB and Biopole) with only Biopole not planned for redeployment. The other eight moorings belong to Polar Oceans (SST-W, SST-C, OP1, OP2, OP3, OP5, M2 and M3) with only the SST moorings not planned for redeployment.

This didn't quite work out due to some Polar Ocean moorings not returning and only parts of others returning leading to a reorganisation of what was possible.

Narrative

09/02/2025 - P3 Recovery (Event 010)

In position 52° 51.28'S 040° 04.97'W for mooring recovery @ 18.23 UTC
Mooring all onboard @ 00.40 UTC

Comments - Struggled to lift Trimsyn pellet float onboard as line appeared shorter than need for vessel movement and weight of buoy needs to be considered further.

The only place that the release codes exist for the releases recovered on this mooring (93 and 2060) was within the Deck Unit. There are no build sheets and hence no record of the codes if the deck unit fails.

OPIC instrument recovered with significant damage and I understand only 3 samples.

10/02/2025 - WCB Recovery (Event 014)

In position 53° 47.44'S 037° 56.05'W for mooring recovery @ 14.02 UTC
Mooring all onboard @ 18.54 UTC

Comments – Continue to have an issue with the recovery line float as with P3. The crew are finding it impossible to bring onboard to separate and end up cutting it off the larger buoy lifting line once attached to the recovery line.

13/02/2025 – ECB Recovery (Event 023)

In position 54° 06.23'S 036° 14.79'W for mooring recovery @ 13.30 UTC
Mooring all onboard @ 16.29UTC

Comments – Both the beacons fitted at deployment had failed due to water ingress, whether this was due to damage on deployment or due to other factors it is not known.

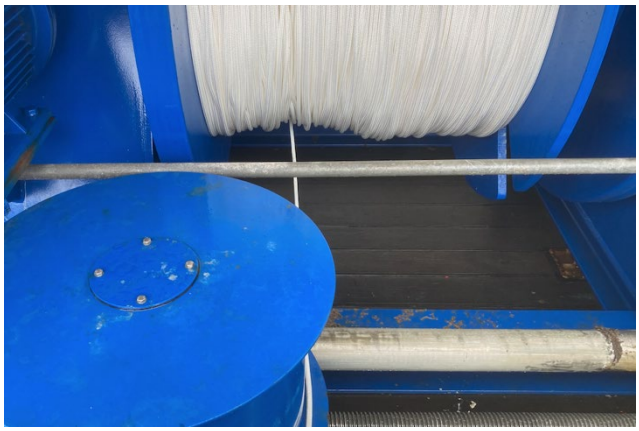
14/02/2025 – P3 Deployment (Event 028)

In Position 52° 49.01'S 040° 01.81'W for mooring deployment @ 20.20 UTC

20.34 UTC - Commenced Deployment

Comments - Main buoy lifted and deployed using Scientific Mooring Winch with vessel pitching. Whilst trying to get the buoy to take slack away we reached the first instrument break at 25m rope out. At this point it appears that the line had bitten into the lay more deeply than first recognised whilst lifting the buoy. This bite rotated with the drum until it was probably above the spooling wheel. Before the winch could be stopped and direction reversed the bite pulled out flicking the line over the spooling gear and coming to rest on and edge of the winch support frame causing the line to be damaged. The line was stoppered off to the deck roller and the multi-purpose winch deployed to secure the main float and enable its recovery to deck. All back onboard by 20.50 UTC. The deployment was suspended pending a full review of the options available.

To try and restrain the rope in future a tube was fitted in the position shown below as a trial. It is lashed to the structure under the motor and rests in the grating to the right-hand side. If this proves useful then proper mountings should be considered, especially on the RHS as the grating is only a composite material.



Scientific Mooring Winch Showing Restraining Bar.

18/02/2025 – Deployment of WCB (Event 052)

Deployment commenced at 53° 48.34'S 037° 55.86'W @ 21.39 UTC

Weight Released at 53° 47.72'S 037° 56.60'W @ 23.21 UTC

Position (Determined by EK640 Echosounder) - 53° 47.74'S 037° 56.5'W

Comments – Deployment went well until it came to easing the releases over the stern, due to the length of the chain once the releases had gone over the stern the steadying line controlling the top of the releases became snagged and

couldn't be retrieved resulting in needing to be cut. As it is above the releases hopefully it won't cause any issues on recovery but could be a consideration if there is an issue.

Due to doubts over whether P3 will be deployed on this cruise it was decided to add the UVP to this mooring.

20/02/2025 – Deployment of ECB (Event 064)

Deployment commenced at 54° 06.23'S 036° 13.96'W @ 13.54 UTC

Weight Released at 54° 06.21'S 036° 14.50'W @ 14.59 UTC

Position (Determined by EK640 Echosounder) - 54° 06.21'S 036° 14.41'W

Comments - Due to the failure of the original beacons it was decided to fit two Sable beacons as the on/off function on one appeared iffy despite appearing to work on recovery.

24/02/2025 – Recovery of SST – C (Event 083)

Arrived on station on evening of 23rd and overnight time spent trilaterating releases and trying to see top floats on EK80. As SST – C was visible on Echo sounders it was decided to attempt recovery of this one first.

Mooring sighted at 60° 13.33'S 025° 08.23'W @ 18.50 UTC

Mooring Onboard @ 21.55 UTC

Comments - The mooring was recovered intact even if the recovery line float was entangled with the top buoy cluster making recovery challenging in the conditions.

25/02/2025 – Recovery of SST – W (Event 086)

Mooring sighted at 60° 06.36'S 025° 17.46'W @ 11.20 UTC

Mooring Onboard @ 13.08 UTC

Comments – Releases responded, but upper float could not be located on EK80 echosounders. Mooring was released, but there was no appearance of the top float, although there was a couple of reports of single light flashes in the distance nothing definite was identified. Continued to track the releases to the surface, where the release floats were sighted and ship manoeuvred to recover. Recovery was challenging due what remained of the mooring and the lack of knowledge as to what remained that was unseen. Floats and releases recovered leaving line trailing into the water. Some white rope, different to the mooring ropes and of unknown source, was entangled with the Aquadopp just above the release floats and was seen to be loose on the rope. As what remained below was unknown and hence sensor might drop off the rope it was recovered by being able to grapple the loose white rope whilst slowly hauling the rope to keep the sensor at the surface. A SBE 39 was found clamped to the rope further up but then end of the rope appeared

where it had parted. No definite cause for the rope failure was identified, but it occurred near some black tape which might have been the location of the SBE37 above and hence the rope might have snagged and parted at some point.

03/03/2025 – Recovery of OP3 (Event 110)

Mooring sighted at 60° 39.34'S 042° 13.51'W @ 13.00 UTC

Mooring Onboard @ 14.00 UTC

Comments - uneventful and fully intact.

03/03/2025 – Recovery of OP1 (Event 111)

At Mooring site at 60° 38.20'S 042° 05.95'W @ 14.44 UTC

Mooring Release declared unsuccessful @ 17.27 UTC

Comments – This mooring used Ixsea releases, but due to other issues we were using the Edgetech box to communicate with it. This isn't as intuitive as the Ixsea box on first using, but advice received from ashore was that they were lying down and nothing appeared after releasing.

03/03/2025 – Recovery of OP2 (Event 112)

Mooring sighted at 60° 37.95'S 042° 10.51'W @ 17.55 UTC

Mooring Onboard @ 19.48 UTC

Comments – releases along with floats immediately above recovered, but wire had failed just above first set of floats as shown below.

04/03/2025 – Recovery of OP5 (Event 119)

Mooring sighted at 60° 37.22'S 041° 56.30'W @ 19.04 UTC

Mooring Onboard @ 20.36 UTC

Comments – Mooring fully recovered onboard.

08/03/2025 – Recovery of Biopole Mooring (Event 139)

Mooring sighted at 62° 07.98'S 050° 29.18'W @ 12.32 UTC

Mooring Onboard @ 15.40 UTC

Comments – The mooring was recovered as shown in the revised drawing from held on record, but as suspected there weren't links below equipment to allow for their safe removal. Given it is common practice to deploy moorings buoy first and recover top buoy first there should be links both above and below equipment to allow speedy and safe fitting/removal.

11/03/2025 – Recovery of M2 (Event 158)

At Mooring site at 62° 36.90'S 043° 14.61'W @ 10.53 UTC

Comments - Mooring responded to acoustic signal and acknowledged release of both releases without appearing to rise. To more positions taken to trilaterate again for future reference as below. No sacrificial wires onboard and so unable to dredge. This raises the issue of having a dredging kit mobilised onboard when ever recovering moorings just in case.

2nd Position - 62° 36.11'S 043° 15.60'W
3rd Position - 62° 37.71'S 043° 15.61'W

Further Comment – mooring checked on return from M3. It remains in position and upright.

14/03/2025 – Recovery of M3 (Event 168)

Mooring sighted at 63° 32.47'S 041° 47.41'W @ 12.18 UTC

Mooring Onboard @ 14.43 UTC

Comments – top float came to surface completely entwined with first set of floats which made recovery challenging. One section of wire had kinked and twisted just above an instrument, not clear when this happened but given the wire wasn't damaged then it was probably on recovery.

14/03/2025 – Deployment of M3 (Event 169)

Deployment commenced at 63° 31.86'S 041° 47.80'W @ 21.00 UTC

Weight Released at 63° 32.00'S 041° 46.62'W @ 23.21 UTC

Trilaterated Position 63° 31.92'S 041° 46.247'W

Comment – deployment well and as per the drawing shown in the drawings section.

17/03/2025 – Deployment of OP2 (Event 185)

Deployment commenced at 60° 38.47'S 042° 07.89'W @ 13.21 UTC

Weight Released at 60° 38.472'S 042° 10.645'W @ 16.38 UTC

Trilaterated Position 60° 37.04'S 042° 08.030'W

Comment – deployment well and as per the drawing shown in the drawings section.

18/03/2025 – Deployment of OP1 (Event 190)

Deployment commenced at 60° 38.76'S 042° 05.50'W @ 11.29 UTC

Weight Released at 60° 37.43'S 042° 05.50'W @ 14.42 UTC

Trilaterated Position 60° 37.04'S 042° 08.030'W

Comments – the new deployment arrangement called for the two lowest clusters of three floats to be modified onto Eddygripp ropes, however due to time constraints they were serviced and redeployed on chains.

18/03/2025 – Deployment of OP5 (Event 192)

Deployment commenced at 60° 36.58'S 041° 57.13'W @ 18.44 UTC

Weight Released at 60° 36.89'S 041° 58.61'W @ 20.08 UTC

Trilaterated Position 60° 36.96'S 041° 58.620'W

Comment – deployment well and as per the drawing shown in the drawings section.

22/03/2025 – Deployment of P3 (Event 206)

Deployment commenced at 52° 51.31'S 040° 05.17'W @ 12.25 UTC

Weight Released at 52° 51.54'S 040° 05.34'W @ 16.04 UTC

Trilaterated Position 52° 51.3767'S 040° 05.0480'W

Comment – deployment well and as per the drawing shown in the drawings section.

Mooring redeployments

See Sections 4.1 and 4.2 for deployed mooring arrangement diagrams

Serial Numbers Etc.

Deployments

WCB (Ecosystems)

Releases – Xisea Type Oceano R5 (PAA01211)

Serial Nos. 21020004
21020005

Beacons

Novatech Iridium Beacon

Model MMI-513-22000
Serial No N07-038 (Body)
M21UCS (Head)
IMEI 301434061315010

Argos Beacon

Model SMM 500
Serial No 251
ID 35520

ECB (Ecosystems)

Releases – Xisea Type Oceano 2500S (AR861B2S Series)

Serial Nos. 93
2060

Beacons

Xeos Technologies Sable Iridium Beacons

Model Sable SMM 500
IMEI 300034013901110

Model Sable SMM 500
IMEI 300034012098770

M3 (Polar Oceans)

Releases – Edgetech

Serial Nos. 33614

33147

Beacons

Novatech VHF RF
Model RF-700A 1
Serial No. W02-085
Frequency 159.48000 Mhz
Channel B

Novatech “Double Burst” Flash

Model ST-400A
Serial No. Z03-086
Note Auto ‘Daylight Off’ Should be disabled

OP2 (Polar Oceans)

Releases – Edgetech

Serial Nos. 32131
49027

Beacons

Novatech VHF RF
Model RF-700A 1
Serial No. W08-053
Frequency 159.48000 Mhz
Channel B

Novatech “Double Burst” Flash

Model ST-400A
Serial No. V08-057
Note Auto ‘Daylight Off’ Should be disabled

OP1

Releases – Xisea Type Oceano 2500S (AR861B2S Series)

Serial Nos. 565
1618

Beacons

Novatech VHF RF
Model RF-700A 1
Serial No. W02-084
Frequency 154.58500 Mhz
Channel A

Novatech “Double Burst” Flash

Model ST-400A
Serial No. W02-087
Note Auto ‘Daylight Off’ Should be disabled

OP5

Releases – Xisea Type Oceano 2500S (AR861B2S Series)

Serial Nos.	564
	1615

Beacons

Novatech VHF RF

Model	RF-700A 1
Serial No.	Y07-010
Frequency	160.725 Mhz
Channel	C

Novatech “Double Burst” Flash

Model	ST-400A
Serial No.	W02-088
Note	Auto ‘Daylight Off’ Should be disabled

P3

Releases – Xisea Type Oceano R5 (PAA01211)

Serial Nos.	22060086
	22060087

Beacons

Novatech Iridium Beacon

Model	MMI-513-22000
Serial No	N07-037 (Body)
	# M21UC4 (Head)
IMEI	301434061312050

Argos Beacon

Model	SMM 500
Serial No	280
ID	60210

Mooring Equipment Issues

Scientific Mooring Winch

After the recovery of P3, during the winding off the rope, the winch failed electrically. Initial indications that the drive unit had failed again proved unfounded and the smoke marks on the casing actually came from the adjacent brake rectifier unit which had failed. Apparently, this is a double action rectifier, and no spares are presently onboard. The ship's team couldn't replicate exactly, but did provide a working solution. The only compromise was that it wouldn't release directly if the winch was hauled. So, to haul you first need to payout slightly, before selecting haul. This is not a serious problem, the operators quickly got the hang of, but obviously it needs repairing before it's next required use.

During the first attempted deployment of P3 the rope jumped the spooling gear after biting in whilst paying out. It presently has a temporary bar fitted to act as retainer should the same occur again. Consideration should be given to making this a more permanent arrangement.

On completion of all operations the deck team kindly greased it for us before covering over.

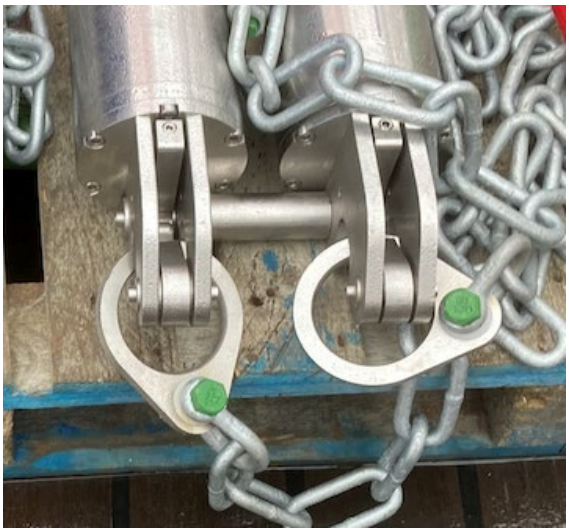
Deck Unit (Ixsea)

The unit worked well with the overside hydrophone (dunker), but issues were experienced trying to use it on the hull mounted transducer connection in the Main Lab. When plugged in its operation was very patchy and unreliable. AME (E) checked the cable including remaking the plug twice, but consistent use couldn't be achieved. The cable actually worked better with the plug removed and just wires pushed into the deck box socket, but this didn't happen without some issues.

The arrangement and lead need a through overhaul and probably a new Amphenol connector to cover all the bases. The lead will be returned to Cambridge for attention.

Releases

The Ecosystem Oceano releases seemed to suffer greater corrosion than Polar Ocean releases of the same type. Both the 2500 and R5 releases are made from Super duplex stainless steel which is a magnetic version of the stainless steel. It is understood that Polar Oceans source their fittings from Ixsea and so are presumably of the exact same material as their releases came up in a pristine state and only required servicing and the same hardware was reused i.e. spacer bars, washers and screws. The picture below shows a pair of Polar Ocean releases ready to redeploy with original hardware.



The R5s on the Ecosystem moorings used A2 and A4 stainless steel fittings and experienced significant corrosion/erosion and shown in the pictures below. It is noted that the biofouling of the South Georgia moorings was more excessive that the Polar Ocean mooring, but does this explain the disparity in corrosion levels?

Sable Beacons

When the two Sable beacons were removed from the P3 and WCB moorings it was found that they had both been deployed without the bottom securing bolt being fitted. Essentially, they had just been pushed together. It was also found that one antenna was different to the electronics contained within, meaning the IMEI number on the circuit board didn't match the messages identification when tested. That was beacon 300034013901110.

It was felt that we could not redeploy without a locking screw and so an arrangement, similar to that shown in the manual, was fashioned with onboard materials. The barrel connector, as shown below, has a metric thread and so was forced on to give a secure connection. Maybe when they are next turned round then the centre threaded rod should be changed for metric.

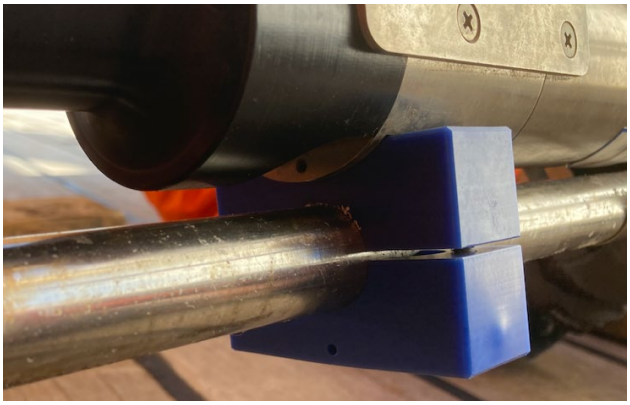
Seaguard Current Meter

It was found that some of the instruments did not have some of the side bars that other ones did despite having the fixing holes for them. It was also apparent that the bars were not swapable from one model to another as the dimensions were slightly different. Whether the additional bars are an extra or just missing, but would be good to identify and aquire them before these instruments are required for use in anger.

Hardware

There is a lack of cap screws helps onboard to service the mooring instruments and so we had to review condition and reuse where possible to eke out the supplies we had. In particular M6 x 60mm and M6 x 75mm A4 cap screws for the instrument overhauls and original CTD clamps.

The lack of replacement fittings required us to use the new supplied CTD clamps on the ECB mooring. However, they are only threaded into plastic rather than using through bolts with nuts and washers. There is also a gap when tightened, as shown below, and so there was no confidence that the threads would withstand the whole deployment and so an additional Jubilee clip retaining strap was fitted.



In particular the Biopole mooring lacked a number of master links in the system, particularly below instruments which caused issues and concerns during recovery. This meant that the stoppering off had to occur using the 2t shackle that attached the rope. This was a very tight fit and also meant that the larger instrument shackle needed to disconnected and then left inline rather than just using a master link and removing the instrument complete, which would have been a much more straightforward and less risky process.

Shackles and Master Links – because of the lack of equipment in the mooring boxes and the requirement to renew hardware the cupboard in the Rough Workshop was raided for Master links, 2t shackles and the last two 6.5t shackles as they were only thing that would fit the UVP frame. We also use a few 2t shackles from Polar Oceans for the Trimsyn buoys.

5.1.2 Scientific Equipment

Authors: Matt Hood and Simon Wright

Bio Wire

Setup

The termination (potted) was retained from the previous cruise, though with an empty oil-filled junction box (stainless steel housing). Testing was carried out prior to oil-filling:

Fibre optic attenuation: -12.56 dB from PC to termination

Insulation resistance: > 220 MΩ at 250 V, > 550 MΩ at 500 V

Testing was repeated after oil-filling:

Fibre optic attenuation: -13.20 dB from PC to termination

Insulation resistance: > 220 MΩ at 250 V, > 550 MΩ at 500 V

Load test: 4 t for 5 minutes

When taking the OFJB apart, the strimmer wire holding the lid in place snapped. The lid then had to be hammered through from the other side. An alternative to the strimmer wire might be better.

CRUISE

During the cruise, the Biowire was damaged as a result of a problem with the belly box. The Hydrowire had been selected in order to deploy the bongo but when engaged the box pulled both the bio and hydrowire. At the time the biowire had been pulled through the block on the stern gantry and was lashed to the back of the mooring winch and so the cable pulled over the top of then refrigerated container behind the winch kinking the wire badly (deck engineers have taken actions to ensure this can't happen again). Roughly 14m meters had to be cut off the biowire to bring it back to good cable and both the electrical and fibre connections redone. During this time it was decided that because the deep tow would have to be reterminated anyway and for ease of termination the new MacArtney bullet would be used, leaving the deep tow without a termination. In conjunction to this the new oil filled junction box was requested to give it it's first test in anger. After the termination was completed an insulation resistance and fibre attenuation test were carried out prior to and after the box was filled with oil. With both of them passing, the biowire was connected to the RMT cross (stored in the science hanger) as a final test with the camera and lights being used to confirm we had comms from the dwnm computer.

Sadly this termination did not last long as the cable from the bullet to the junction box pulled out on the junction box side by about an inch whilst it was being pulled from the rough workshop to the stern gantry. This might have been down to the different style of cable gland fitted to the polycarbonate junction box compared to the far more substantial glad one on the ss junction box. This cannot be confirmed for certain although the cable never got caught on anything during the move, and I cant see the harm in changing it anyway as it provides more protection from the cable pulling out whilst passing the termination over the sheath. From a quick visual assessment everything seemed to be alright though, except for some of the oil leaking onto the deck, so the cable was pushed back into the junction box and was carried

down to the square. Before passing it over the block, the biowire was connected up to the RMT to test if it was alright but the diagnostic tool for the dwnm showed an Rx power of -35 Db and no connection was able to be made. To ensure this was a broken connection and not dirt that had got onto the fibre the power was turned off to clean both connectors.

Whilst doing this I managed to give myself an electric shock off the junction box. During the test, myself and Simon had been communicating via radio and I had asked him to turn off the power so that I could disconnect the fibre bulkhead to clean it. I'm unsure as to whether I was just a bit too eager, and Simon was still turning it off, or if it takes a while to discharge but turning it off was only a precautionary measure as I did not intend to touch the power at all. The electric shock was received when I touched the anode in order to pick the junction box off the deck and caused my hand to pull away quite quickly. No injury was caused and the incident was reported to the bridge the next day, but I do not believe this was down to the cables pulling out of the junction box as they were still all secure in the wago connectors and no damage to the sheathing was found then the junction box was disassembled. Further investigation should be taken before this junction box is used again.

After cleaning and reconnecting the fibre again, I think the break had been disturbed enough to break it entirely with the diagnostic program showing a Rx power of -49.9 db. When reterminating it was decided that the original ss junction box would be used rather than the new polycarbonate one, mainly because of the risk of electric shock but also because the ss junction box has a lifting eye on it which makes it much easier to secure onto a length of rope whilst passing it over the sheath. After reterminating, an insulation resistance and fibre attenuation test were performed pre and post oil filling and once again the biowire was connected to the RMT cross to ensure everything was working as it should.

This termination remained in use till the end of the cruise where it was cut off so both the bullet and the junction box could be sent back to Cambridge. As it stands currently both the Biowire and Deep tow cables are unterminated.

Post-cruise tasks

Test new oil filled junction box to ensure that it is safe to use

Change SS junction box fibre connection from a cable gland and whip to bulkhead connector like the new oil filled junction box so that the fibre whip can be removed before passing it over the sheath which could potentially damage it

Modify new junction box so that a lifting eye can be fitted making it easier to pass through the block

Change the cable gland on the new oil filled junction box to match the one on the SS junction box

Find or purchase a new quick filler for the junction boxes

Purchase ss grub screws for MacArtney termination (mild steel ones had to be used during cruise)

Deep Tow

Setup

The wire was unterminated upon arrival to the ship and was re-terminated during mobilisation using the new MacArtney termination and an OFJB. The intention was for it to be a spare for the Bio Wire and to teach Matt and Simon how to do a termination in case it became necessary.

It was suggested afterwards that cutting the armouring wires in a downward spiral might make it easier to push the inner cone underneath them without having to uncross all of the wires in all three layers.

The two M4 grub screws that secure the outer cone to the fork were missing. During the load test, M4 button head bolts were used instead (mild steel grub screws were found when the termination was used on the biowire and were removed at the end of the cruise)

Didn’t leave long enough on the core – can’t be used for MOCNESS.

Cruise

Termination removed during cruise to be used on Biowire. As of the end of the cruise cable is unterminated.

Post-cruise tasks

Design a mandrel for pushing the inner cone under the armouring wires evenly. Should have a chamfered edge, 12 mm ID, 30-35 mm OD and >110 mm long.

DWNM

Setup

The new small-form factor PC was used to host the DWNM and installed in the cabinet in the winch control room above the deck unit.

Port 1: CTD

Worked when plugged in. Baud rate 9600.

Port 2: ALT/AHRS

Installed seaVIEW version 1.9.0 to configure. Works with both new and old cable, once O2 and ALT ends had been distinguished using pin out diagram and bleep test on multimeter. Baud rate 9600.

Port 3: Flowmeter

Initially confused with COM5 as in the User Guide in the DWNM software but works on COM3. Installed ROVlog to configure. Baud rate 19200.

Port 4: PAR

Initially confused with COM3 as in the User Guide of the DWNM software but works on COM4. Installed SatView to configure sensor but unable to without Instrument Package Files. Baud rate 9600.

Port 5: O2

Only works on black fish using new ALT/O2 cable as there is 0 V_{out} on pins 5 and 6 on the green fish. Configured using diagnostic cable (SubConn-DSUB) and DSUB-USB into DWNM PC. Settings changed as in user guide using AADI Real Time Connector software. Comm TimeOut changed to Always On in User Maintenance settings (password 1000).

Port 8: Fibre

-11.26 dB on MOOG software. Baud rate 115200.

Camera

Co-axial cable from deck unit to DWNM PC had to be switched so both were on video port 1 (left on deck unit, right on DWNM PC). Otherwise worked well with a smooth video feed.

Lamp

Visible and UV lamp worked when plugged in, including brightness.

cruise

During the cruise we experience connection issues with both fish. Over the course of the cruise the mocness had been left lashed on deck outside whereas the RMT cross had been brought inside the science hanger after each deployment and secured there. The problems started with the mocness failing to connect to the dwnm system. Even after cleaning the bulkhead connector on the fish (green) remained dirty and as there was frozen water on the frame. Originally we believed that the cleaning solutions were freezing upon contact with the bulkhead and so attempts were made to warm up the bulkhead before cleaning but this did nothing to help with the connection issues and so the mocness was substituted for the RMT which connected first time upon being brought out from the hanger. This continued the next

day even though it was warmer than the day before and we started to wonder whether the issue was down to the temperate as the RMT had connected first time when brought out of the hanger but by the time we had moved the mocness out and put the RMT nets in its place it was struggling to connect again although a thorough cleaning seemed to solve this problem. On the 3rd day to pre-empt this we took the green fish out of the mocness and brought it inside the rough workshop so that it could warm up before deployment but this failed to resolve the issue and so once again the RMT was substituted in. Once connected up it was noted that the light was not responding to any input commands from the DWNM during the pre-deployment checks. In a rush to get this in the water and as the camera was working fine it was decided to fish the RMT blind. It was also noted at this time that the ethernet light on the DWNM was red instead of green but the significance of this was not understood until we had sent it down to 1000m and attempted to fire the first net at which point nothing happened. Upon recover our fears had been confirmed and none of the nets had been fired.

We now found ourselves in a situation where we had 2 broken fish, both failing within a short space of time and with no obvious reason as to why. Having talked to Gareth questions were raised as to whether the DWNM computer might be to blame and so the spare deck unit was set up but still no connection could be established. Focusing on the RMT fish (black), the next assumption was that the nudam board might have gone pop which would explain why we were able to establish a solid fibre connection but have no input control to either the light or the motor. To determine this the black fish was opened up and inspected by Chris but no obvious signs of damage or loose connections could be found. Thoughts then turned to the multiplexer board culminating in the board being taken out of the spare deck unit and being put in the black fish, but still no connection could be established. My next port of call was to see if a connection could be established if the ethernet cable could be taken out of the black fishes nudam board and placed into the green fishes proving definitively that the board was at fault. Whilst trying to do this I must have disturbed the board as lights came on and when I checked the diagnostic program an ethernet connection between the black fish and rack mounted DWNM had been established. As it turns out the top board had become dislodged slightly separating the connection between the 2 nudam boards but not enough for it to be visually apparent. Due to the way the board is secured to the fish no measures could be taken to better secure the top board whilst at sea but this should definitely be looked at back in Cambridge.

As for the green fish (mocness), once it was opened up I was able to bypass the bulkhead connector by plugging straight into the multiplexer board, and when tested was able to establish a solid connection with the DWNM. Once the connector had be changed for a new one the fish was tested again and worked fine.

Post-cruise tasks

Update DWNM software to accurately reflect correct COM ports and possibly change the name of the ethernet indicator to more accurately reflect its role

More cleaning equipment for fibre

Look at securing the nudam boards better

One of the altimeters didn’t work and will need looking at

RMT8

Setup

Made bracket to hold camera and light (also transferable to Mockness) as no bracket could be found to mount them. Stauff clamp was missing for the altimeter mount and so one was stollen from the engine room. Both the junction box and the flow meter had to be jubilee clipped onto the cross as no brackets could be found to mount them.

During the cruise the RMT suffered from misfiring nets because the spring steel arms that retain the latches within the RMT release mechanism were worn out and so were not providing enough resistive force, and as a result when the nets were fired they would either pull closed immediately or soon after firing as a result of the drag on the net. To solve this both releases were stripped down during the cruise and the spring steel strips turned upside down or re-bent. This seemed to have solved the problem although it would be good to replace or make spares for these should they go again.

On the final deployment of the RMT, during the pre-deployment checks the timing was found to be out (cam positions were behind where they should have been). Problem was rectified on deck, and RMT deployed. During the trawl though the nets failed to fire properly:

First net didn't fire

Fired again which released first net

During this section the net pulled the second release causing the net to close prematurely

Second net was fired but net pulled through soon after

After recovering to deck the timing was found to be out again, presumably caused by a sticking mechanism that meant the camshaft wasn't intonating as it should be. Although I don't think this was the actual problem from earlier failed nets as timing was found to be correct on those but rather a combination of both worn out springs and a sticking mechanism. This highlights that both releases need a decent service before the can be reliably used again.

It was also noted during the cruise that the bolts in either end of the bottom weight bar kept coming loose. This didn't cause any problems as they were check before each deployment but a possible remedy to this would be to modify the end plates so that the bolts could be wire locked off to them although this would require drilling the head of the bolt to pass the wire through.

The altimeter originally fitted to the RMT proved to be faulty as it never gave a reading and was replaced with the one off Mocness. Altimeter was marked as bad and sent back to Cambridge for repair.

After the termination was changed on the Biowire to the new MacArteny bullet, 2 shackles had to be used to attach the termination to the cross. This seemed less preferable to the old style termination which used a clevis fitting to secure onto the cross. The benefit of which was that it greatly limited the movement of the cross relative to the bullet protecting the fibre and electrical wire from pulling or pinching. As a means of getting by we ensured that when the RMT was connected the opening where the cable came out of the termination always pointed towards the cross and we took the cable back on itself in a big loop attaching it to the cable above the termination using several cable ties before bringing it down to the cross. This means you need to have a fairly long length of cable coming out of the termination to the junction box (roughly 3.5m) which is fine as this is what's needed for the mocness but

still doesn’t entirely remove the chance of it damaging the cable during deployment. To solve this properly a H style adaptor would need to be machined to replicate the restrictions of the old clevis style termination with the 2 female sockets being 90 degrees apart so that the opening in the termination can face towards the cross.

The new UV light was trialled towards the end of the cruise, but the scientists on board were not so keen on it as the image quality and depth of vision were greatly reduced. The overall effect was more of a purple haze and so the light was changed back to the original white light. It was suggested that maybe an infra red light might work better as this would not disturb the potential catch meaning it could be run continually unlike the current light.

Post-cruise tasks

Rebuild and service both releases

Look at securing bolts into weight bar

Build H style adaptor for new termination.

Look into infra red light and camera

MOCNESS

Setup

Set up of the mocness was hampered by the lack of documentation or bracketry for the instruments that were to be fitted. This meant that 2 new brackets had to be made from Unistrut and flat bar to provide a base to which the CTD, junction box, and flowmeter could be jubilee clipped. There was also no bracket to fix the camera and light to and so a further bracket had to be made to fit the bracket made up for the RMT (which was beneficial as there was only one camera and light so this had to be constantly transferred each time). Furthermore no indication could be found for the location of the altimeter and so this was jubilee clipped to the frame.

During the cruise the mocness performed fine, and apart from one slightly torn net that was caused as the cod end was dragged onboard no issues occurred. Deployments were significantly hampered by fish problems though as stated earlier in the report.

One of the intentions of the cruise was to test the second release, which we had been informed only needed filling with oil. When the release was finally found some of the parts were missing and it was apparent that the release would need building first before testing. By the time the rest of the parts were found in an unmarked box at the bottom of one of the mooring containers it was too late to test the release and so all the parts were packaged up in one box and sent back to Cambridge.

Post-cruise tasks

Make suitable brackets for mocness instruments and or document where stuff goes.

Build second release so that all that needs doing to it is filling it full of oil before testing.

Bongo

Setup

The lifting block was replaced with a larger version.

Gunnebo swivel was seized solid so that although it rotated nicely the pin could not be removed to take out the old swaged eye. Tugs lent us a swivel for the cruise that was the same as the one originally on there but as a preventive measure it would be good to separate the swivel after use so this can't happen again.

The problem of the swivel entering the winch room was observed again, and so to remedy this the compensator wire had to be re-swaged after 1.5 m of line was taken out. This was done by fixing the bongo to the deck using a ratchet strap and then a block and chain, fixed to the deck using an eye, used to pulled tension out until it could be stoppered off. At this point the line was cut and re-swaged before the stopper (mole grip) could be removed.

The cod end supports also had to be moved inboard to avoid the bulwark doors, but throughout the cruise the frame was always lifted clear of the stand and pulled back before the doors were opened which removed the need for this to be done, but it is good to keep this as a standard practice incase the doors are opened without the frame being moved.

It was noticed during the cruise that the main poles that run the length of the bongo were deforming under the weight of the compensator when stored horizontally on deck. In order to support the compensator a large piece of wood was placed underneath to take the weight of it. The practice of moving it about with the seaonics crane was also stopped as it was noticed that this was also deforming the poles. This meant it either had to be moved in a 4 man lift, which was just about alright for short distances but was no good for anything further than a couple of meters, or by 2 pallet trucks which proved to be a massive pain. Moving forwards, it might be good to look at the frame design and integrate a trellises like bracing to it to support it further stopping deformation and add a dedicated lifting point at the centre of mass so that it can easily be moved about the ship. In addition to this, as much as the piece of wood worked well it would be good to have a cradle made that can support the compensator when not in the stand.

Also, during the cruise, the 3 floats that help keep it upright began to come loose, which was put down to the distortion within the frame. This continued to worsen even after the above measures were taken until some of the mounting pads for the stauff clamps came off. A repair was done by Simon to the floats with longer bolts being used and the pads that had come off being masticed and back on and as a further measure a ratchet strap was wrapped around the frame to keep its shape but the floats need to be replaced or a different way of fixing the devised.

It was also noticed that the poles and floats were filling with water increasing their weight after each dip and so it would be good to fit drain holes to the bottom bungs in the poles to stop this happening again.

As a final thing to consider, when the bongo is being lifted up in the stand, just before it reaches vertical the weight comes off the winch and if not pushed forwards into the stand it has the potential to fall to the side. One remedy to this would be to add soft close system (like fancy kitchen cupboards) that would keep it more stable or moving the winch position that might be more of a pain.

Post-cruise tasks

Make cradle to support weight of compensator when not sat in frame

New floats for bongo

Spare swivels or disassemble swivel and store in rough workshop at end of cruise so it doesn’t seize

Look at supporting the frame with a bolt on trellis

Look at modifying stand to make lifting safer

Mammoth

Setup

New ropes for the auxiliary winches had to be made as they had previously been modified so the mammoth could be deployed off the starboard gantry. This task was managed by the scientists who opted to change the way it attached to the carousel, moving away from a y shaped line to one long line with a large spliced loop in it that would allow the carrousel to move on the rope. This is easier to do as the previous way required the 2 bottom line lengths to be spot on or the carrousel would sit at a cocked angle but the carrousel didn't appear to move much on the rope.

As part of the mammoth set up, a new reed switch needed to be fitted to one of the flow meters. Whilst doing this the other flow meter which was being used as a comparison got broken as well. During the cruise both flow meters were taken off and given to AME electronics as they had spare reed switches but the fix was also unsuccessful and so as it stands currently both flow meters will need looking at and repairing before the next cruise.

3rd March: Mammoth was deployed in a sea state that in hindsight was slightly beyond what it was comfortable with and came back with significant damage, which included several severely torn nets, broken cod end sleeves, damage to the carousel, and a broken mechanism. The mammoth was brought into the hanger and the slow process of untangling the nets some of which had risen back up through the mouth of the mammoth and tangled into other nets began. Once it had been stripped down and all the sleeves removed a proper assessment of the damage could be made. We had enough spare nets that, by repairing some of the less damaged nets (which was very kindly done by Katrin, Nadine, and Petra) we would be able to make a full set. There were spares for the cod end sleaves to replace the damaged spigots although the sleaves themselves had also been damaged and so would need to be assessed to decide which ones could be used. The damage to the carrousel was caused but the spigots pulling out which had flared the ends of the bars but not by enough that they could not be reformed. This just left the mechanism which had taken the brunt of the damage. One of the arms (number 5) had sheared the bushes that it pivots on and had been pulled down by the tension of the spring. This had also deformed one sides of the frame significantly causing the other arm to come out of alignment. To be fair the damage looked much worse than it was and it was decided that by taking the mechanism apart and removing the arm we could move everything else back up and run the mammoth with 8 nets instead of 9 (loosing the very last net). It was during the strip down that we discovered small fractures in the welds of other arms, which might explain why the arm went in the first place but I don't think this was the cause of the problem but rather a result of it brought on by weaking that had been happening in the background. Part of the problem with the arms, and I think why we are getting these small fractures, is that the bosses on which the arm pivots have been welded onto the main arm but without any decent penetration to give it strength. At the point where the arm bends as it enters the mammoth the bar has been spot faced to accept the 2 bosses that have then been welded on. The weld does not cover the entirety of boss resulting in 4 tails from which these fractures can propagate. In addition to this the boss that has been welded on had not been chamfered and so the weld just lay on top of both bars without any penetration whatsoever. Presumably the rest of the bars have been made exactly the same and before the mammoth is deployed again I think the whole mechanism should be stripped down, each bar thoroughly inspected and maybe a new set made up (with decent welding). The lack of penetration can also be found in the frame as the 2 sides of sheet stainless are just but welded together with the weld predominately laying on top so the half of the joint is not fixed at all. This is why when all the

nets are cocked the safety bar is so hard to move compared to when the tension is off as the entire frame is bowing. On to this sheet steel the carriers are mounted using 2 M8 cap heads at 90 degrees to each other, although these are fairly substantial because there is no strength in the frame and each carrier is independent to each other they are able to move as the frame distorts.

Once enough of the arms had been removed, the frame was straightened so the arms would sit right but by hammering it back into place the weld split and so had to be reinforced by a section of mild steel angle that sat over the top of the joint with 2 holes drilled into it to allow for longer M8's to pass through and into the carriers. Because of the way the Mammoth has been designed it is difficult to significantly strengthen this joint to avoid this happening again. It might be worth looking into getting a thicker piece of stainless laser cut with slots in to allow the movement of the arm to be unimpeded which once bent to 90 degrees can be place over the outer face of the joint to strengthen it. The only problem with this is that it would have to be quite a sharp bend as any internal radius would fowl the corner of the frame (which cannot be removed as this will take away some of the weld) useless you can space it off with a shim.

Once the mechanism had been fixed, braced and the springs attached our attention could then move on to the cod ends. Where the spigots had pulled out of the carousel often the countersunk screw had pulled through the sleeve rather than the spigot splitting at the pin. Where this happened an assessment had to be made as to whether it was safe to fix these in case they broke again and caused more damage to the nets. This was based on the size of the hole created by the countersunk screw and how far the fractures had spread through the sleeve. To attach a new spigot most of the time a penny washer had to be added to give the spigot a base to sit on but if the hole was too big then the spigot would pull through. The only spares that had been sent to fix the cod ends were the body's for the spigots and although this was helpful, preassembled spigots would be better as it was difficult to disassemble the pin even once the roll pin had been drilled out as the heads were stuck on the shaft and one snapped on the centre line of the roll pin hole during removal. I think the spigots had also been stuck on to the sleeves as the new spare bodies kept coming loose irrespective of how tight they were done and so had to be checked each time before deployment.

After all the sleeves had been repaired as best they could they were fitted to the carousel to identify which of the arms had flared and then the arms reformed to better hold the spigots. Once this was done the rest of the mammoth could be rebuilt ready for the next deployment. The mammoth also had to be reprogramed to account for the loss of one of the nets but I was important that the mammoth was still fired 10 times so the timing was correct ready for the next deployment.

Because of the damage to the Mammoth a discussion was had as to whether we should continue to deploy the mammoth off the stern or if it would be better to deploy it midship. By deploying it midship any effects of the swell on the carousel would be greatly reduced but conversely you would be far more susceptible to the wind as you would no longer be in the lea of the ship. It was decided that the mammoth would be deployed from the starboard gantry on the GP wire for its first deployment after the incident. This involved removing one of the lines for the auxiliary winch which meant that it would be lifted at an angle which was not ideal but could not be avoided. The forward block was used as this had already been set up for the hydrowire. Unlike the bongo it was decided that the mammoth should be lifted over the bulwark doors and then after the carousel had been lowered and the auxiliary line clipped on to the mammoth the frame would be lowered till it was just proud of the gunwale

so that the safety latch could be removed. To protect the side of the ship and the mammoth, Brock (one of the deck crew) tied a rope seizing with a hard eye at the top of each side to allow for a steadying line to be passed through for recovery and deployment.

This continued to be the format for deployment for the rest of the cruise and worked well, with the scientists noting that the catch was in a better condition compared to stern deployments. Special attention had to be given to the wind though which then became the limiting factor for deployment, with one incident where the wind picked up significantly whilst the mammoth was deployed. During this recovery, as the carrousel was being lifted the wind took the nets which acted like a sail and blew the carousel out of Sophie's hands. The carousel was caught, and the nets folded which took the power out of them and allowed for the recovery to be finished. If this is to continue though, the recovery method in this situation needs to be address because although it makes it a lot easier to recover and protects the nets, to fold them requires someone to lean over and pull the nets which in turn runs the risk of them getting caught up and pulled over.

On one of the last deployments of the mammoth 3 of the nets failed to fire upon recovery which was due to the battery running out during the cast. Because the mammoth runs off lithium batteries which are very susceptible to the cold and have a tendency to cliff dive its hard to gauge how much life is left in them. This is not so much of a problem from a deployment point of view as the safety latch can be replaced before recovery and then the nets uncocked safely once its back on deck, but from a science point of view it would be good to avoid this. One option is to look into rechargeable batteries which can be topped up before each deployment. Even better would be to have rechargeable batteries that could be charged without having to remove them from the battery holder so that before each deployment the battery case could be removed and the batteries charged through the subcon connector but I don't know how feasible this is.

Post-cruise tasks

Fix broken arm and other arms where fractures have been found – maybe redesign arms

New cod end sleeves and a complete set of spigots not just the body's

Reweld fame where braced

Look at making a more permanent bracket to brace frame

Needs a good service

Debate as to where it should be deployed and what can be done to preserve catch

Order new nets

Look at battery problem

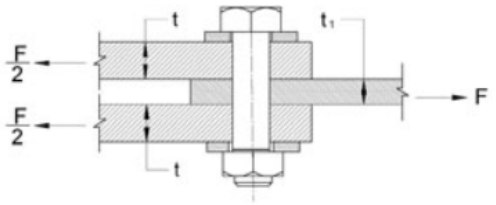
Make more spare cod end sleaves

Make a metal pallet for the mammoth to replace the wooden one its currently sat on

AGT

Setup

The scientists opted to use the undamaged AGT frame. The rubber matting was replaced, and the nets fitted. The bridle was fitted on the port side with the new weak link, which has a theoretical breaking force of 20 kN.(~2T)



Bolt or Pin Double Shear Stress	
Applied Force F (N, lbs) =	20000.00
Bolt/Pin Diameter d (mm, in) =	8.00
Plate Thickness t (mm, in) =	5.00
Plate Thickness t1 (mm, in) =	5.00
Ultimate (Yield Min.) Stress (N/mm^2, lbs/in^2) =	502.00
Factor of Safety =	1.00
Results	
Section Area of Bolt/Pin (mm^2, in^2) =	50.265
Shear Stress ave Bolt/Pin (N/mm^2, lbs/in^2) =	198.95
Bearing Area Stress B_t (N/mm^2, lbs/in^2) =	250.00
Bearing Area Stress B_{t1} (N/mm^2, lbs/in^2) =	500.00
Allowable Stress (N/mm^2, lbs/in^2) =	502.00

This made the bridle lopsided, therefore a master link was added on the starboard side to make the lengths even.

Over the course of the cruise, the rubber matting started to perish and eventually ripped off. This was replaced, but the rubber was modified to have 2 shoulders cut in at the far ends **(see picture)** so that it formed an upside down T shape. This was done because one of the reasons why the rubber was perishing apart from general wear and tear from deployments was the way it sat when the AGT was lashed to the deck. Because the AGT was stored upright the rubber was forced out at a tight angle because of 2 sections of the frame which sat lower than the rest of the frame. Where this was tightest at the edges a split began to propagate which would then spread along the rubber until it ripped off. By cutting the rubber so that it sits around these bits the rubber was able to come out from the frame at a more relaxed angle and wouldn't create this split. A special pallet was also made to store it that consisted of 2 pallets fixed together with a large block of wood at either end for the frame to land on. This raised it up which also helped the angle which the rubber sits at.

A couple of times during the cruise the outer net had to be repaired. There was rope of a similar diameter in the rough workshop that did the job but for future cruises it would be better to get similar rope to do the job as the stuff in the workshop wasn't quite right for it.

The recovery line for the AGT was too long and had to be cable tied to the top of the frame to keep it out of the way of the nets as it kept getting tangled up underneath the frame during recovery. This worked fine for the cruise as the line was never needed but was only meant to be a temporary solution till the line could be shortened although we never got round to this. Before the next cruise though it would be good to assess both the weak link and the recovery line.

Post-cruise tasks

Re assess recovery line length and weak link position

Make a proper certified weak link

Buy suitable rope for repairing the nets

EBS

Setup

Setting up the EBS on the whole went fairly well although it was a bit of a struggle to set up the camera system because of a lack of documentation and the new cables needed for the pressure switch being in a different box to the rest of the kit. Once the cables had been found though it all went together fair smoothly although it was not obvious that the lights in the new system were to be powered off the aux port of the camera. The brackets that held the lights also had to be modified as the stauff clamps were too big for the lights. 2 new sets of stauff clamps were sourced from the engine room and the metal plate which the stauff clamps attach to modified to fit the smaller hole positioning. This caused a bit of a problem as the outer slots that allowed for the angle of the lights to be changed could no longer be used. Instead the stauff clamp that clamps on to the frame used this and 2 new holes were drilled on the same line as the holes that had previously been used by this clamp. Spacers also had to be made out of the old stauff clamp so that the nuts for the clamp holding the lights didn't foul the ebs frame. This did for the cruise but proper spacers should be made before the next cruise.

The new recovery line for the EBS seemed to be too long and had to be snaked across the top of the frame to reduce the length of it before it joined the bridle. This was not a massive problem but in the past it looked like the recovery line just ran along one side of the frame before joining the bridle. Also it would be good to check whether there would be enough hight on the stern gantry to recover the EBS should the recovery line have to be used.

No weak link was supplied with the EBS and so it was advised that a 2 tonne shackle be used instead. Due to the safety factor incorporated in the manufacture of shackles this would give a breaking load of roughly 10 tonne which seems too high for a weak link and so it would be good (and the same for the AGT) to have a certified weak link made up with an agreed breaking load that the ship is happy with.

During one deployment a spring was lost from one of the doors but this did not effect the performance of the EBS at all.

For some reason the Rayfin camera decided to record in alternating 5 and 10 minuet intervals rather than 15 minuets like it should do. It was decided not to try and solve this in case it stopped recording. This should be looked at in Cambridge.

During this cruise the new pressure switch for the lasers was trialled but without much success. The lasers never came on and after an investigation it was found that the rectifier that changed the 24v input to 5v output had melted. Having talked to AME electronics they suggested that this is not the best way to step down the input voltage as it will generate a lot of heat, and as its within a sealed pressure housing that heat will have nowhere to go so more than likely this will happen again. A new rectifier matching the same specs as the old one was soldered on to the feather board and the intention was to test it again but due to other constraints from the cruise there was a delay in refitting the pressure switch until what turned out to be the last deployment of the EBS. After the deployment the pressure switch was checked again and found to be intact but after looking at the footage the lasers never came on. I think this might have been down to the battery which does not appear to hold its charge for more than a 24 hour period. When the pressure switch had been fitted it had been done in a bit of a rush and because the battery had been charge a couple of days before it was assumed that the battery still had plenty of charge left in it. After this failed the deployment the battery was charged again the night before and on the day of the proposed deployment was checked just before fitting to the EBS. When it was plugged into the charger

though the light indicated that the battery was low and started charging it which took the best part of an hour before it was full again. The deployment didn’t go ahead so this suspicion can’t be confirmed for certain but if the battery is definitely dead and needs replacing then maybe it would be worth looking into purchasing one with a lower output voltage.

During one of the deployments the EBS suffered significant damage to the door opening mechanism at the bottom of the EBS and sheared where this leaver met the bottom door. This had been highlighted as a potential problem when work was being done before the cruise, as a small fracture in the weld had been noticed, but given time constraints only a patch repair could be done at the time. The door was rewelded and worked fine for the rest of the cruise but it has highlighted a weak point within the design that should be addressed before it is used again. In order to stop this in the future, it would be good to have the bars that form the frame of the leaver running all the way to the top of the door and the sides welded on to that rather than the leaver and the door being 2 separate constructions welded together. If this was being done it would also be good to look at the pivot for the lever as currently 2 holes have been drilled into the bars for the pins to sit through attaching it to the frame but this removes most of the strength from the bars right where you need it. And so if the design of the door is changed as above this would become the next weak point which would be much harder to fix in the field should this happen again. What would be better is 2 eyes being welded to the top of the lever moving the pivot point up slightly but keeping the strength in the structure below. Matching eyes would have to be added to the frame as well but a solid single bar rather than 2 pins could be used to attach the lever which would also stop any twisting motion in the leaver (not that there was any indication of this in the fracture).

Post-cruise tasks

Make new certified weak link

Redesign pressure switch for lasers

Remake clamps for lights

Look at laser battery to see if its on it’s last legs

Shorten recovery line

Look at the design for the door and pivot point

Acoustic Calibration

Setup

We ran into a couple of problems whilst setting up and running the acoustic calibration. The first of which was that the network ports recommended to be used. It turned out that the VLAN had been reconfigured on the network port

See section 3.1 for further details

Post-cruise tasks

Cut port line – did ek80 but this meant no me70

Ethernet cables

Reproposed network ports

Moorings

Setup

The two new Novatech iridium beacons were activated in Relay on 01/02/25 (IMEIs 301434061312050 and 301434061315010). The mooring weights (railway wheels) were confirmed via load cell.

Workshop

Replace tweezers damaged whilst trying to extract strimmer wire from bio wire OFJB.

Second ATEX walkie-talkie still missing.

Consumables

M6 x 60 + M6 x 70 / 75 cap heads

5.2 AME Electrical

Authors: Chris Gray and Liam Tracy

See Annex AME-E for full report. Below is a table of instruments overseen and deployed by AME Electrical on SD046

Instrumentation

Systems used on cruise

Instrument	#SN if Used	Make and Model	Comments
Acoustic			
Bio Multi-beam(ME70)	Yes		
Bio Multi-beam(MS70)	Yes		
Bio Multi-freq (EK80)	Yes		
Omnidirectional SU94	No		
Omnidirectional SC94	No		
Scanmar net system	No		
Echo sounder (EA640)	Yes		
Bottom profile (Topas)	No		
Swath (EM124)	Yes		
Swath (EM712)	Yes		
ADCP 75kHz	#SN/No		
ADCP 120kHz	#SN/No		
USBL	329980-001	WMT 6 Omni 2012 and 2013. Directional 2714	
Underway Mini SVS	#SN/No		
K-Sync	Yes		
Meteorological			
Air Temperature and Humidity 1 foremast	U0221024	Vaisala HMP-155	
Air Temperature and Humidity 2 science mast 1 inboard	S0850275	Vaisala HMP-155	
Air Temperature and Humidity 3 science mast 1 outboard	S0850273	Vaisala HMP-155	
3D Winds foremast	0115018894	Metek uSonic-3 Cl.AH	
3D Winds science mast 2 port	0111016979	Metek uSonic-3 Cl.AH	
3D Winds science mast 2 stbd	0111016986	Metek uSonic-3 Cl.AH	
Dew Point PT100	174768	Mitchell Inst. Opti-Dew 2	
Dew Point Chilled Mirror	174220	Mitchell Inst. Opti-Dew 2	
Ceilometer	PARSERICSA-2212	Vaisala CL31	
PAR Sensor foremast	SATPRS2212	Seabird PAR-SER ICSA	

PAR Sensor science mast	SATPRS2040	Seabird PAR-SER ICSA	
Precipitation	0490	TheisClima Drisdrometer	
Freezing Rain	13316	Rosemount 0871LH1	
Radiometric SST 1 port	13317	Heitronics CT15.85	
Radiometric SST 2 stbd	190029	Heitronics CT15.85	
Solar Radiation SW foremast	190057	Kipp & Zonen SMP22-A	
Solar Radiation LW foremast	190056	Kipp & Zonen SGR4-A	
Solar Radiation SW science mast	190028	Kipp & Zonen SMP22-A	
Solar Radiation LW science mast	190057	Kipp & Zonen SGR4-A	
Visibility Sensor	N2410065		
Barometer 1 upper	U0250643	Vaisala PTB 330	
Barometer 2 lower	U0221024	Vaisala PTB 330	
Underway Sea Water			
Fluorometer	1498	Chelsea Technologys	
Transmissometer	1279DR	C-Star	
Thermosalinograph	4538936-0130	SBE45	
Temperature 1	38-0767	SBE38	
Temperature 2	38-0771	SBE38	
Flow Meter	24/414055	Litre-miter	
Towed Systems			
Magnetometer	No		
XBT	No		
Rapid cast (CTD)	69835	Rapid Pro CTD	
Rapid cast (SVP)	#SN/No	Rapid Pro SVP	

Instrument	#SN if Used	Make and Model	Comments
Other Ship Science Systems			
Gravity Meter	#SN/No	Dynamic Gravity Systems AT1M	
Piccaro	#SN/No		
Black Carbon	#SN/No		
TE49i	#SN/No		
Goniomiter	#SN/No		
Ship wave recorder	#SN/No		
Ti CTD			
Deck unit 1	No	SBE11plus	
Underwater ACD/ Depth	No	SBE9plus	
Temp1	No	SBE3plus	

Temp2	No	SBE3plus	
Cond1	No	SBE 4C	
Cond2	No	SBE 4C	
Pump1	No	SBE5T	
Pump2	No	SBE5T	
Standards Thermometer	No	SBE35	
Transmissometer	No	C-Star	
Oxygen sensor	No	SBE43	
PAR sensor	No	QCP2350	
Fluorometer	No	CTG Aqua Tracker MkIII	
Altimeter	No	Tritech S10127 232	
CTD swivel linkage	No	Focal Technologies Group	
LADCP Master Down	No	TeleDyne WHM300	
LADCP Slave Up	No	TeleDyne WHM300	
Pylon	No	SBE32	
SS CTD			
Deck unit 1	90876	SBE11plus	
Underwater ACD/ Depth	0480 then 1225	SBE9plus	0480 removed after cast 005
Temp1	32307	SBE3plus	
Temp2	34874	SBE3plus	
Cond1	41913	SBE 4C	
Cond2	42813 then 43248	SBE 4C	42813 removed after cast 007
Pump1	52395	SBE5T	
Pump2	51807	SBE5T	
Standards Thermometer	0051	SBE35	
Transmissometer	1497	C-Star	
Oxygen sensor1	430242 then 432291	SBE43	430242 removed on cast 002
Oxygen sensor2	430620 then 434244 (Ti)	SBE43	430620 removed after cast 007
PAR sensor	70687	Biospherical Instruments Inc. QCP-2350	
Fluorometer	088-216	CTG Aqua Tracker MkIII	
Altimeter	10127.27001	PA200	
CTD swivel linkage	**#SN/No**	Focal Technologies Group	
LADCP Master Down	14897	TeleDyne WHM300	
LADCP Slave Up	15060	TeleDyne WHM300	
Back Scatter Flouromiter	No	Wetlabs EcoBB	
Eco Flouromiter	No	Wetlabs Eco CDOM	
Pylon	3270740-1106	SBE32	

Workboat Systems			
EM2040	No		
EK80	No		
Seapath	No		
SVS	No		
System(s) brought by science team (non-AME)			
EXTRA NOTEWORTHY Sensors	Yes/No	MAKE	SEE YYY NOTES

6. Data Systems

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Summary

The SD046 is a multidisciplinary science cruise aboard the RRS Sir David Attenborough collecting data and samples in four distinct phases: 1) South Georgia, 2) A23 transect and 3) BIOPOLE and 4) A23a iceberg. The South Georgia phase (**SG**) comprised of the Western Core Box transects, two benthic stations and mooring work at the sites P3, Western Core Box and Eastern Core Box. The A23 transect phase (**A23**) consisted of oceanographic measurements at predefined transect points and mooring work at the South Sandwich Trench sites SSC and SST. The BIOPOLE phase (**BP**) consisted of several stations with intensive biological net and trawl sampling and mooring work at the sites M2, M3, OP1, OP2, OP3 and OP5. The iceberg A23a phase (**iceberg**) collected underway samples from the uncontaminated seawater system, ice, oceanographic measurements and plankton community composition around the A23a iceberg grounded at the South Georgia shelf. Furthermore, sampling from the uncontaminated seawater system and marine mammal efforts took place in all cruise phases. Several onboard experiments have been conducted using subsamples or individual organisms taken from the acquired samples.

Each cruise phase is in details described in the cruise report section "*Cruise phase narratives"*.

This section of cruise report contains:

6.1. Data storage and access

6.2. Event logging

6.3. Sampling logging

6.4. Data products

6.5. Datasets collected

6.6. SDA scientific data acquisition systems

6.7. Data management notes

Please also note an addendum with regards an error on the read node of the PostgreSQL database cluster.

6.1 Data storage and access

Data from each SDA cruise is recorded into a separate cruise folder */data/cruise/sda/current/*, where /*current* is a symbolic link referring in this case to the folder */20250201*. This cruise folder has two sub-directories:

- ***/data/cruise/sda/20250201/system*** This directory contains all data from systems synchronised on the ship Storage Area Network (SAN). Each operational system synchronised on the SAN has its own folder and contain read-only daily ascii files

with data from the respective system/instrument. As indicated in the Figure 6.6.1, 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.

- ***/data/cruise/sda/20250201/work*** This directory is writable and contains data created by the cruise participants, such as per-instrument processed data and information, data analysis, cruise report chapters or digital logs. There are several sub-folders pre-created in the /work sub-directory. The intended use of each sub-directory is described in the document ***L_drive_guidance.docx***, which is also included in the /work sub-directory at the beginning of the cruise.

The cruise folder can be accessed via a Samba connection called ***leg*** *(\samba.sda.bas.ac.uk\leg)* by mapping a network drive. The leg drive is intended for work-related content only. Some regular tidying was required during the cruise to keep the top work area structure as predefined and consistent with other cruises.

A summary of the datasets generated during the SD046 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 full cruise report.

Post-cruise, **the SD046 cruise 'leg' directory (*/data/cruise/sda/20220201*)** content will be permanently stored in the BAS read-only cruise archive. Access to the cruise data archive as it existed at the end of the cruise will be 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.

6.2 Event logging

Events are processes and actions related to scientific instruments recording and deployments. Event logs provide essential context to scientific data collected on the ship. Acquired information is used for data discovery. Events are logged using a web-based event logger that has been integrated with the SDA underway data streams from the RVDAS PostgreSQL database, where each event can be annotated with relevant underway data (e.g. position, water depth, wind speed, air temperature etc.) based on matching timestamps. Users can also define variables of *boolean*, *integer* or *string* type to record additional relevant information. More information about the web event logger is available in the document */work/data_management/event_logs/Digital_Event_Logging.docx.*

Briefly, each event log should include at the minimum a timestamp, event number, latitude and longitude for each deployment instrument being *in_water*, *at_depth* and *out_water*.

The SDA event logging system was used during the SD046 to provide an overview of instrument recording or 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. **219** individual events were recorded during the SD046 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 science operations.

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. Table below lists the event logs created on SD046.

Table (6.2.) Event logs created during SD046

Event log name	Event log description
Acoustic Instruments - depth	Status of the echosounders EA640, EM124 and EM712 providing the water column depth
ADCP	Daily stops and restarts of the WMADCP
AGT	Deployments of the Agassiz Trawl
Bridge log	Deployments recorded by officers on the bridge
BONGO	Deployments of the Bongo net
CTD	Deployments of the CTD
EBS	Deployments of the Epibenthic Sledge
EK80	Status of the EK80 echosounder
i-Dirac	Recording of i-Dirac status and parameters
Mammoth	Deployments of the Mammoth multinet
ME70	Status of the ME70 echosounder
Mocness	Deployments of the Mocness multinet
Marine Mammal Observations - effort	Marine Mammal Observation efforts
Marine Mammal Observations - sightings	Marine Mammal Observation sightings
Moorings	Deployments and recoveries of moorings
PSO Diary	Diary of the Principle Scientists
RapidCast	Deployments of the Rapidcast
RMT8	Deployments of the RMT8 net
SDA Underway Systems	A catch-all log for all SDA underway systems without dedicated logs. Mostly includes uncontaminated seawater system events.
Underway water sampling	Samples taken from the uncontaminated seawater system

Some event logs were during SD046 maintained by the science support staff, others were kept up-to-date by the science team members (ADCP, AGT, EBS, EK80, i-Dirac, MMO-effort, MMO-sightings, ME70). A recently added function of duplicating existing event logs was very useful and frequently used. Edits of the created logs were carried out from a command line using the utils scripts at sdl-eventlog-s1.sda.bas.ac.uk.

In order to standardise the digital event logs for more automated processing as well as archiving in the scientific equipment deployment database (the UK PDC Marine Metadata Portal), 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/).

At the end of the cruise, the event logs were downloaded from the web-interface into .csv files.

The bridge log and **science logs** are available in the sub-directory:
/work/data_management/event_logs/

6.3. Sampling logging

Any pathnames given here are relative to the cruise *leg*: */data/cruise/sda/20250201*

6.3.1 Underway water sampling

All underway water sampling has been recorded by all those sampling underway water using a paper sample log available at:
/work/data_management/sampling_log_templates/underway_sampling_log_SD046.xlsx

A digital event log has been created in the SDA web event logger called “Underway water sampling”.

The paper logs were scanned and then digitised using the web logger by the Physics team. The scanned paper logs are in the folder: */work/data_management/underway_log_scans*

6.3.2 CTD water sampling

All CTD sampling has been recorded on the paper CTD bottle cop sheet available at:
/work/data_management/sampling_log_templates/CTD_sample_cop_SD046.xls

The scanned paper cop sheets are available in the folder:
/work/scientific_work_areas/ctd/CTD_sample_cop_logsheets/

6.3.3 BioBOL sample information

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. Therefore, a Ship Sample Template has been created in the collaboration of the BAS biological collections curator, Ecosystems team and PDC to capture in a standardised way minimum information about ship samples. The template is intended to provide sample information (metadata) for all samples that will require completion of the BioBOL form and will be stored at BAS. The Ship Sample Template has been integrated with the BioBOL form, which significantly improved adoption and use of the standardised template.

More information about recording of information from ship samples is available at the SDA Wiki at https://www.sda.bas.ac.uk/Sample_metadata_guide.

Using the sample template to record sample metadata has a number of benefits:

- information can be organised and prepared to complete BioBOLs
- samples can be curated when they arrive to BAS
- samples can be linked to information in the corresponding cruise event or experiment
- samples can be added into a sample database
- samples can be assigned a globally unique identifier (that can be used as a research output in its own right and linked to scientific articles, published data or grant applications)

The **Ship Sample Template** is available in the folder:
/work/data_management/sampling_log_templates/ShipSampleTemplateMaster_SD046.xlsx

The BioBOL form with the integrated ship sample template is available in the folder:
/work/cruise_information/BioBOLs/Northbound BioBOL – blank.xlsm

6.4 Data products

Various data products were created during each phase of the cruise, i.e. South Georgia (SG), A23 transect and South Sandwich Trench moorings (A23), BIOPOLE stations (BP) and A23a (iceberg) using the PostgreSQL database cluster, the read-only node (sdl-pgdb-read.sda.bas.ac.uk, rvdas_views schema) or the data management module (data-managment/1.0) and python scripts (*/work/data_management/python_scripts)*.

Any data pathnames given here are relative to the cruise *leg*:
/data/cruise/sda/20250201

6.4.1 Cruise tracks and map

Cruise tracks – contains 1 min cruise track .csv file and a geopackage of cruise track points and line.

Sampling stations – contains compiled cruise stations file *(sampling stations.csv)* with a geopackage and a summary of all A23a iceberg stations and waypoints *(A23a_iceberg_sampling.csv).*

Cruise maps – a map of the whole cruise and each phase (SG, A23, BP, A23a iceberg) generated in ArcGIS Pro.

The SD046 cruise track, sampling stations and maps are available in the folder:
/work/scientific_work_areas/gis

6.4.2 CTD bottle and underway sampling summary

A CTD bottle file was created using the python script:
/work/data_management/python_scripts/ctd_bottles_SDA.py

CTD bottles – contains for each CTD stainless steel (SS) cast a summary of all bottle firings with respective parameters (times, depth, temperature, conductivity and salinity):
/work/data_management/CTD_bottles/CTD_bottles_SS.csv

CTD bottle sampling– contains a summary of CTD bottle firing times, depths, geolocation, sampling station and all 3108 CTD samples taken across all cruise phases (SG, A23, BP, A23a iceberg):
/work/data_management/data_products/CTD_bottle_sampling_SD046_SG_A23_BP_iceberg.csv. See the **cruise report Appendix** section.

Underway sampling – download from the “Underway water sampling” event log that contains a summary of all 1362 underway samples taken during the cruise aligned with underway data (geolocation, depth and sea surface environmental parameter from the ship sensors): */work/data_management/data_products/underway_water_sampling.csv.* See the **cruise report Appendix** section.

Underway ship data – contains various .csv files with summary of underway ship and environmental data: (a) *5min_ucsw.csv* (5-min interval output from the uncontaminated sea water sensors, used for underway lugol’s sampling), (b) *1min_seapath_gga_vtg.csv* (1min interval of ship speed_over_ground and course_over_ground on request of the marine mammal observers), (c) *1min_wave_motion*.csv* (1-min interval of wave height, ship roll, pitch and heave for requested time intervals to be used for assessing conditions suitable for the scanning electron microscopy operation):
/work/data_management/data_products/underway_data_summaries/

6.4.3 Bathymetry geo-tiff files for swath bathymetry

The UK PDC provided a high-resolution bathymetry data (100m resolution in latitude and longitude, EPSG 3395 – World Mercator Projection) for the area of South Sandwich Islands and Powell Basin (SSI_20250113_100m.asc and Powell_Basin_100m_epsg3395.asc). The files were transferred to the SDA SAN, uploaded into ArcGIS Pro and smaller sections depending on the sampling locations exported as GeoTIFF files, which were then used as a background for the EM124 multibeam echosounder for swaths before mooring operations or benthic instrument deployments. The original .asc files and high-resolution geotiffs created are in the folder:*/work/scientific_work_areas/bathymetry*

6.5 Datasets collected

The tables in this section summarise the datasets created on the SD046 cruise to discover the breadth of data acquired, to show where the data reside at the end of the cruise and the key dataset creator and/or contact.

For each dataset, the following information has been compiled:

- Dataset – brief title of the dataset
- Instruments – the device (platform/instrument/sensors) used in the dataset collection, includes mapping to the corresponding NERC Vocabulary Server terms (http://vocab.nerc.ac.uk/), if available, or a link to information from the manufacturer
- Description – brief description of the dataset
- Metadata – link to metadata available for the dataset, both scanned paper logs and/or digital log
- Digital data – data path to the data available as they existed at the end of the cruise
- Physical samples – path to description of physical samples collected as part of the dataset
- Access – indicates availability of the data, where '**open'** = data available immediately, '**embargo'** = data available after the embargo period of 2 years from the end of the cruise data collection (following the NERC Data Policy)
- Contact – key contact for the dataset, which can be the dataset creator or responsible person

6.5.1 Underway systems

Systems that can operate continuously and measure ship-related parameters or the environment surrounding the ship.

Dataset	**Ship's permanently installed underway sensors**	
Instruments	List of instruments is in the section 6.6 - *SDA scientific data acquisition systems* (http://vocab.nerc.ac.uk/collection/L05/current/DLOG/)	
Description	Timestamped outputs from 65 separate data streams as recorded by the RVDAS data logging system. Includes permanently fitted sensors associated with position and attitude, sea surface oceanography, atmosphere and meteorology, bathymetry, and platform monitoring. Available as daily ascii files and replicated within a PostgreSQL database.	
Metadata	Digital logs	/work/data_management/event_logs/SDA_Underway_Systems.csv
	Sensor metadata	/work/data_management/underway_metadata/
Digital data	Raw daily files	/system/datalogger_basnoc_rvdas/acquisition/

	Summary (intervals)	/work/data_management/data_products/5min_ucsw.csv
	Processed (averages)	/work/scientific_work_areas/physics/Underway/
Access	open (raw data), embargo (processed data)	
Contacts	UK Polar Data Centre, Sally Thorpe (BAS), Katherine Turner (BAS)	

Dataset	**pCO_2 system**	
Instruments	Dartcom Live pCO_2 system (http://vocab.nerc.ac.uk/collection/L22/current/TOOL2066/)	
Description	A permanently fitted pCO_2 system comprising foremast-sourced air intake, uncontaminated seawater intake and calibration gas standards	
Metadata	Digital logs	/work/data_management/event_logs/SDA_Underway_Systems.csv
Digital data	Raw daily files	/system/gas_pml_dartcom_live_pco2
Access	open	
Contacts	AME BAS, UK Polar Data Centre	

Dataset	**EA640 single-beam echosounder**	
Instruments	Kongsberg EA640 single-beam bathymetric echosounder (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0965/)	
Description	The EA640 single-beam echosounder used throughout the cruise to assist navigation.	
Metadata	Digital logs	/work/data_management/event_logs/Acoustic instruments – depth.csv
Digital data	Raw daily files	/system/datalogger_basnoc_rvdas/acquisition/
Access	open	
Contacts	UK Polar Data Centre	

Dataset	**EM124 multibeam bathymetry**	
Instruments	Kongsberg EM124 multibeam bathymetric echosounder (https://vocab.nerc.ac.uk/collection/L22/current/TOOL1799/)	
Description	Full ocean depth multibeam echosounder used occasionally during the cruise to assist navigation and opportunistically acquire bathymetry swath for deployments of moorings, AGT and EBS	
Metadata	Digital logs	/work/data_management/event_logs/Acoustic instruments – depth.csv
Digital data	Raw daily files	/system/multibeam_kongsberg_em124/acquisition/raw
Access	open	
Contacts	UK Polar Data Centre	

Dataset	**EM712 multibeam bathymetry**	
Instruments	Kongsberg EM712 multibeam bathymetric echosounder (https://vocab.nerc.ac.uk/collection/L22/current/TOOL1601/)	
Description	Continental shelf multibeam echosounder used a few times during the cruise to assist navigation.	
Metadata	Digital logs	/work/data_management/event_logs/Acoustic instruments – depth.csv
Digital data	Raw daily files	/system/multibeam_kongsberg_em712/acquisition/raw
Access	open	
Contacts	UK Polar Data Centre	

Dataset	**EK80 echo-sounder**	
Instruments	Simrad EK80 bioacoustic echosounder (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1205/)	
Description	A scientific echo sounder used during the cruise to collect bioacoustics data and assist in Antarctic krill target fishing.	
Metadata	Digital logs	/work/data_management/event_logs/EK80.csv
Digital data	Raw daily files	/system/bioacoustics_simrad_ek80
Access	2 years embargo	
Contacts	Sophie Fielding (BAS)	

Dataset	**ME70 echo-sounder**	
Instruments	Simrad ME70 multibeam echosounder (https://www.simrad.online/me70/ins/me70bo_ins_en_us.pdf)	
Description	A multibeam scientific echo sounder used to analyse Antarctic krill swarms.	
Metadata	Digital logs	/work/data_management/event_logs/ME70.csv
Digital data	Raw daily files	/system/bioacoustics_simrad_me70
Access	2 years embargo	
Contacts	Sophie Fielding (BAS)	

Dataset	**Vessel-mounted acoustic doppler current profiler (VMADCP)**	
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 mostly from the 150kHz instrument. The 75kHz instrument has been used only very briefly.	
Metadata	Digital logs	/work/data_management/event_logs/ADCP.csv
Digital data	Raw daily files	/system/adcp_teledyne_ocean_surveyor/
	Processed	/work/scientific_work_areas/physics/VMADCP
Access	open (raw)	
Contact	Hugh Venables (BAS)	

Dataset	**Wave radar**	
Instruments	Rutter Sigma s6 WaMoS II wave radar (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0999/)	
Description	An X-band directional radar measuring wave and surface current parameters.	
Metadata	Digital logs	/work/data_management/event_logs/SDA_Underway_Systems.csv
Digital data	Raw daily files	/system/wave_rutter_sigma_s6_wamos_ii/
Access	open	
Contacts	UK Polar Data Centre	

Dataset	**Gravity meter**
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	Digital logs	/work/data_management/event_logs/SDA_Underway_Systems.csv
Digital data	Raw daily files	/system/dgs_gravity_logger/acquisition/GravityData
Access	open	
Contacts	AME BAS, UK Polar Data Centre	

Dataset	**Eddy covariance CO_2 flux system**	
Instruments	Picarro G2311-f flux gas concentration analyser (https://www.picarro.com/environmental/products/g2311f_ec_flux_gas_concentration_analyzer), (http://vocab.nerc.ac.uk/collection/L05/current/382/) Metek uSonic3 ultrasonic anemometer (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1402/) LPMS motion reference unit	
Description	The CO_2 flux system comprises; a Picarro gas analyser sampling air from the foremast, a foremast-mounted Metek anemometer, and a co-located motion reference unit.	
Metadata	Digital logs	/work/data_management/event_logs/SDA_Underway_Systems.csv
Digital data	Raw daily files	/system/gas_pml_co2flux
Access	2 years embargo	
Contacts	Thomas Bell (PML)	

Dataset	**Sea ice camera imagery (forward looking)**	
Instruments	2 x Campbell Scientific outdoor observation and surveillance field cameras (http://vocab.nerc.ac.uk/collection/L05/current/311/)	
Description	Continuous recording of images from two cameras mounted to railings on the foremast. Associated with the eddy covariance CO_2 flux system.	
Metadata	Digital logs	none
Digital data	Raw files	/system/gas_pml_co2flux/acquisition/Cameras
Access	2 years embargo	
Contacts	Thomas Bell (PML)	

Dataset	**Marine Mammal Observations (MMO)**	
Instruments	Binoculars (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1478/)	
Description	Marine mammal observations, efforts and sightings undertaken by trained observers following the transect line and distance sampling protocol.	
Metadata	Digital logs	/work/data_management/event_logs/ Marine Mammal Observations – sightings.csv /work/data_management/event_logs/ Marine Mammal Observations – effort.csv
Digital data	Files, images	/work/scientific_work_areas/marine_mammal_observation
Access	2 years embargo	
Contacts	Manuela Bassoi (FURG, Brazil), Jen Jackson (BAS)	

Dataset	**i-Dirac**	
Instruments	i-Dirac (https://amt.copernicus.org/articles/13/821/2020/amt-13-821-2020.pdf)	
Description	A field portable temperature programmed gas chromatograph for long-term measurements of selected halocarbons in the atmosphere was used mainly at the station BP2_8 of the BIOPOLE phase. Recorded data were transferred from raspberry pi on the leg work drive.	
Metadata	Digital logs	/work/data_management/event_logs/i-Dirac.csv
Digital data	Raw files	/work/scientific_work_areas/I-dirac
Access	2 years embargo	

Contacts	Thomas Lachlan-Cope (BAS)

6.5.2 Deployable and Sampling systems

Tethered systems that are deployed from the vessel and measure the environment *in-situ* or obtain physical samples of the environment (water, sea ice, community of organisms etc.) for onward analysis.

Dataset	**Uncontaminated seawater (UCSW) sampling**	
Instruments	Non-toxic seawater supply (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0413/)	
Description	The system consists of a hoist that can lower the UCSW inlet pipe flush with the hull (~7.1 m depth) or fully deploy 30 cm below the hull (~7.4 m depth). Water is drawn into the vessel by two variable-speed pumps (via a strainer) and distributed to many of the Deck 3 lab spaces. The uncontaminated sea water was sampled for DOC, DIC, POC/TOC/BSI, Si isotopes; nutrients; black carbon; chlorophyll/Lugol's; d18O; salinity and POM	
Metadata	Paper logs	/work/data_management/underway_log_scans
	Digital Logs	/work/data_management/data_products/Underway_water_sampling.csv
Digital data	/work/scientific_work_areas/biogeochemistry/ /work/scientific_work_areas/nutrients/ /work/scientific_work_areas/phytoplankton /work/scientific_work_areas/zooplankton /work/scientific_work_areas/ctd	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Laura Taylor (BAS) – DOC, DIC, POC/TOC/BSI, Si isotopes; Edward Mawji (NOC) – nutrients; Laura Wilki Johnston (BAS) – black carbon; Amanda Burson (BAS) – chlorophyll-a/Lugol's; Rachel Sanders (BAS) – d18O; Hugh Venables (BAS) – salinity, Gabrielle Stowasser (BAS) – POM.	

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/X_other_work_areas/AME E/CTD Logsheets
	Digital logs	/work/data_management/event_logs/CTD.csv
Digital data	Raw	/system/ctd_seabird_sbe911plus/
	Processed	/work/scientific_work_areas/ctd/SBEproc
Access	2 years embargo	
Contacts	Sally Thorpe (BAS), Hugh Venables (BAS)	

Dataset	**Lowered Acoustic Doppler Current Profiler (LADCP) data**	
Instruments	4 x Teledyne WHM300 ADCP (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0749/)	
Description	LADCP data were collected at every CTD deployment to look at the current in the water column.	
Metadata	Digital logs	/work/data_management/digital_event_logs/CTD.csv
Digital data	Raw	/system/ctd_seabird_sbe911plus/
	Processed	/work/scientific_work_areas/physics/LADCP/
Access	2 years embargo	
Data users	Shenjie Zhou (BAS)	

Dataset	**CTD bottle sampling**	
Instruments	Niskin bottles (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0412/)	
Description	Seawater collected using Niskin were used to sample for salts, dissolved oxygen, dissolves nutrients, dissolved inorganic carbon and total alkalinity (DIC/TA), silicon isotopes (d30Si), oxygen isotopes (d18O), dissolved organic carbon (DOC), particulate organic carbon (POC), total organic carbon (TOC), biogenic silica (BSi), chlorophyll-a/Lugol's, phyto- experiments, particulate organic matter (POM), black carbon, eDNA, grazing and microplastics	
Metadata	Paper Logs	/work/scientific_work_areas/ctd/CTD_sample_cop_logsheets
	Digital logs	/work/data_management/data_products/CTD_bottle_sampling_SD046.csv
Digital data	/work/scientific_work_areas/biogeochemistry/ /work/scientific_work_areas/nutrients/ /work/scientific_work_areas/phytoplankton /work/scientific_work_areas/zooplankton /work/scientific_work_areas/ctd	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Laura Taylor (BAS) – DIC/TA, Si isotope, DOC, POC/TOC/BSI; Edward Mawji (NOC) – nutrients; Laura Wilki Johnston (BAS) – black carbon; Amanda Burson (BAS) – chlorophyll-a/Lugol's, phyto experiments; Rachel Sanders (BAS) – d18O; Hugh Venables (BAS) – salts, O2; Gabi Stowasser (BAS) – POM; Jasmine Yang (University of Bristol)– eDNA; Dan Mayor (University of Exeter) – grazing; Joana Fragão (BAS) – microplastics	

Dataset	**Rapid Cast**	
Instruments	Teledyne Rapid Cast CTD (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1847/)	
Description	CTD probe used to collect measurements of conductivity, salinity, temperature and depth while a ship is underway. Used only at the beginning of the cruise before the probe broke.	
Metadata	Digital logs	/work/data_management/event_logs/RapidCast.csv
Digital data	Raw files	/system/winch_teledyne_rapidcast
Access	open	

Contacts	UK Polar Data Centre

Dataset	**AGT**	
Instruments	Agassiz trawl (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1252/)	
Description	A dredge that consists of a heavy rectangular iron frame to which is fitted the mouth of a bag of stout netting which collects samples of organisms living on or just above the seafloor.	
Metadata	Digital logs	/work/data_management/event_logs/AGT.csv
Digital data	/work/scientific_work_areas/benthic_biology	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Huw Griffiths (BAS)	

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/event_logs/Bongo.csv
Digital data	/work/scientific_work_areas/zooplankton	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Jen Freer (BAS), Dan Mayor (University of Exeter), Nadine Johnston (BAS)	

Dataset	**EBS**	
Instruments	Epibenthic sledge (http://vocab.nerc.ac.uk/collection/L22/current/NETT0182)	
Description	A British Antarctic Survey-built sledge that consists of a stainless steel metal frame with two nets built in and is designed to be towed along the seabed to stir up the top layer of sediment and collect organisms living just above the seafloor.	
Metadata	Digital logs	/work/data_management/event_logs/EBS.csv
Digital data	/work/scientific_work_areas/benthic_biology	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Katrin Linse (BAS)	

Dataset	**Mammoth**	
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 nine nets with the mesh size 300µm.	
Metadata	Digital logs	work/data_management/event_logs/Mammoth.csv
Digital data	/work/scientific_work_areas/zooplankton; /work/scientific_work_areas/Nets	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Data users	Nadine Johnston (BAS), Jen Freer (BAS), Dan Mayor (University of Exeter)	

Dataset	**Mocness**
Instruments	Mocness net (http://vocab.nerc.ac.uk/collection/L22/current/NETT0185/)

Description	A British Antarctic Survey-built version of the Multiple Opening and Closing Net with an Environmental Sensing System consisting of nine nets designed for capturing zooplankton up to the depth of 1000m.	
Metadata	Digital logs	/work/data_management/event_logs/Mocness.csv
Digital data	/work/scientific_work_areas/zooplankton; /work/scientific_work_areas/Nets	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Geraint Tarling (BAS), Gabrielle Stowasser (BAS)	

Dataset	**RMT 8**	
Instruments	Rectangular Midwater Trawl 8 (http://vocab.nerc.ac.uk/collection/L22/current/NETT0180/)	
Description	A British Antarctic Survey-built pelagic trawl system consisting of two nets with a mouth opening of 8 m^2. Mainly used to catch krill and macrozooplankton	
Metadata	Digital logs	/work/data_management/event_logs/RMT.csv
Digital data	/work/scientific_work_areas/zooplankton; /work/scientific_work_areas/Nets	
Physical samples	/work/cruise_information/BioBOLs	
Access	2 years embargo	
Contacts	Gabrielle Stowasser (BAS), Ryan Saunders (BAS)	

6.5.3 Moorings

A number of mooring recovery and redeployment events took place on the SD046 cruise. An overview is provided below. Details of mooring instruments are in the cruise report section '*Sampling overview'* and folder /work/scientific_work_areas/moorings.

Dataset	**BIOPOLE mooring**
Instruments recovery	300kHz RDI Workhorse Sentinel ADCP, SBE37 SMP CTD, McLane sediment trap, Seaguard Current Meter and O2 sensor https://vocab.nerc.ac.uk/collection/L22/current/ TOOL0018/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0306/
Description	site: BIOPOLE, deployment: 05/03/2024 (cruise SD035), **recovery**: 08/03/2025 (event number 139), **not re-deployed**, water column depth: ~3440m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Geraint Tarling (BAS)

Dataset	**P3 mooring**
Instruments recovery	300kHz RDI Workhorse Sentinel ADCP, SBE37 SMP CTD, Ocean Plastic Incubator Chamber (OPIC) sampler, McLane sediment trap, Seaguard Current Meter and O2 sensor https://vocab.nerc.ac.uk/collection/L22/current/ TOOL0018/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0306/
Instruments deployment	300kHz RDI Workhorse Sentinel ADCP, SBE37 SMP CTD, Phytoplankton sampler, McLane sediment trap, Seaguard Current Meter and O2 sensor 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: P3, **recovery**: 09/02/2025 (event number 10), **deployment:** 22/03/2025 (event number 206), water column depth: ~3780m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Geraint Tarling (BAS)

Dataset	**South Georgia WCB mooring**
Instruments recovery	SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, McLane sediment trap, Aquadopp Doppler current profiler, Sonovault passive acoustic hydrophone http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1208/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0888/ http://vocab.nerc.ac.uk/collection/L05/current/369/
Instruments deployment	SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, McLane sediment trap, Aquadopp Doppler current profiler, Sonovault passive acoustic hydrophone http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1208/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0888/ http://vocab.nerc.ac.uk/collection/L05/current/369/
Description	Site: WCB, **recovery** 10/02/2025 (event number 14), **deployment**: 18/02/2025 (event number 52), water column depth: ~320m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/ /work/scientific_work_areas/Sonovault data WCB
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Sophie Fielding (BAS)

Dataset	**South Georgia ECB mooring**
Instruments recovery	SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, McLane sediment trap, Aquadopp Doppler current profiler, Sonovault passive acoustic hydrophone http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1208/ https://vocab.nerc.ac.uk/collection/L22/current/TOOL0786/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0888/ http://vocab.nerc.ac.uk/collection/L05/current/369/

Instruments deployment	SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, Sonovault passive acoustic hydrophone http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0061/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1208/ http://vocab.nerc.ac.uk/collection/L05/current/369/
Description	Site: ECB, **recovery** 13/02/2025 (event number 23), **deployment:** 20/02/2025 (event number 64), water column depth: ~270m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/; /work/scientific_work_areas/Sonovault data ECB
Access	2 years embargo
Contacts	Sophie Fielding (BAS)

Dataset	**SSTC mooring**
Instruments recovery	SBE37 SM CTD, Aquadopp 6000 3D Doppler current meter, RBRsoloT http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1024/
Description	site: SSTC, **recovery**: 24/02/2025 (event number 83), **not re-deployed**, water column depth: ~5850m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Rachael Sanders (BAS)

Dataset	**SSTW mooring**
Instruments recovery	SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Description	site: SSTW, **recovery**: 25/02/2025 (event number 86), **partially recovered** (SBE37 SM CTD not recovered), **not re-deployed**, water column depth: ~4380m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Rachael Sanders (BAS)

Dataset	**OP1 mooring**
Instruments recovery	SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Instruments deployment	SBE 37 SM CTD, SBE 39 TR, Aquadopp 6000 3D Doppler current meter, RBR soloT http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1024/
Description	site: OP1, **recovery**: 03/03/2025 (event number 111), **not recovered** (only release remained), **deployment**: 18/03/2025 (event number 190), water column depth: ~3600m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/

Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

Dataset	**OP2 mooring**
Instruments recovery	SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Instruments deployment	SBE 37 SM CTD, SBE 39 TR, Aquadopp 6000 3D Doppler current meter, RBR soloT http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1024/
Description	site: OP2, **recovery**: 03/03/2025 (event number 112), **no instruments recovered** (broken wire), **deployment**: 17/03/2025 (event number 185), water column depth: ~3200m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

Dataset	**OP3 mooring**
Instruments recovery	SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476 /
Description	site: OP3, **recovery**: 03/03/2025 (event number 110), **not re-deployed**, water column depth: ~1800m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

Dataset	**OP5 mooring**
Instruments recovery	SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0017/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476 /
Instruments deployment	SBE 37 SMP CTD, Aquadopp 6000 3D Doppler current meter, RBR soloT http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL1024/
Description	site: OP5, **recovery**: 04/03/2025 (event number 119), **deployment**: 18/03/2025 (event number 192), water column depth: ~3400m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

Dataset	**M2 mooring**
Instruments recovery	SBE37 SMP CTD, SBE39 TR, Aquadopp 6000 Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Description	site: M2, **recovery**: 11/03/2025 (event number 158), **not recovered** (did not release), **not re-deployed**, water column depth: ~3040m

Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

Dataset	**M3 mooring**
Instruments recovery	SBE37 SMP CTD, SBE39 TR, Aquadopp 6000 Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Instruments deployment	SBE37 SMP CTD, SBE39 TR, Aquadopp 6000 Doppler current meter http://vocab.nerc.ac.uk/collection/L22/current/TOOL0018/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0266/ http://vocab.nerc.ac.uk/collection/L22/current/TOOL0476/
Description	site: M3, **recovery**: 14/03/2025 (event number 168), **deployment**: 14/03/2025 (event number 169), water column depth: ~4600m
Metadata	/work/data_management/event_logs/Moorings.csv
Digital data	/work/scientific_work_areas/Moorings/PolarOceans/
Access	2 years embargo
Contacts	Povl Abrahamsen (BAS)

6.5.4 Onboard experiments

Samples were collected from various instrument deployments for onboard experiments. Each experimental dataset below indicates from which sampling instrument were the samples taken and a brief description of the experimentation. For full details on the methodology and scientific objectives, see the respective report chapters.

Dataset	**Copepod activity**
Sampling Instruments	British Antarctic Survey Motion Compensated **Bongo** Net (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0993/) Hydro-Bios MultiNet **Mammoth** (http://vocab.nerc.ac.uk/collection/L22/current/NETT0187/)
Description	To assess the swimming behaviour of surface and deep (potentially diapausing) copepods, the activity of the calanoid copepod *Calanoides acutus* was measured using Locomotor Activity Monitors (LAMs; TriKinetics Ltd.). Individuals were collected from Bongo and Mammoth net deployments. Sorting, identifying and preparation of the incubations took place under red light in the dark lab. Prepared LAMs were then incubated in CT2 with activity monitored via TriKinetics software. Incubations were stopped after 72 hours, individual copepods that remained in good condition were photographed for lipid sac size. Approx half of the samples were placed in Eppendorfs and stored at -80°C for subsequent genetic analysis. The other half placed within pre-weighed tin capsules and dried at 50°C for subsequent CHN analysis.
Metadata	/work/data_management/event_logs/Bongo.csv /work/data_management/event_logs/Mammoth.csv
Digital data	work/scientific_work_areas/zooplankton work/scientific_work_areas/Nets
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Jennifer Freer (BAS)

Dataset	**Copepod direct respiration**
Sampling Instruments	British Antarctic Survey Motion Compensated **Bongo** Net (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0993/) Hydro-Bios MultiNet **Mammoth** (http://vocab.nerc.ac.uk/collection/L22/current/NETT0187/)

Description	Direct respiration experiments were conducted on the copepod species *Calanoides acutus*, CV and female individuals, to determine their metabolic rate during austral autumn. Individuals for CHN (post respiration experiments) and CHNT0 analysis were placed in tin capsules and then in 96 microwell plates, dried (at 40°C) and stored on SDA at +4°C. Microwell plates for CHN analyses and microwell plates for CHNT0 were then at +4°C to be transported back to the UK. Additionally, copepod individuals were frozen and stored in Eppendorf tubes at -80°C to be transported back to UK for lipid analyses and for Electronic Transfer System analyses (indirect respiration experiments).
Metadata	/work/data_management/event_logs/Bongo.csv /work/data_management/event_logs/Mammoth.csv
Digital data	work/scientific_work_areas/zooplankton work/scientific_work_areas/Nets
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Nadine Johnston (BAS)

Dataset	**Zooplankton grazing and respiration**
Sampling Instruments	British Antarctic Survey Motion Compensated **Bongo** Net (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0993/) Hydro-Bios MultiNet **Mammoth** (http://vocab.nerc.ac.uk/collection/L22/current/NETT0187/) **Mocness** Net (http://vocab.nerc.ac.uk/collection/L22/current/NETT0185/)
Description	Grazing experiment of selected mesozooplankton species was performed using samples from the nets. After incubation for 24h, samples were fixed in Lugol's for cell counting and individuals selected for CN analysis. Respiration experiment was performed for 24h at atmospheric pressure and pressure of 10Mpa and 20Mpa for analysis of electron transport system and lipid composition. Additionally, krill faecal pellet production experiments were also performed.
Metadata	/work/data_management/event_logs/Bongo.csv /work/data_management/event_logs/Mammoth.csv /work/data_management/event_logs/Mocness.csv
Digital data	work/scientific_work_areas/zooplankton work/scientific_work_areas/Nets
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Dan Mayor (University of Exeter)

Dataset	**Krill length and maturity**
Sampling Instruments	Rectangular Midwater Trawl 8 (http://vocab.nerc.ac.uk/collection/L22/current/NETT0180/)
Description	*Euphausia superba* collected during the South Georgia phase were used for length and maturity measurements of individuals, as described e.g. in https://doi.org/10.3354/meps11634.
Metadata	/work/data_management/event_logs/RMT.csv
Digital data	work/scientific_work_areas/zooplankton work/scientific_work_areas/Nets
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Sophie Fielding (BAS)

Dataset	**Black carbon**
Sampling Instruments	Niskin bottles (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0412/)
Description	Samples were taken from pre-dawn CTD Niskin bottles at chlorophyll maximum and exposed to low, medium and high treatment of washer solution from the engine. After 72h of incubation the chlorophyll fluorescence parameter Fv/Fm (variable to maximum

	fluorescence) was measured to assess photosystem II (PSII) maximum efficiency, i.e. the efficiency of light energy conversion as an indicator of phytoplankton health.
Metadata	/work/data_management/event_logs/CTD.csv /work/data_management/data_products/CTD_bottle_sampling_SD046.csv
Digital data	work/scientific_work_areas/phytoplankton
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Laura Wilkie Johnston (BAS)

Dataset	**Phytoplankton grazing and production**
Sampling Instruments	Niskin bottles (http://vocab.nerc.ac.uk/collection/L22/current/TOOL0412/)
Description	Dilution micro-grazing experiment was performed using phytoplankton community <200µm taken from pre-dawn CTD Niskin bottles. Samples were incubated for 48h in dilution series and filtered for chlorophyll, POC, Lugol's and flow cytometry analysis. ^{13}C primary production experiment was performed using microplankton community from pred-dawn CTD Niskin bottles (depth 10m) incubated for 10h and filtered for POC analysis.
Metadata	/work/data_management/event_logs/CTD.csv /work/data_management/data_products/CTD_bottle_sampling_SD046.csv
Digital data	work/scientific_work_areas/phytoplankton
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Amanda Burson (BAS)

Dataset	**SEM**
Sampling Instruments	Agassiz trawl (http://vocab.nerc.ac.uk/collection/L22/current/TOOL1252/) Epibenthic sledge (http://vocab.nerc.ac.uk/collection/L22/current/NETT0182)
Description	Samples were taken from AGT and EBS and prepared for SEM analysis using the scanning electron microscope Hitachi TM4000Plus
Metadata	/work/data_management/event_logs/AGT.csv; /work/data_management/event_logs/EBS.csv
Digital data	work/scientific_work_areas/SD046_SEM
Physical samples	/work/cruise_information/BioBOLs
Access	2 years embargo
Contacts	Katrin Linse (BAS)

6.6 SDA scientific data acquisition systems

6.6.1. Overview

There are a number of scientific data systems onboard the SDA, which fall into several 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 synchronised onto the central ship Storage Area Network (SAN), iii/ permanently-present systems (e.g. EM124 multibeam echosounder) that have complex data but some information can be recorded by underway loggers and iv/ mobile data system brought for a specific cruise with data stored elsewhere (e.g. gliders).

The SDA operates a primary underway data logging system (RVDAS) and a secondary system (SCS), which functions as a backup. Underway data loggers usually receive (or

request) data outputs from sensors, timestamp them, and store them securely for onward reuse. The workflow of underway scientific data logging onboard the SDA is depicted in Figure 6.6.1 and describes how sensors data outputs are recorded, archived and visualised.

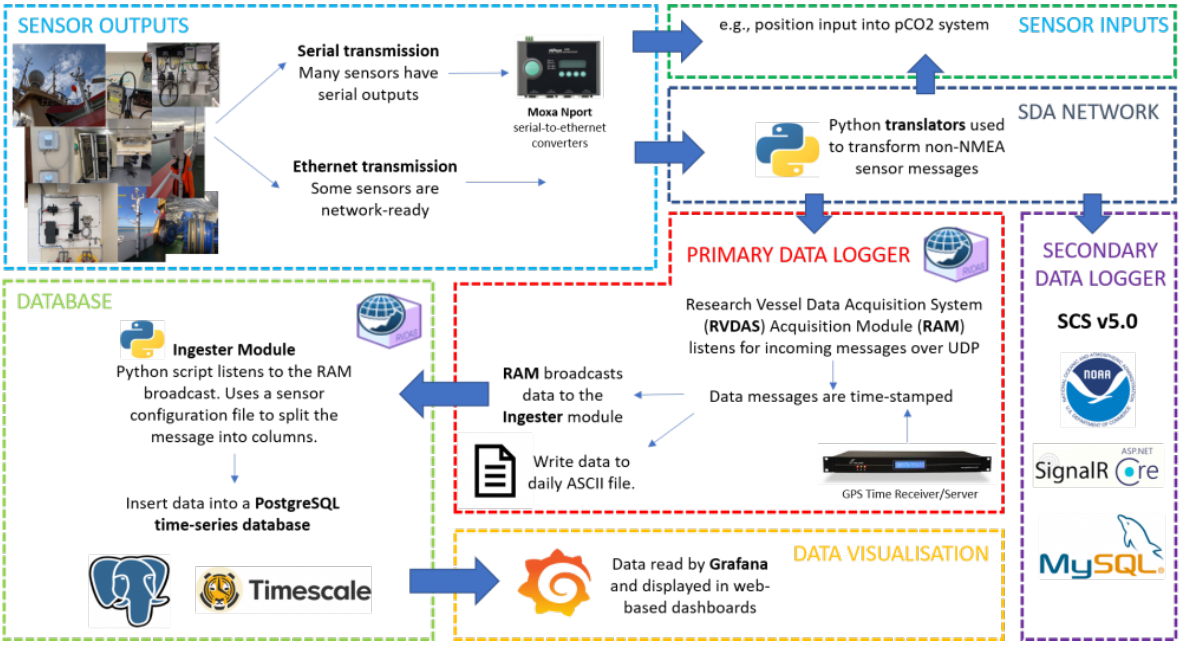

Figure 6.6.1: Data workflow of the SDA underway logging system

6.6.2. Research Vessel Data Acquisition system (RVDAS)

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 SD046** are summarised in Table 6.6.2B with the colour-coded grouping described in Table 6.6.2A below. During SD046, RVDAS logged 65 separate data streams. 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.

The list of underway system instruments is also available from the SDA Wiki at https://www.sda.bas.ac.uk/Underway_data:_description_of_messages.

The status of the current list of sensors live and recording on RVDAS, can be monitored in the Grafana dashboard **Sensors status live**.

Table 6.6.2A: Colour index of system groups used in Table 6.6.2B

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

Table 6.6.2B: A list of all the underway data streams logged by RVDAS during SD046. Cells in grey represent sensors that are currently configured but did not acquire data during this cruise. Systems marked with asterisk (*) comprise multiple sensors logging together to a single data stream. A metadata element such as serial id is recorded to differentiate individual sensors.

	System Name	Installed Location	RVDAS name
	Fugro Oceanstar v3 GNSS	Centre Main Mast	sd_gnss_fugro_oceanstar_centremast1
	SAAB R5 Supreme GNSS	Centre Main Mast	sd_gnss_saab_r5_supreme_centremast1
	Seatex GNSS (Part of Kongsberg Seapath 320)	Port Main Mast	sd_gnss_kongsberg_seapath_320_port1
	Seatex GNSS (Part of Kongsberg Seapath 320)	Starboard Main Mast	sd_gnss_kongsbegr_seapath_320_stbd1
	Seatex MRU5+ (part of Kongsberg Seapath 320)	Deck 2, near CRP	sd_attitude_kongsberg_seapath_320_motion_port1
	Seatex MRU5+ (part of Kongsberg Seapath 320)	Deck 2, near CRP	sd_attitude_kongsberg_seapath_320_motion_stbd1
	Kongsberg Seapath 320 Heading	Various	sd_attitude_kongsberg_seapath_320_heading_port1
	Kongsberg Seapath 320 Heading	Various	sd_attitude_kongsberg_seapath_320_heading_stbd1
	iXblue Phins Surface PAA00011-C inertial navigation system (Heading)	Deck 2, near CRP	sd_attitude_ixblue_phins_surface_heading_crp1
	iXblue Phins Surface PAA00011-C inertial navigation system (Attitude)	Deck 2, near CRP	sd_attitude_ixblue_phins_surface_motion_crp1
	SMC (Ship Motion Company) IMU-108 motion reference units	Mooring space	sd_attitude_smc_imu108_heli1
	Raytheon Standard 30 MF Gyro	Instrument Room Port, Deck 8	sd_attitude_raytheon_standard_30mf_port1
	Raytheon Standard 30 MF Gyro	Instrument Room Starboard, Deck 8	sd_attitude_raytheon_standard_30mf_stbd1
	Safran (Sagen) BlueNaute Gyro	Instrument Room Centre, Deck 8	sd_attitude_safran_bluenaute_centreline1
	Northern Solutions EMES60 Electromagnetic Speed Logger	Hull	sd_speedlog_northern_solutions_emes60_hull1
	Skipper DL850 Doppler Speed Logger	Hull	sd_speedlog_skipper_dl850_hull1
	Sonardyne Ranger2 USBL	Hull	sd_usbl_sonardyne_ranger2_hull1
	Sea-Bird Electronics SBE45 MicroTSG Thermosalinograph	UCSW Lab, Deck 3	sd_thermosalinograph_seabird_sbe45_ucsw1
	Sea-Bird WET Labs C-Star Transmissometer (CST)	UCSW Lab, Deck 3	sd_transmissometer_wetlabs_cstar_ucsw1
	Sea-Bird WETStar Flow-through Fluorometer (WSCHL)	UCSW Lab, Deck 3	sd_fluorometer_wetlabs_wschl_ucsw1
	Heitronics CT15.85 Infrared Radiation Thermometer	Port wing, Deck 10	sd_radiometer_heitronics_ct15_85_port1
	Heitronics CT15.85 Infrared Radiation Thermometer	Starboard wing, Deck 10	sd_radiometer_heitronics_ct15_85_stbd1
	Rutter sigma S6 WaMoS II wave radar	Various	sd_wave_rutter_sigma_s6_wamos_ii_bridge1
	Valeport miniSVS Sound Velocity Probe	Starboard Aux Machinery 2, Deck 1 (ucsw inlet)	sd_soundvelocity_valeport_minisvs_ucsw1
	Sea-Bird Electronics SBE38 Thermometer	Starboard Aux Machinery 2, Deck 1 (ucsw inlet)	sd_thermometer_seabird_sbe38_ucsw1
	Sea-Bird Electronics SBE38 Thermometer	Starboard Aux Machinery 2, Deck 1 (ucsw inlet)	sd_thermometer_seabird_sbe38_ucsw2
	Observator OMC-116M Windsensor	Port Main Mast	sd_anemometer_observator_omc116_portmast1
	Observator OMC-116M Windsensor	Starboard Main Mast	sd_anemometer_observator_omc116_stbdmast1

	FT Technologies FT702LT V22 Windsensor	Centre Main Mast	sd_anemometer_ft_tech_ft702lt_centremast1
	Biral SWS-200 Visibility & Present Weather Sensor	Starboard wing, Deck 10	sd_met_biral_sws200_stbd1
	Eliasson CBME80 Ceilometer	Starboard wing, Deck 10	sd_cloud_eliasson_cbme80_stbd1
	Sea-Bird Satlantic Photosynthetically Active Radiation (PAR) Sensor	Science Mast, Deck 11	sd_radiometer_satlantic_par_scimast1
	Sea-Bird Satlantic Photosynthetically Active Radiation (PAR) Sensor	Foremast	sd_radiometer_satlantic_par_foremast1
	Vaisala HMP155E Air Temperature & Humidity	Science Mast, Deck 11	sd_met_vaisala_hmp155e_scimast1
	Vaisala HMP155E Air Temperature & Humidity	Science Mast, Deck 11	sd_met_vaisala_hmp155e_scimast2
	Vaisala HMP155E Air Temperature & Humidity	Foremast	sd_met_vaisala_hmp155e_foremast1
	Kipp & Zonen SGR4-A Pyrgeometer (IR radiation)	Science Mast, Deck 11	sd_radiometer_kipp_zonen_sgr4_scimast1
	Kipp & Zonen SGR4-A Pyrgeometer (IR radiation)	Foremast	sd_radiometer_kipp_zonen_sgr4_foremast1
	Kipp & Zonen SMP22-A Pyranometer (Solar irradiance)	Science Mast, Deck 11	sd_radiometer_kipp_zonen_smp22_scimast1
	Kipp & Zonen SMP22-A Pyranometer (Solar irradiance)	Foremast	sd_radiometer_kipp_zonen_smp22_foremast1
	METEK Usonic-3 Class-A H Anemometer	Port Main Mast	sd_anemometer_metek_usonic3_portmast1
	METEK Usonic-3 Class-A H Anemometer	Starboard Main Mast	sd_anemometer_metek_usonic3_stbdmast1
	METEK Usonic-3 Class-A H Anemometer	Foremast	sd_anemometer_metek_usonic3_foremast1
	Vaisala PTB330 Barometer	Aerosol Lab, Deck 10	sd_met_vaisala_ptb330_v2_aerosol1
	Vaisala PTB330 Barometer	Aerosol Lab, Deck 10	sd_met_vaisala_ptb330_v2_aerosol2
	Vaisala CL31 Lidar Ceilometer	Starboard wing, Deck 10	sd_cloud_vaisala_cl31_stbd1
	Michell Instruments Optidew2 Chilled Mirror Hygrometer	Port wing, Deck 10	sd_met_mitchell_optidew2_aerosol1
	Thies Clima Laser Precipitation Monitor (Disdrometer)	Science Mast, Deck 11	sd_met_thiesclima_5_4110_scimast1
	Campbell Scientific (Goodrich) 0871LH1 Freezing-Rain sensor	Science Mast, Deck 11	sd_met_campbell_0871lh1_scimast1
	Handix Portable Optical Particle Spectrometer (POPS)	Science Mast, Deck 11	sd_aerosol_handix_pops_scimast1
	BAS (Alpha Sense) Optical Particle Counter	Science Mast, Deck 11	sd_aerosol_bas_opc_scimast1
	Magee AE33 Aethalometer (Black Carbon)	Atmospheric lab, Deck 5	sd_aethalometer_magee_ae33_aerosol1
	Kongsberg EM124 multibeam	Hull	sd_multibeam_kongsberg_em124_hull1
	Kongsberg EM712 multibeam	Hull	sd_multibeam_kongsberg_em712_hull1
	Kongsberg EA640 singlebeam	Hull	sd_singlebeam_kongsberg_ea640_hull1
	Skipper GDS102 singlebeam navigation echosounder	Hull	sd_singlebeam_skipper_gds102_hull1
	Dynamic Gravity Systems (DgS) AT1M Gravity Sensor	Gravity Meter Room, Deck 2	sd_gravimeter_dgs_at1m_grav1
	ODIM Winch logging and monitoring system*	Winch Control Room, Deck 5	sd_winch_odim_v3_wcr1
	Litremeter LMX.24 PeltonWheel Flowmeter with a Fluidwell F112-P control/display unit	UCSW Lab, Deck 3	sd_flowmeter_litremeter_lmx24_ucsw1
	Kongsberg Vessel Insight data logging system*	Deck2	sd_datalogger_kongsberg_vessel_insight_omni0
	Schneider APC Temperature Data Logger*	Various	sd_platform_schneider_ap8953_omni0
	Comet T3510 Air Temperature and Humidity*	Server Room	sd_platform_comet_t3510_omni0
	Yotta A1819 Air Temperature*	Various	sd_platform_yotta_a1819_omni0
	C4R hoist monitoring*	Various	sd_platform_c4r_hoist_hull1_

6.6.3. Data synchronisation and data volumes

The total data volume under the SD046 cruise leg directory was 16T, where the /work folder was 8.4 TB.

For permanently installed systems, automated scripts (rsync append) periodically synchronise data from local acquisition machines to the central onboard Storage Area Network and these data are visible under the cruise leg /system sub-directory. A full list of the synchronised systems that were operational and acquired data during the SD046 can be found in Table 6.6.3, together with their size on disk:

Table 6.6.3: Synchronised data systems operational during the cruise SD046 and their data volume over the cruise period.

System Name	Description	Size in GB
adcp_teledyne_ocean_surveyor	Vessel mounted acoustic doppler current profiler	11
aerosol_bas_opc	Optical Particle Spectrometer	0.105
aerosol_handix_pops	Optical Particle Spectrometer	0.162
bioacoustic_simrad_ek80	Biological echosounder EK80	1200
bioacoustic_simrad_me70	Biological echosounder ME70	34
bioacoustic_simrad_ms70	Biological echosounder MS70	0.017
camera_axis_m1045	Front-facing webcam	18
ctd_seabird-sbe911plus	CTD, LADCP and rosette and 20L Niskin bottles	3.0
datalogger_bas_eventlog	Eventlog database backup	0.458
datalogger_basnoc_rvdas	RVDAS primary underway data logger	181
datalogger_noaa_scs	SCS secondary underway data logger	93
dgs_gravity_logger	Gravity meter	1.6
gas_pml_co2flux	PML CO_2 flux system	216
gas_pml_dartcom_live_pco2	pCO_2 underway measurement sytem	0.008
multibeam_kongsberg_em124	Bathymetric multibeam echosounder	41
multibeam_kongsberg_em712	Bathymetric multibeam echosounder	0.7
platform_bas_dwnm	BAS downward monitor	0.759
platform_light_structures_ilms	Ice Load Monitoring System	267
wave_rutter_sigma_s6_wamos_ii	Wave radar	5000
winch_teledyne_rapidcast	Rapidcast with CTD probe	0.006

6.6.4. Data visualisation

Grafana data visualisation was used during the SD046, 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 Grafana dashboards, the bridge event log and daily science plan were made available via the MediaBentos system on screens in the labs, data suite and winch control room. The only drawback was that the elements were occasionally disappearing and had to be reset by the IT team.

6.7. Data management notes

Underway data logging systems worked well during the SD046 cruise. Data from local acquisition machines were also reliably synchronised on the SDA SAN. Only issues were with the waver radar that has occasionally stopped logging and with the Fugro Oceanstar v3 GNSS that stopped logging closer to the end of the cruise, which impacted the event bridge

log that is using the GPS data stream. The science logs were using the Seatex GNSS (part of Kongsberg Seapath 320) and were therefore not impacted.

The SD046 was a large multidisciplinary cruise enabling cross-team connections that were not previously very common. For example, two of the SD046 phases (SG and A23) were in the past often conducted as separate surveys, pelagic and benthic sampling were usually conducted as part of separate projects and cruises with predominantly physical oceanography typically did not have data management support onboard.

The SD046 revealed potential benefits of a closer collaboration between the Polar Oceans team and UK Polar Data Centre in developing processing routines/data products that could be used by cruise participants while onboard. Providing data outputs on a regular basis in a dedicated leg work area with applied basic quality checks and in a self-described, open and broadly usable data format containing sufficient contextual metadata would be useful. Such data products, e.g. near real-time cruise underway data summaries or sampling summaries, could enable scientist to create their own plots, with the understanding that the provided outputs are not data with the greatest processing level applied and are aimed only to facilitate their decisions on sampling strategies and experimentation onboard. This would also avoid duplication of effort in creating very similar data products across both teams or confusion which data products to use and where to find them.

Addendum

An error on the read node of the PostgreSQL database cluster occurred at 2024-03-13 21:41Z. The cluster automatically switched everything over to the still working write node and science staff would have seen no impact – underway data were still being logged and Grafana dashboards (now pointing at the write node) would have shown no issues. The failed read node triggered an alert but this was not spotted until the following morning. IT support cleared the error and the read node came back online at 2024-03-14 10:33Z. From this point the read node started to backfill its data gap, replicating from the write node and working chronologically forwards from the initial error. The Grafana dashboards all went back to pointing to the read node when it came back online and as a consequence they started to show out-of-date data – this state persisted until 13:34Z when the replication process filled the data gap and caught up to the current time. The cause of the initial node failure is still being investigated but there are a number of improvements that can be put in place to reduce the onward consequences of such a failure in the future. A first simple step is to provide a database replication status indicator on the ‘Sensor Live’ Grafana dashboard – if this shows a failure, it will hopefully be picked up by science/general users in a timely fashion and communicated to IT/data support staff. This step will reduce the time required to fill any data gap. A second step is to provide a backup version of the mostused

Grafana dashboards using the write node as their data source. This will mean that we can switch over to these versions and continue to view up-to-date dashboards while any gap filling replication is in progress. In summary, the database cluster worked exactly as it should in dealing with a failed node and with a few small changes we can minimise the recovery time and maintain normal data operations throughout any recovery period.

7. Physical Oceanography

7.1 CTD processing

Author: Hugh Venables

Introduction

A Conductivity-Temperature-Depth (CTD) unit was deployed attached to a Rosette carrying 24 Niskin bottles. The CTD unit (Sea-Bird SBE911plus) was equipped with the following sensors: one pressure sensor, two temperature sensors (plus an SBE35 Deep Ocean Standard Thermometer, see below), two conductivity sensors, two submersible pumps, two dissolved oxygen sensors, one transmissometer, one fluorometer (chlorophyll a), one altimeter, and one PAR sensor. The PAR sensor was mounted on the vane of the rosette. Finally, the rosette held two lowered acoustic Doppler current profilers (LADCP), which have their own chapter in this report (Chapter 7.2). For details on each instrument, please see the AME and data management reports. In total, there were 71 CTD casts during the cruise, including 3 test casts, 5 aborted cast due to winch problems and 2 shallow casts for filming purposes.

Data acquisition and initial processing

All CTD data are saved in the onboard storage systems (see data management document and "Data output structure" section below) in hexadecimal (.hex) format, which is then (i) converted to engineering units in a human-readable ".cnv" format, (ii) aligned (oxygens advanced by 5 s), and (iii) corrected for the conductivity cells' thermal mass using Sea-Bird's proprietary software SBE Data Processing. All CTD sensors measured continuously during deployment at a frequency of 24 Hz, whereas the SBE35 sensor only took measurements once a bottle was closed, for calibration purposes (see below).

In-house processing algorithm

Before processing first cast

Setup paths, cruise name, file naming preferences and SBE data output in *CTDvarn.m* (constantly read by processing subroutines).

For each cast:

1. Run SBE batch process routine process_ctd_cast (.bat, reads .txt file), that does the following:

- Convert from hexadecimal (deck unit output) to ".cnv" files
- Align casts
- Correct for conductivity cell's thermal mass
- Create .btl files, as requested for oxygen sample processing

This can be run on any windows machine with SBEDataProcessing, including the virtual CTD processing computer available on the four screen displays

2. Run *ctdreadGEN.m* (converts SBE batch processing output to a matlab file, .red). Enter cast number (XXX), and, if selected in CTDvarn, event number (EEE). Frame type, FF also added (can be set to '' in CTDvarn if you don't want this

3. Run *editctdGEN.m* (manual filtering of bad data, -> .edt)

4. Run *batch_ctdGEN.m* (several routines are called within):

- *deriveGEN.m*: derives variables, saved as *SD046_ctd_XXX_FF_EEE.var*
- *onehzctdGEN.m*: gets casts in 1Hz sampling (for LADCP processing), saved as *SD046_ctd_XXX.1hz*
- *splitcastGEN.m*: divides cast into down & up casts, saved as *SD046_ctd_XXX_FF_EEE.var.dn* and *SD046_ctd_XXX_FF_EEE.var.up* respectively
- *fallrateGEN.m*: removes data for depths above already reached during downcast and when being lowered at < 0.25 m/s, overwriting the downcast file, but keeping the original as .vhc.dn
- *gridctdGEN.m*: bins data to 2dbar pressure levels, saved as SD046_ctd_XXX_FF_EEE_2db.mat (. Changed to _ before 2db to make it look like a proper matlab file)

6. Run *ctdplotGEN.m* for plotting figures as a preliminary visual check

Bottle Files and reading samples

batch_botGEN.m wraps the following calibration routines:

1. *makebotGEN.m*: reads Seabird data and creates bottle file
2. *sb35readGEN.m*: reads SB35 file, writes tempcals.all
3. *readsalGEN.m*: reads salinity from csv file and adds to mat file
4. *addsalGEN.m*: reads in bottle file and adds salinity data
5. *salcalGEN.m*: calculates offsets between CTD and salinometer salinities to correct/calibrate CTD data
6. read/add/caloxyGEN.*m* files for oxygen samples as above
7. *mergebotGEN.m*: merges salinity and oxygen calibration

Calibration Process

1) tempcal_decide.*m* – reads tempcals.all to find offsets between SBE35 thermometer and CTD temperatures. Accounts for gradient of CTD profile to correct for SBE35 being higher than the CT sensors. Likely to be a fit against pressure, or a constant offset

2) tempcalbottGEN – apply temperature calibration to bottle files (dead end step, these .tcl are only partially calibrated and not returned to)
3) salcalGEN_tcal – back-calculate conductivity for each sample, from salinometer salinity and calibrated temperature
4) salcal_decide – find conductivity offset between samples and CTD. Accounts for gradient of CTD profile to correct for bottles being higher than the CT sensors.
5) salcalappGEN – apply above calibrations to bottle and cast files, write ascii file of calibrations applied. For bottles, reads .all and writes .cal. For casts, reads .var and writes .clb
6) *batch_calGEN.m* - reprocesses all CTD data with the respective calibrations applied. From .clb to ???.clb.dn (24hz files) and _cal_2db.mat (2db files)

Changes to code:

csvread -> readmatrix

nanmean -> mean(…,"omitmissing")

salinity_processing.m In ctd/Salinometry. Reads and writes csv files. Change from Excel to gsw equation for calculation of salinity from salinometer conductivity ratio. Runs for both underway crates (amalgamate results into one long file) and CTD casts (read by readsalGEN.m). Results very similar, e.g. 34.257211381000310 from matlab route, 34.257213 from excel. By comparison, increasing the last digit of the salinometer output by one gives 34.257409 so the difference is approximately 100 times less (though systematically down)

CTDvarn

incEvent added as a flag for including event number in filenames. 1 for including as well as cast number, 0 for omitting (including if just using event number directly instead of cast number, in which case tweak batch files). Doesn't include 1Hz files to keep naming consistency

isunix added as an option for path setting (for a linux environment)

var2dbQ – grid to length of file (1) or consistent length file (0)

ctdreadGEN

Asks for event number as well as cast number (if incEvent set to 1). Stores this in SD046_ctd_CastEventList so other scripts don't need to ask.

editctdGEN

If a large chunk of conductivity data is removed from start or end of a cast (to pressure>1dbar), a check has been added for whether to remove from other sensors (eg CTD broke surface and then submerged again at end) or not (individually bad Cond sensor). Questions and plots clarified.

say_what() function added to reduce chance of crashing out of editing process with an incorrect response (takes 0, n, N, no, No and various more esoteric answers as no and similarly for 1, y, yes etc.). Outputs 0/1.

deriveGEN (and elsewhere)

Switched to TEOS10 scripts for derived variables

salcalGEN

Arranges samples so still works if salt samples not in Niskin bottle order

readoxyGEN

Does unit conversion to umol/kg (using density at fixing temperature, which is the volume used to reach umol/l)

tempcal_decide

Tidied up, with better plots and comments. Broken stick fit to offset that can be taken across to salcalGEN_tcal/salcalappGEN

tempcalbottGEN

Written to apply temperature calibration to a dead-end set of bottle files, to allow bottle conductivity to be back-calculated with calibrated temperatures (salcalGEN_tcal). Once both temperature and conductivity calibrations are known, they can then be applied in parallel in salcalappGEN

salcal_decide (despite name, really to calibrate conductivity rather than salinity). As per tempcal_decide

salcalappGEN

Writes an ascii file of the applied calibrations. The existence of this file is then used to make the processing scripts run in calibration mode (running CTDvarn_cal and changing file names). Loses the awkwardness of parallel cal versions of each script.

CTD Calibration

For calibration, reference measurements were taken from SBE35 for temperature (measures when bottle is closed), and from bottled seawater salinometer analysis for conductivity. As back-calculating conductivity involves CTD temperature, this was done in two steps, plus oxygen in parallel. Due to significant changes to the calibration offsets in Cond 1 later in the cruise, data were initially reprocessed with ctchoice=2, except for cast 7.

The first step is to plot temperature offsets in **tempcal_decide.m**, read from \ctd\BASproc\SBE35\tempcals.all (other calibration scripts can be aimed at this file). The plots account for the temperature gradient and height difference between the CTD sensors and SBE35 calibration sensor and filter results. The calibration is likely to be either a constant offset, or a function of pressure (code set up for a broken-stick fit, as used here). There are also plots to check for changes over time.

This calibration is applied in **tempcalbottGEN.m**. This creates the dead-end step of .tcl files that are read by **salcalGEN_tcal.m** to back-calculate conductivity for each sample, from salinometer salinity and calibrated CTD temperature

salcal_decide.m then repeats the steps of tempcal_decide (reading from \ctd\BASproc\salts\salcals12_tcal.all.mat (a salcals12.all.mat is also created through the cruise and is worth checking to see changes in sensor behaviour, but not for calibration)

oxycal_decide.m leads to an oxygen offset, a joint function of oxygen and pressure for SD046. Due to the large offsets this is done in parallel with the above rather than after conductivity calibration.

The three sets of calibrations can then be applied in **salcalappGEN.m**. This writes **SD046_ctd_SS_calibrations.txt** to record the calibration offsets (they are also kept in salcalappGEN). Cruise-specific functions added at the end of salcalapp (generally when calibrations are a function of cast number) should be copied into this file, shown below

SD046_ctd_SS_calibrations.txt:

CTD calibration offsets

for cruise SD046

Temp1 offset: @(press,temp,cond,stano,gtime)interp1([0,2000,6200],[0.00055,-0.00065,-0.00065],press)

Cond1 offset: Condoffset2_sd046

Temp2 offset: @(press,temp,cond,stano,gtime)interp1([0,2000,6200],[-0.00025,-0.00125,-0.00125],press)

Cond2 offset: @(press,temp,cond,stano,gtime)interp1([0,2750,5000,6200],[0.0008,-0.0009,-0.0009,-0.0003],press)

Oxygen1 offset: oxygenoffset1_sd046

Oxygen2 offset: oxygenoffset2_sd046

```
function offset=Condoffset2_sd046(press,temp,oxygen,stano,gtime)
if stano<=50
 x1=[0 3000 6200];    %SD046 cond 1 to cast 50
 y1=[0.0019 -0.0012 -0.0021];

elseif stano>50&stano<=56
x1=[0 6200];    %SD046 cond 1 casts 51:56
 y1=[0.005 -0.0003];
else
x1=[0 2000 6200];    %SD046 cond 1 casts 57 onwards
 y1=[0.0092 0.0063 0.0053];
end
offset=interp1(x1,y1,press);
end

function offset=oxygenoffset1_sd046(press,temp,oxygen,stano,gtime)
 if stano>7&stano<=30

x1=[160 360];
y1=[4 12];
 xp1=[0 3500 4500 6200];
 yp1=[0.3 -1.8 -2.5 -13];
offset=interp1(x1,y1,oxygen)+interp1(xp1,yp1,press);

 elseif stano>30
```

```
x1=[160 360];
y1=[5.5 17];
xp1=[0 3500 4500 6200];
yp1=[0.3 -1.8 -4 -13];
offset=interp1(x1,y1,oxygen)+interp1(xp1,yp1,press);
 else
    offset=0; %unknown
 end
end

function offset=oxygenoffset2_sd046(press,temp,oxygen,stano,gtime)
if stano>7&stano<=30
x2=[160 360];
y2=[2 4.5];
xp2=[0 3500 4500 6200];
yp2=[-0.5 0.4 -0.5 -9.5];
offset=interp1(x2,y2,oxygen)+interp1(xp2,yp2,press);
elseif stano>30
x2=[160 360];
y2=[2.5 10];
xp2=[0 3500 4500 6200];
yp2=[0.3 1 -0.6 -9.5];
offset=interp1(x2,y2,oxygen)+interp1(xp2,yp2,press);
else
   offset=0; %unknown
end
end
```

Data output structure

All raw cruise CTD data is stored in:
/leg/system/ctd_seabird_sbe911plus/acquisition/data/SD046/CTD

All processed cruise data including the calibrated files is stored in:
/leg/work/scientific_work_areas/ctd/BASproc

All in-house BAS scripts, including the LADCP processing, are available in their private Github repository. Processing and plotting scripts developed specific for this cruise can be found in https://github.com/martimmas/cruise_work.

Recommendations

The CTD setup and running was mostly done by AME Electrical. When they were busy it was passed on to experienced members of the Physical Oceanography team. This makes a lot of sense in terms of using the full skills of AME, often at short notice as things need fixing. For CTD-heavy cruises there should be a training process early on to keep these skills within the Physical Oceanography team, to keep the flexibility within the AME team.

The instructions for running the CTD should also be fleshed out slightly for the upcast and bottle depths/firing, especially for assessing when offsets have settled sufficiently and that some depths will be responsive to the upcast profile, rather than fixed by the downcast (chlorophyll maximum especially)

Overall, a wider range of input, from Polar Oceans and Ecosystems into how the process is managed and carried out would be beneficial.

7.2 Lowered Acoustic Doppler Current Profiler (LADCP)

Authors: Shenjie Zhou, Ryan Saunders

Summary

SDA CTD rosette stainless still frame is equipped with two Teledyne RDI Workhorse Monitor 300 kHz instruments (**Figure 7.2.1**). The LDACPs are named as MASTER looking down and SLAVE looking up. No technical problems with the LADCPs were encountered. Post-processing scripts used were modified to extract specific backscatter strength information on request of Ryan Saunders.

Figure 7.2.1 Position of two LADCPs mounted on CTD rosette, MASTER (down-looking) and SLAVE (up-looking) LADCPs are mounted at the bottom and side of the frame as indicated by the annotation.

Instrument Details

Instrument	Make	Serial Number	CTD cast numbers
LADCP master down	TeleDyne WHM300-I-UG301	14897	01-end
LADCP slave up	TeleDyne WHM300-I-UG301	15060	01-end

Data processing

AMEs, Chris Gray and Liam Tracy, managed the execution of pre- and post-deployment scripts and data backups. After each cast, data were uploaded to the computer using a specific naming convention that includes cruise number (SD046), CTD cast number, CTD frame ‘SS’ for stainless steel, followed by letter ‘M’ or ‘S’ for MASTER or SLAVE, respectively. For MASTER down-looking LADCP data from CTD cast 001 (#stn), the raw file name would be: SD046_001_SS_M.000.

Data	Path
Raw data	/leg/system/ctd_seabird_sbe911plus/acquisition/data/SD046/LADCP/Data/
Processed data (.MAT files)	/leg/work/scientific_work_areas/physics/LADCP/LDEO_IX_15beta/processed/SD046_data_%#stn.mat /leg/work/scientific_work_areas/physics/LADCP/LDEO_IX_15beta/processed_withVMADCP/SD046_data_%#stn.mat
Plots	/leg/work/scientific_work_areas/physics/LADCP/LDEO_IX_15beta/processed/
Backscatter data (.xls files)	/leg/work/scientific_work_areas/physics/LADCP/LDEO_IX_15beta/processed/MVBS_%#stn_ladcp.xls /leg/work/scientific_work_areas/physics/LADCP/LDEO_IX_15beta/processed/MVBS_%#stn_ladcp_coarse.xls

The processing of raw data was completed using Lamont-Doherty Earth Observatory (LEDO) Implementation of the velocity inversion method (Visbeck 2002, also see Thurnherr 2021, https://www.ldeo.columbia.edu/~ant/UserManuals/LDEO_IX.pdf). The working version is LDEO IX Software and inherited/iterated from previous SDA cruise. The original version of the code is available at https://www.ldeo.columbia.edu/~ant/LADCP/. But the ship leg drive is likely to have the code ready upon departure. For further LADCP code acquisition, please contact Povl Abrahamsen (BAS).

The LEDO_IX toolbox incorporate the measured CTD temperature and salinity and retrieve the depth information in reference to CTD altimeter records. The main calling function for the data processing is `process_cast.m`, which only requires the cast number. However, a user-defined directory pathway along with other cruise-dependent parameters will be needed and these parameters can be defined/changed in `set_cast_params.m`.

In this cruise, three sets of `set_cast_params.m` scripts were created at different stage for different purpose. `set_cast_params_healthcheck.m` for general health check on the instruments, the produced output is based on the parameters determined by `default.m`. This script helps to identify some intermittent issue with the transducers (see **Figure 7.2.2**). The beam performance issue does not persist throughout the cruise therefore, no hardware repairing is needed.

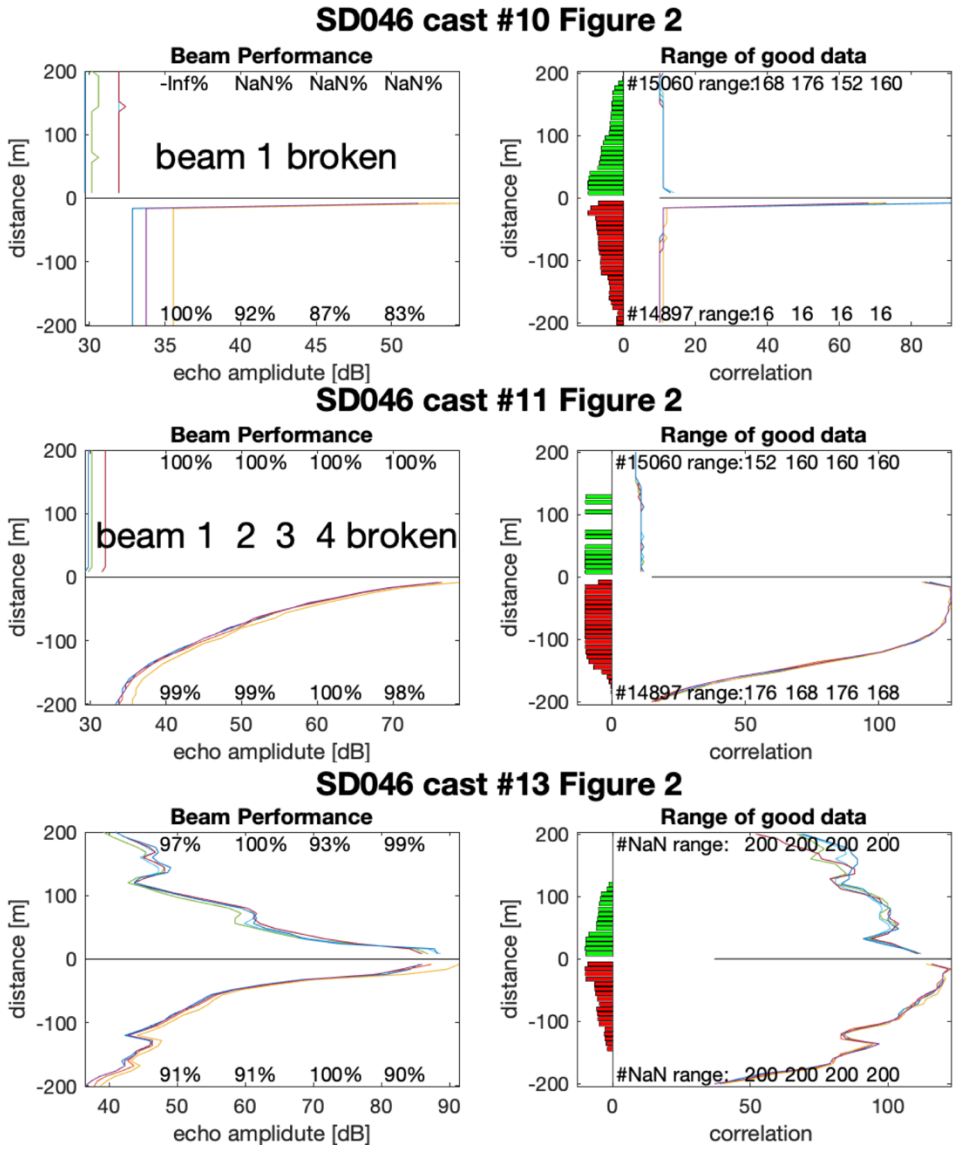

Figure 7.2.2 The Beam Performance evaluation for cast #10, #11 and #13. In #10 and #11, the beam performance picked up issues intermittently but did not persist into later casts (e.g., #13).

set_cast_params_prelim_sd046.m for performing LADCP processing when the CTD data was not yet processed. This script shouldn't be used once the workflow of CTD/LADCP is established on the ship. But it is a good practice for running through the data processing and get people familiarise the code structure.

`set_cast_params.m` is constantly used throughout the whole cruise. It contains the information of file directory for LADCP raw data, processed CTD data, Vessel-Mounted ADCP data (for the better inversion solution). It also provides the chance for making cast-to-cast parameters change.

Scripts run smoothly throughout most of the casts, some adjustments are made on parameters in some casts to assure a 'clean' result. In cast #23, three gaps were recorded in over in total 6380 ensemble depths, which cause problem for proceeding with the processing. The gaps in depth matrix are eliminated by linear interpolation to temporally solve the problem, but this is preferably resolved by investigate the CTD files where the depth record is originally generated. In cast #60, the down-looking LADCP didn't pick up the bottom depth from the bottom track data (p.zbottom=NaN) even though the target strength

field showed clear reflectance indicating the sea bed. This is hacked by manually forcing the p.zbottom=p.maxdepth (**Figure 7.2.3**). The p.maxdepth is the maximum depth that LADCP/CTD reached to and normally is not treated as the accurate representation of the bottom depth, especially in cases when it was not a full-depth cast.

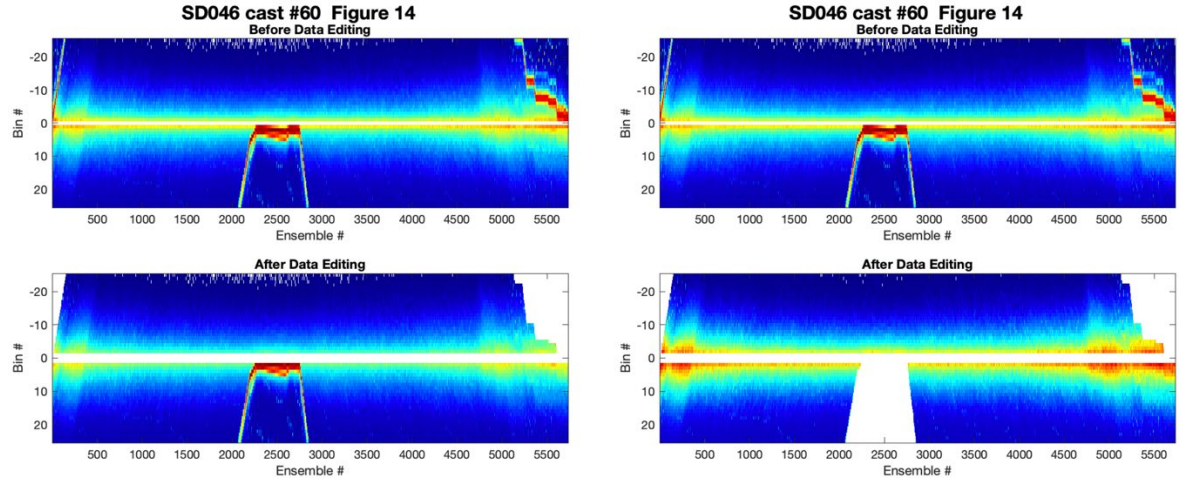

Figure 7.2.3 Target strength retrieved from cast #60. Left panel shows the data before after editing without a valid bottom depth from the bottom track information. The down-looking LADCP target strength shows clear strong reflectance suggesting the detection of seabed. Right panel shows the data edit after forcing to catch the bottom depth (`p.zbottom=p.maxdepth`).

In the shallower cast where the CTD did not reach the seabed, the bottom track mode parameter is set to 0 (`p.btrk_mode=0`) to avoid detecting bottom in down-looking data. **Figure 7.2.4** shows the difference before and after the bottom track mode was turned off for cast #17. The default setting edits out the data from down-looking LADCP as if those data were part of the seabed reflectance, while it is not.

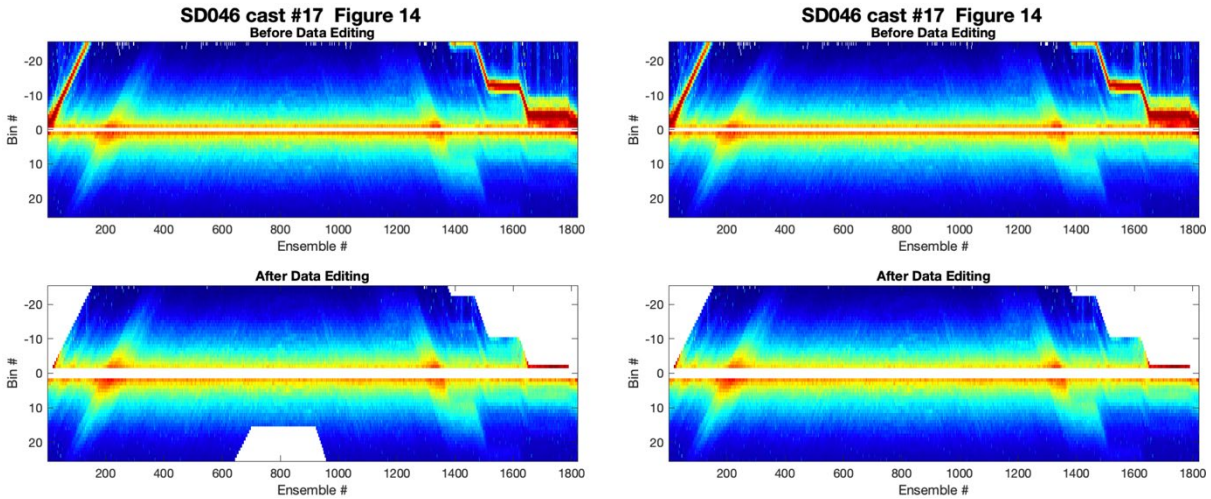

Figure 7.2.4 Target strength retrieved from cast #17. cast #17 is a shallow cast and didn't reach to the seabed. Left panel shows the data before after editing with a default bottom track mode. The down-looking LADCP target strength shows no strong reflectance suggesting that no detection of the seabed. Right panel shows the data edit after bottom track is turned off.

Vessel-Mounted ADCP data was used toward the end of the cruise to improve the quality of the velocity estimate from the inverse method used in LEDO_IX package. This is particular the case for shallow casts when CTD/LADCP never reached the range where the bottom can be detected. **Figure 7.2.5** shows the different velocity estimate with and without the

VMADCP input for cast #27 (the deepest CTD cast at the South Sandwich Trend central station).

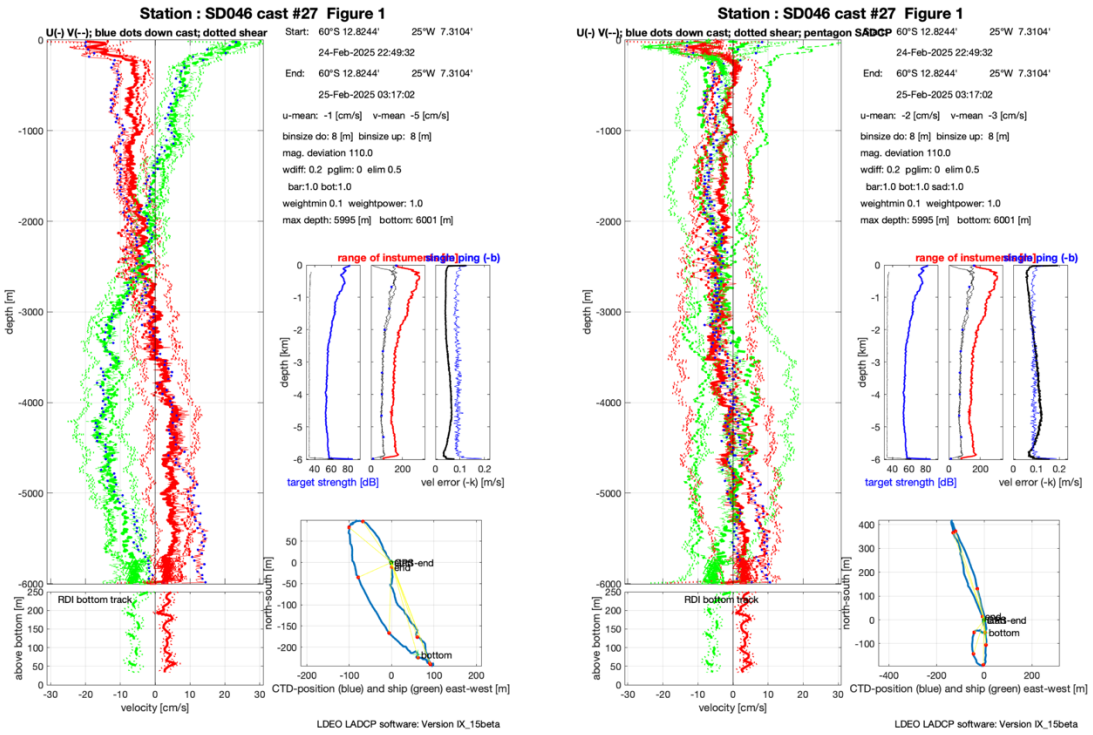

Figure 7.2.5 The time-averaged VMADCP over the small time-window around the LADCP cast was used to provide additional constraint to the inverse method of LADCP velocity calculation. On the right panel, it is obvious that the VMADCP information leads to greater error range of the velocity estimate and less accurate ship position.

Results

A23 section was serviced with a total of 15 CTD casts along with LADCP profiles. The along-track and cross-track velocities were computed using MATLAB scripts that were originally generated by Andrew Meijers and later modified by Ciara Pimm in JR18005 cruise. The code plots the velocity profiles over the along-track distance rather than in longitude-latitude framework. The velocity profiles for A23 section are shown in **Figure 7.2.6**.

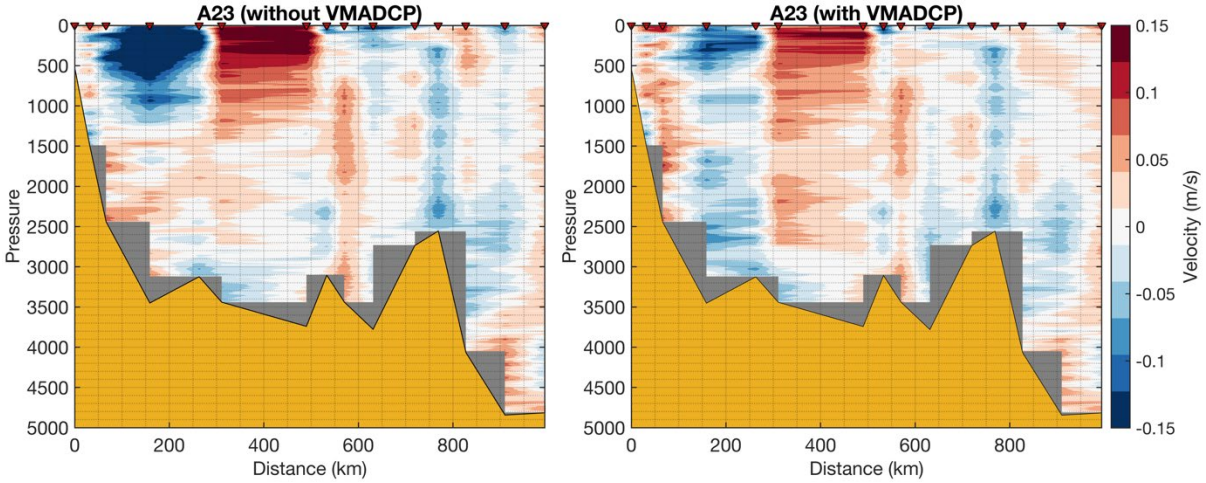

Figure 7.2.6 The cross-track velocity profiles for A23 section plotted against along-track distance from the northernmost A23 station. Red/blue means the water flows into/out of the screen. Red triangle on top of the plot denotes the location of the CTD/LADCP cast. Velocities with and without VMADCP constraints show qualitatively similar pattern.

The root mean square of the difference between LADCP velocities processed without VMADCP and the VMADCP velocities has been shown to be a good indicator of data quality in previous cruise. The data are regarded as good quality if the rms of the difference is smaller than 0.06m/s. However, in this cruise, the rms difference are uncommonly high (**Figure 7.2.7**) compared to the metrics from previous cruises, but such metrics were never estimated on RRS SDA cruise before. So, it is unclear whether the misalignment between VMADCP and LADCP velocity occurred only during this cruise, or it has been a long-term issue carried into SD046 expedition. It was also previously noticed that the SDA VMADCP tends to suffer from a misalignment angle in the velocity field which is in a fixed direction relative to ship heading (see SD035 PICCOLO cruise report). This misalignment could potentially lead to the high RMS.

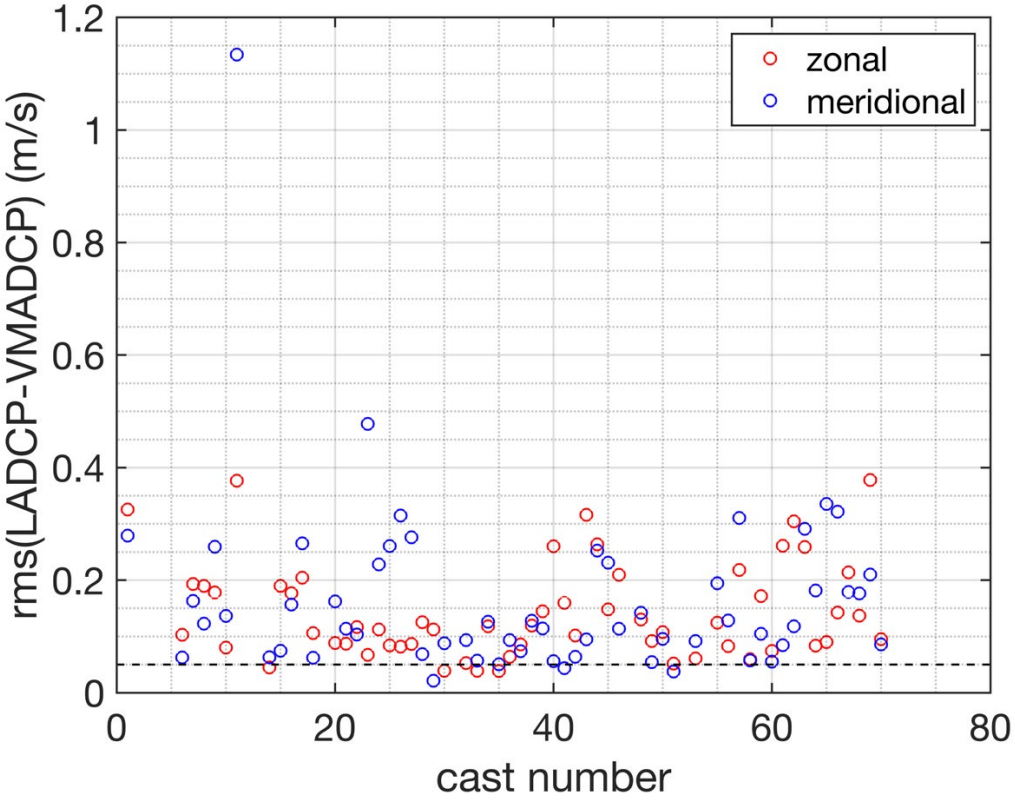

Figure 7.2.7 The Root-Mean-Square of the difference between LADCP velocity estimated **without** VMADCP and VMADCP velocity over the same depth plotted against cast numbers. 0.05 m/s is marked with broken horizontal line.

Another indicator of data quality is the instrument range, which has been used to investigate the quality of LADCP data alone in previous cruise, as the areas of low backscatter can affect the range of instrument and therefore the quality of the data. In most cases, the instrument range is over 80 m suggesting a good data quality acquired from LADCP (**Figure 7.2.8**). Therefore, the misalignment between LADCP velocities and VMADCP velocities can potentially be sourced from the VMADCP data.

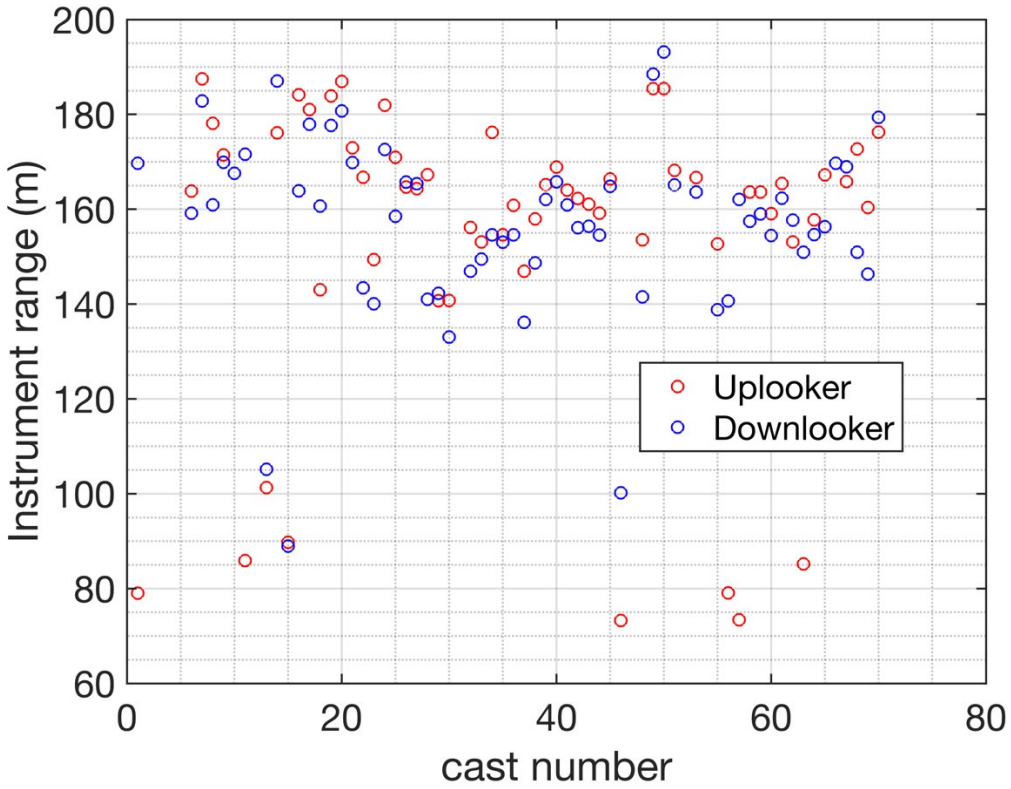

Figure 7.2.8 Instrument ranges (m) plotted against cast number. Red circles are from the up-looking LADCP, blue circles are from the down-looking LADCP.

Estimating Mean Volume Backscattering Strength (MVBS)

LADCPs measure the echo intensity of ensonified targets in the water column and can provide valuable information on biological backscattering layers analogous to scientific echosounders once appropriate SONAR equations are applied to calculate quantitative measures of mean volume backscattering strength (MVBS) (Deines 1999, Wade and Heywood 2001, Mullison 2017, Chawarski et al. 2022). Furthermore, the deployment of LADCPs on lowered CTD casts offer the potential to gain insight into the deep-water biological scattering layers that are not possible from hull-mounted echosounders due to the high sound attenuation rates that limit high frequencies (200 to 300 kHz) to the upper 200 m of the water column.

As part of BIOPOLE, we aimed to examine the spatial and temporal patterns in vertical acoustic MVBS profiles of mesozooplankton (~5 mm in size) from a lowered 300 kHz LADCP to parameterise variations in the depth distribution of the large diapausing copepod Calanoides acutus around the Powel Basin and surrounding marginal sea ice zone. This will help to better understand and parameterise the role of deepwater copepods in the biological ‘lipid pump’ at depths that are otherwise difficult to sample with conventional nets and scientific echosounders.

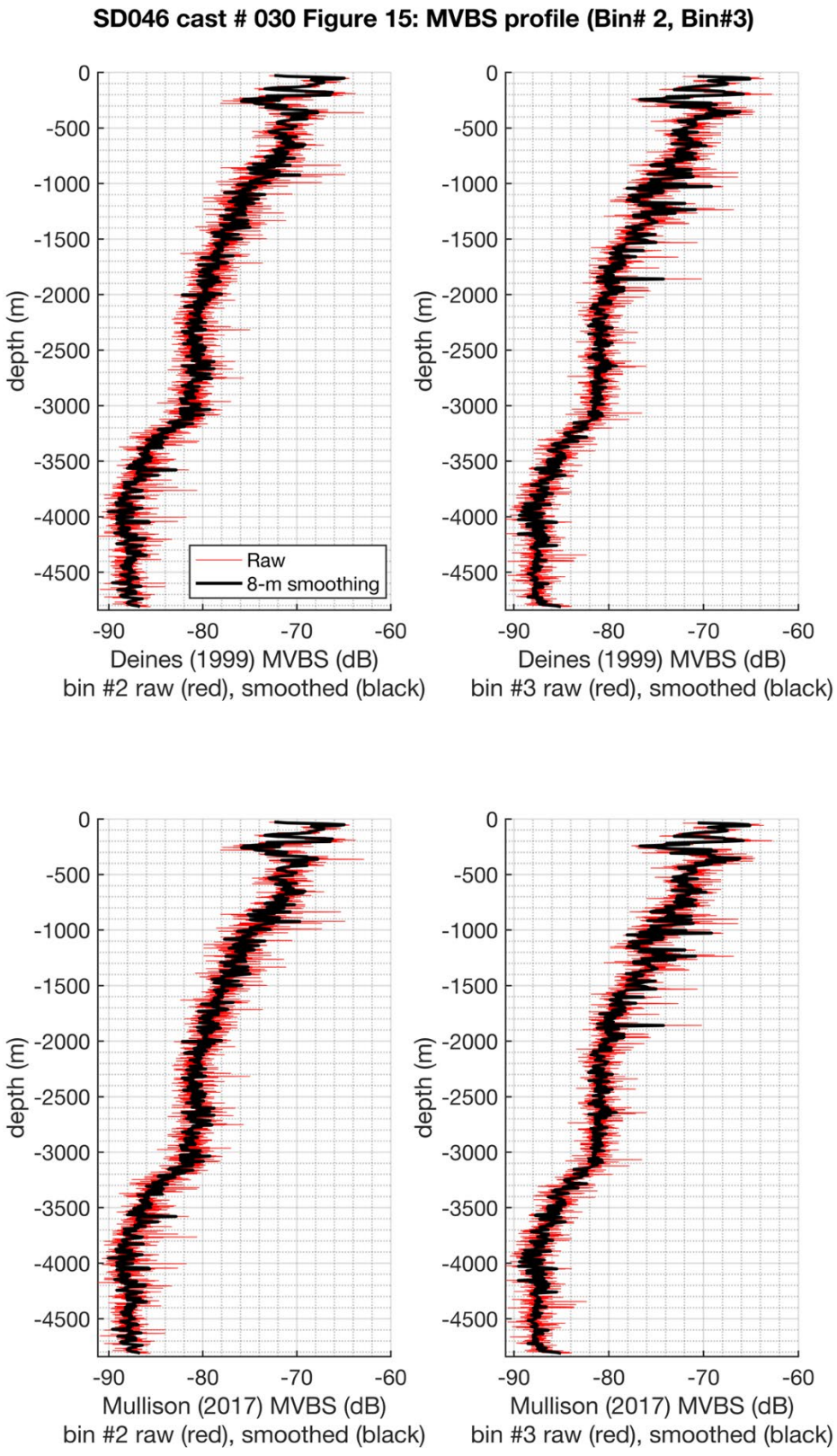

Figure 7.2.9 MVBS profiles from bin #2 and bin#3 estimated from LADCP cast #30. Raw profiles are in red, the 8-meter smoothed profiles are in black. Two types of signal-to-noise ratio methods are tested (Deines 1999 on top panels, Mullison 2017 on bottom panels).

We implemented the SONAR equations described in Deines 1999 and Mullison 2017 to obtain meaningful estimates of MVBS for the study. This procedure was executed using the script `svcalc4.m` that was incorporated into the LEDO_IX package during standard LADCP

current velocity processing during the cruise. Factory supplied beam calibration constants and in-situ estimates of sound speed and absorption coefficients were used in the equation. The modification to incorporate `svcalc4.m` was made in `process_cast.m` as from line 504 to line 598.

Since measures of MVBS are calculated every ~0.5 m during the downward decent of the CTD instrument array, the script `coarse_graining_vert.m` (in ../processed/) was executed subsequently to provide mean MVBS per 8 m depth bins, which is congruent with the 8 m observation window of the LADCP (i.e., 8 m bin increments up to 200 m range from the transducer; **Figure 7.2.9**). Both the Deines (1999) and Mullison (2017) formula were tested here. No discernible difference was detected, knowing that the sound speed coefficient in the script is a constant taken from Deines (1999) while the temperature dependent sound speed formula is desired to produce accurate estimate of the MVBS profiles.

LADCP processing warnings for each cast

This section lists any warnings, interesting features or different parameters setup of the processed LADCP data for BIOPOLE II cruise.

001 – Warnings: found 847 (20.2% of total) velocity measurements > 2.5 m/s. removed 380 pressure spikes during: 5 scans. Bottom track mode is off as this cast did not reach to the bottom.
006 – Warnings: found 321 (10.4% of total) velocity measurements > 2.5 m/s. removed 980 pressure spikes during: 10 scans.
007 – Warnings: found 440 (4.9% of total) velocity measurements > 2.5 m/s.
008 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
009 – Warnings: found 178 (5.0% of total) velocity measurements > 2.5 m/s.
010 – Warnings: found 246 (5.6% of total) velocity measurements > 2.5 m/s. removed 850 pressure spikes during: 10 scans. Beam 1 on the up-looking LADCP was broken.
011 – Warnings: Large compass deviation: 58.1338. last LADCP depth is -1001. Increasing error estimate because of elevated shear - inverse difference. Beam 1 2 3 4 on the up-looking LADCP did not work.
013 – Warnings: found 155 (8.3% of total) velocity measurements > 2.5 m/s. removed 602 pressure spikes during: 10 scans.
014 – Warnings: found 198 (5.3% of total) velocity measurements > 2.5 m/s. removed 1176 pressure spikes during: 10 scans.
015 – Warnings: found 356 (8.5% of total) velocity measurements > 2.5 m/s. removed 668 pressure spikes during: 10 scans.
016 – Warnings: found 180 (4.7% of total) velocity measurements > 2.5 m/s. Bottom track mode is off as this cast did not reach to the bottom.
017 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
018 – Warnings: removed 282 pressure spikes during: 10 scans.
019 – Warnings: found 193 (6.0% of total) velocity measurements > 2.5 m/s.
020 – LADCP profile OK.
021 – Warnings: found 122 (2.9% of total) velocity measurements > 2.5 m/s.
022 – Warnings: found 167 (2.6% of total) velocity measurements > 2.5 m/s.
023 – Warnings: found 104 (1.3% of total) velocity measurements > 2.5 m/s.
024 – Warnings: found 163 (2.3% of total) velocity measurements > 2.5 m/s.
025 – LADCP profile OK.
026 – Warnings: found 199 (2.3% of total) velocity measurements > 2.5 m/s.
027 – LADCP profile OK.
028 – LADCP profile OK.

029 – Warnings: Increasing error estimate because of elevated shear - inverse difference.
030 – LADCP profile OK.
032 – Warnings: found 162 (1.1% of total) velocity measurements > 2.5 m/s. Increasing error estimate because of elevated shear - inverse difference.
033 – Warnings: found 119 (1.5% of total) velocity measurements > 2.5 m/s. Increasing error estimate because of elevated shear - inverse difference.
034 – Warnings: found 418 (4.6% of total) velocity measurements > 2.5 m/s.
035 – Warnings: found 169 (2.3% of total) velocity measurements > 2.5 m/s.
036 – Warnings: Increasing error estimate because of elevated shear - inverse difference.
037 – Warnings: Increasing error estimate because of elevated shear - inverse difference.
038 – Warnings: found 247 (2.6% of total) velocity measurements > 2.5 m/s.
039 – Warnings: found 322 (5.4% of total) velocity measurements > 2.5 m/s.
040 – Warnings: Increasing error estimate because of elevated shear - inverse difference.
041 – Warnings: cast duration differs in downlooker/uplooker data.
042 – Warnings: found 103 (2.1% of total) velocity measurements > 2.5 m/s.
043 – Warnings: found 184 (2.6% of total) velocity measurements > 2.5 m/s.
044 – Warnings: found 134 (2.3% of total) velocity measurements > 2.5 m/s.
045 – Warnings: found 333 (4.1% of total) velocity measurements > 2.5 m/s. Increasing error estimate because of elevated shear - inverse difference.
046 – Warnings: found 179 (8.1% of total) velocity measurements > 2.5 m/s. removed 418 pressure spikes during: 6 scans.
048 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
049 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
050 – LADCP profile OK.
051 – LADCP profile OK.
053 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
055 – Warnings: found 399 (4.0% of total) velocity measurements > 2.5 m/s.
056 – Warnings: found 553 (12.9% of total) velocity measurements > 2.5 m/s. removed 294 pressure spikes during: 5 scans. Bottom track mode is off as this cast did not reach to the bottom.
057 – Warnings: found 126 (4.6% of total) velocity measurements > 2.5 m/s. removed 540 pressure spikes during: 10 scans. Bottom track mode is off as this cast did not reach to the bottom.
058 – Warnings: found 141 (2.1% of total) velocity measurements > 2.5 m/s.
059 – LADCP profile OK.
060 – Warnings: found 144 (1.7% of total) velocity measurements > 2.5 m/s.
Increasing error estimate because of elevated shear - inverse difference.
061 – LADCP profile OK.
062 – LADCP profile OK.
063 – Warnings: removed 728 pressure spikes during: 10 scans. Bottom track mode is off as this cast did not reach to the bottom.
064 – LADCP profile OK.
065 – Warnings: found 353 (4.8% of total) velocity measurements > 2.5 m/s.
066 – Warnings: found 215 (4.0% of total) velocity measurements > 2.5 m/s. removed 20 pressure spikes during: 2 scans. Bottom track mode is off as this cast did not reach to the bottom.
067 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
068 – LADCP profile OK. Bottom track mode is off as this cast did not reach to the bottom.
069 – Warnings: found 340 (6.0% of total) velocity measurements > 2.5 m/s. Bottom track mode is off as this cast did not reach to the bottom.

070 – Warnings: found 197 (7.3% of total) velocity measurements > 2.5 m/s. removed 876 pressure spikes during: 10 scans.

Reference

Chawarski J., Klevjer T. A., Coté D. and Geoffroy M. (2022). Evidence of temperature control on mesopelagic fish and zooplankton communities at high latitudes. Front. Mar. Sci. 9:917985. https://doi.org/10.3389/fmars.2022.917985.

Deines, K.L. (1999). Backscatter estimation using broadband acoustic Doppler current profilers. In: Proceeding of the IEEE, 6th Working Conference on Current Measurement, San Diego, CA, USA. Topping et. al., 2015. https://doi.org/10.1109/CCM.1999.755249.

Mullison J. (2017). Backscatter Estimation Using Broadband Acoustic Doppler Current Profilers - Updated. ASCE Hydraul. Meas. Exp. Methods Conf. 031, 1 – 6.

Wade, I. P. and Heywood, K. J. (2001). Acoustic backscatter observations of zooplankton abundance and behaviour and the influence of oceanic fronts in the northeast Atlantic. DEEP-SEA RES PT II. 48, 899 – 924. https://doi.org/10.1016/S0967-0645(00)00113-2.

Visbeck, M. (2002). Deep Velocity Profiling Using Lowered Acoustic Doppler Current Profilers: Bottom Track and Inverse Solutions. J. Atmos. Ocean. Technol. 19, 794 – 804. https://doi.org/10.1175/1520-0426(2002)019%3C0794:DVPULA%3E2.0.CO;2.

7.3 Underway data

Author: Katherine Turner

Underway oceanographic measurements

Seven metres down

A small pole inhales the sea

The flow rate cuts out

Introduction

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, sd046, was set up. The connection to the database was set up via the MATLAB Database Toolbox's internal (native) PostgreSQL interface.

Methodology

As done on previous cruises, for the expedition's duration, a daily workflow was followed in which the underway navigation, meteorological + oceanographic, and bathymetry data for the previous day was processed.

All information on the underway processing, software, prerequisites, file structure, RVDAS data streams and databases, and daily workflow can be found on the BAS GitLab page at: https://gitlab.data.bas.ac.uk/epab/underway-data-processing

Initially data are downloaded from the database onto the L drive and stored in a MatLab file. For most of the scripts, the day number can be provided as an argument. Examples below are provided for 14 February (day 46):

```
load_daily_nav(46);          % load daily navigation streams
append_daily_nav(46);  % append daily navigation to concatenated file
load_daily_bathy(46);    % load daily bathymetry streams
edit_daily_bathy(46);    % edit daily bathymetry streams manually
append_daily_bathy(46);          % append daily bathymetry
load_daily_ocl(46);              % load daily science sensors
edit_daily_ocl(46);              % edit daily oceanographic data manually
append_daily_ocl(46);    % append science data
```

At this stage, the concatenated files of raw/edited data will be up to date. If, for any reason, a file is revised, it can be added to the concatenated file with append_daily_[variable]. However, any subsequent files also need to be appended. Alternatively, all files can be concatenated using make_total_[variable].

edit_daily_ocl() was a new script added on this cruise which uses scripts provided by Hugh Venables and Povl Abrahamsen to manually check the main oceanographic variables (mainly sea surface temperature, conductivity, salinity, chlorophyll, and beam attenuation).

Once all daily files have been processed, we make the averaged files of the whole cruise to that point (with the full duration between 19 February and 26 March) at 1-s and 30-s averaged intervals, using:

```
make_ave_nav;                % calculate averaged navigation files
make_std_attitude;           % calculates max roll, pitch, heave for time interval
make_ave_bathy;              % calculate averaged bathymetry files
make_ave_ocl;                % calculate averaged science files
export_underway_to_netcdf;   % merge the averaged files into a single CF-compliant NetCDF file
export_track_to_gpx(4);      % export the ship track to a GPX interchange file at 2-minute resolution
```

This results in the following files (MATLAB tables), stored in the directory L:\work\scientific_work_areas\underway\underway-data-processing\ :

- sd046_nav_seapath1_1s_ave.mat
- sd046_nav_seapath1_30s_ave.mat
- sd046_nav_seapath2_1s_ave.mat
- sd046_nav_seapath2_30s_ave.mat
- sd046_nav_seapath1_1min_std.mat
- sd046_nav_seapath2_1min_std.mat
- sd046_nav_phinns_1min_std.mat
- sd046_ocl_1s_ave.mat
- sd046_ocl_30s_ave.mat
- sd046_bathy_1s_ave.mat
- sd046_bathy_30s_ave.mat

Options have been added to save these files over a given period and with a given interval as these both proved to be useful in other areas of the cruise. When these files are generated, they are saved as:

- <cruise_name>_<sensor>_<start_jday>_<end_jday>_<interval in seconds>s_ave.mat

There is now also the option to save the files as csv as well, in which case the file will be saved with the identical filename structure as above but with the extension ‘.csv’. Navigation data

Navigational data were collected continuously throughout the cruise and loaded to RVDAS.

Table 7.3.1. Table listing the sensor location on the ship, units and RVDAS table name of the underway navigation instruments used on the SD041 cruise.

Data Stream on RVDAS	Measurement	Units	Sensor Location
attitude_ixblue_phins_surface_heading_crp1_hehdt	Heading	degrees	
attitude_kongsberg_seapath_320_heading_port1_inhdt	Heading	degrees	port
attitude_kongsberg_seapath_320_heading_stbd1_inhdt	Heading	degrees	starboard
attitude_ixblue_phins_surface_motion_crp1_kmatt	Motion data (heave, pitch, roll)	(degrees/100, cm)	
attitude_kongsberg_seapath_320_motion_port1_kmatt	Motion data (heave, pitch, roll)	(degrees/100, cm)	port
attitude_kongsberg_seapath_320_motion_stbd1_kmatt	Motion data (heave, pitch, roll)	(degrees/100, cm)	starboard
gnss_kongsberg_seapath_320_port1_ingga	Global Positioning Data, course over ground	degrees	port
gnss_kongsberg_seapath_320_port1_invtg	Global Positioning Data, course over ground	degrees	port
gnss_kongsberg_seapath_320_stbd1_ingga	Global Positioning Data, course over ground	degrees	starboard
gnss_kongsberg_seapath_320_stbd1_invtg	Global Positioning Data, course over ground	degrees	starboard

Navigation Data

The underway navigational data was processed in MATLAB (R2024b) on Windows (Windows 10 Enterprise). The scripts used were provided by Povl Abrahamsen. The MATLAB scripts were modified to use the native PostgreSQL interface as detailed above, and scripts were updated to call the current set of instrumentation available and run on the more recent version of MATLAB (obsolete functions were removed and\or replaced). All scripts are available under L:\work\scientific_work_areas\underway\code\.

rvdas_tables.m	Makes use of the Database Toolbox 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 1 to the structure *nav_tables* which is called by any scripts loading, saving, or analysing the navigation data.
load_daily_nav.m	Given year and day and loads that day's 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 1.
append_daily_nav.m	Appends the daily files within the directory L:\work\scientific_work_areas\underway\nav
make_total_nav.m	Concatenates all navigation tables within the directory L:\work\scientific_work_areas\underway\nav
make_ave_nav.m	Makes 1-s and 30-s averaged underway navigation data files. An example is shown below in Figure 2.
make_std_attitude.m	Calculates the max and average roll, pitch, and heave over given intervals, example below is for 30minutes as was requested by the phytoplankton team.

Example outputs of the underway navigational data processing are shown in Figures 7.3.1, 7.3.2 and 7.3.3.

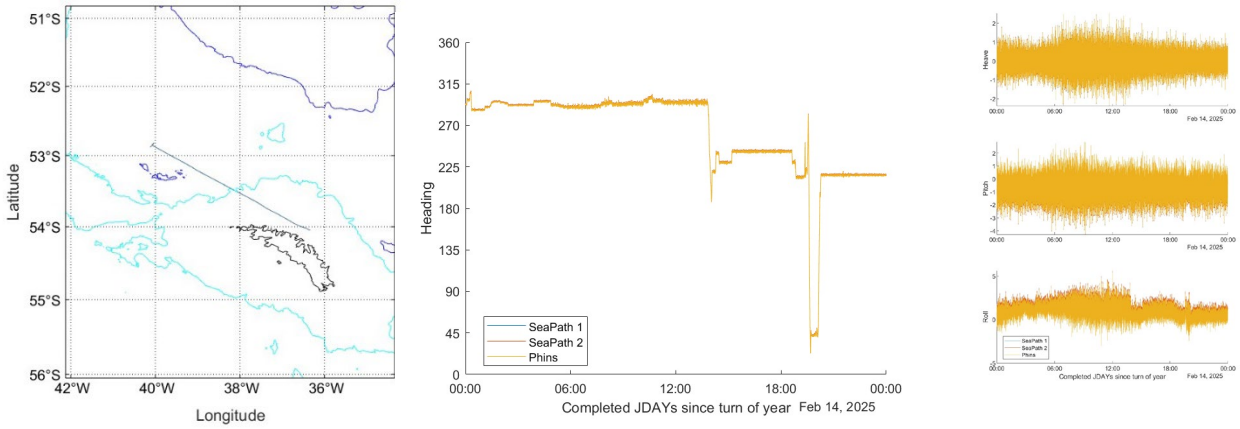

Figure 7.3.1. Example navigation outputs for a single day (14 February 2025 / Julian Day 45). (left) Ship GNSS location (dark blue) when surveying a region to the NW of South Georgia. (centre) Ship heading. (right) Ship heave, pitch and roll.

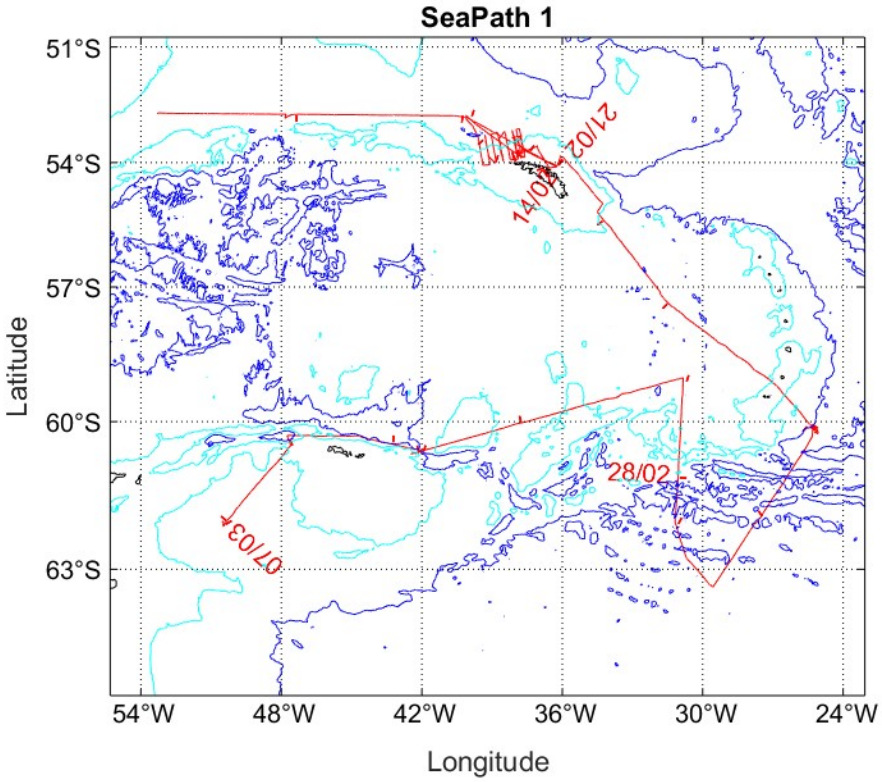

Figure 7.3.2. Ship navigation route (red) from Punta Arenas (Chile) to South Georgia, to the Orkney Passage, to the Weddell Sea, covering the Western Core Box, A23, and BIOPOLE between the 7th of February to the 13th of March 2025, as measured by the SeaPath1 GNSS sensor.

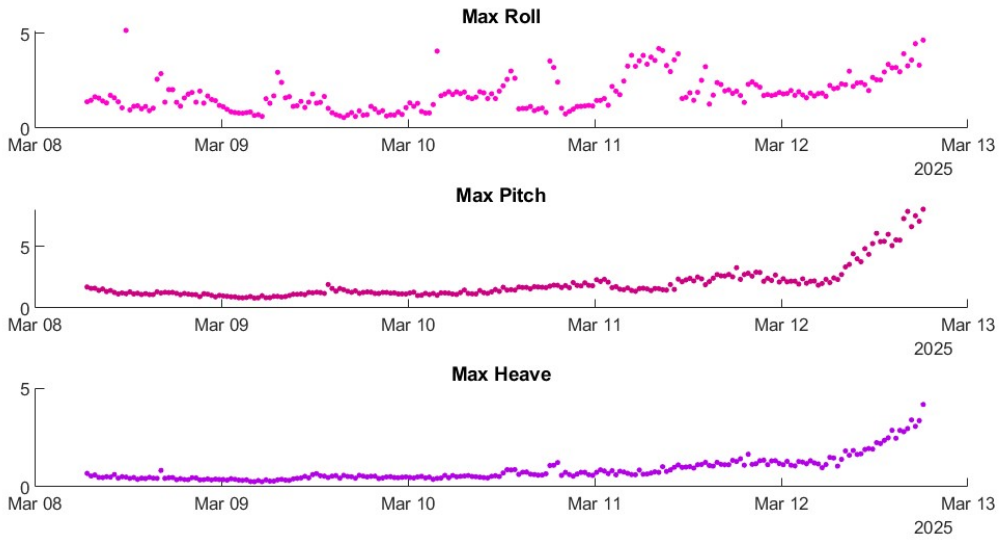

Figure 7.3.3. Max absolute ship roll pitch and heave between the 8th of March 6:30 am to the 12th of March 6:30 pm in half hour bins ?max(abs(roll))

Issues and Recommendations

- During this period, we also monitored the Raytheon attitude sensors, as these are the ones used by the bridge. We found their readings to be very similar to our Seapath estimates. However, since this monitoring significantly slowed down data loading and consumed a large amount of storage, it was paused. These sensors remain available but are currently commented out in the set_underway_params script for anyone interested in using them in the future.
- Several of the science team's instruments were sensitive to movement, leading to requests for estimates of maximum roll, pitch, and heave over given periods. A script to provide these estimates is now available within the code directory. Efforts have been made to ensure the script is as reproducible as possible in case similar data is needed on future cruises.
- Additional customizations have been added to the averaging scripts to facilitate data checks. These include options to select specific time intervals and to modify the averaging period (the original script supported 30s and 60s averaging). Additionally, some variable names have been updated for clarity, making it easier to share the data with others, and an option to save the final file to csv has been added.
- On the 25th of March 2025 during a storm there was a time when the sensors cut out, so these data points are missing:
    - **SeaPath 1 :** 25-Mar-2025 14:17:47 to 25-Mar-2025 14:23:25 (338 s)
    - **SeaPath 2** : 25-Mar-2025 14:15:33 to 25-Mar-2025 14:23:59 (506 s)

Bathymetric Data

Bathymetric data were collected continuously by the EA640 echosounder throughout the cruise and opportunistically with the EM124 and EM712 swath systems and were loaded to RVDAS.

Table 7.3.3. Table listing the sensor location on the ship, units and RVDAS table name of the underway bathymetry instruments used on the SD046 cruise.

Data Stream on RVDAS	Measurement	Units	Sensor Location
multibeam_kongsberg_em124_hull1_kcdpt	Water depth	metres	hull
multibeam_kongsberg_em712_hull1_kodpt	Water depth	metres	hull
singlebeam_kongsberg_ea640_hull1_dbdbt	Water depth	metres	hull

Processing bathymetric data

The underway bathymetry data was processed in MATLAB (R2024b) on Windows (Windows 10 Enterprise). The scripts used were provided by Povl Abrahamsen. The scripts were updated to call the current set of instrumentation available. All scripts are available under L:\work\scientific_work_areas\underway\underway-data-processing.

rvdas_tables.m	Makes use of the Database Toolbox 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 3 to the structure *bathy_tables* which is called by any scripts loading, saving, or analysing the bathymetry data.
load_daily_bathy.m	Given year and day and loads that day's bathyhmetry 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*.
edit_daily_bathy.m	Graphical interface to remove erroneous data points / spikes to clean the data per day, an example of cleaned bathymetric data can be found in Figure 4.
append_daily_bathy.m	Appends the daily files within the directory L:\work\scientific_work_areas\underway\bathy
make_total_bathy.m	Concatenates all bathymetry tables within the directory L:\work\scientific_work_areas\underway\bathy
make_ave_bathy.m	Makes 1-s and 30-s averaged underway bathymetry data files. The averaged and cleaned bathymetry data for the whole cruise is plotted in Figure 11.

An example of cleaned bathymetric data on a day when two sensors were used is shown in Figure 7.3.4.

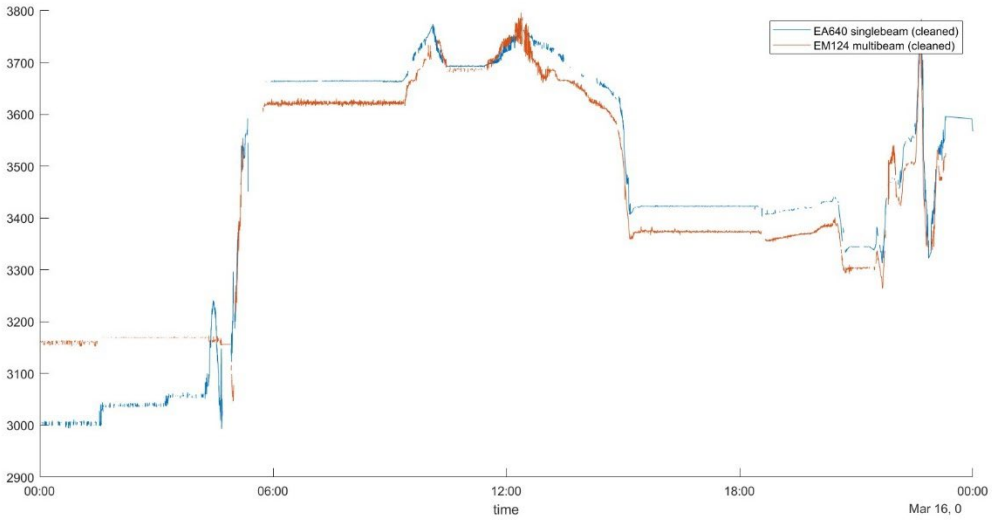

Figure 7.3.4. Bathymetric data for the 16th of March 2025 collected during the deployment of moorings OP1 and OP5, and the transit towards science station BP2_1.

Issues and Recommendations

- The EM122 multibeam sensor was replaced by the EM124, and the scripts were updated accordingly, as reflected in the table.
- The EM124 and EM712 instruments were activated only when needed, whereas the EA640 operated continuously, resulting in data gaps for the first two sensors.
- The EA640 occasionally experienced blips during the cruise, requiring a reset either by restarting the software or by AME electrical power cycling at source. Additionally, bad weather and storms—occurring several times during the cruise—affected data quality.
- A new function was added to edit_daily_bathy, improving the editing process by providing more flexibility for positive and negative responses.
- The scripts were updated to ensure compatibility with the latest version of MATLAB.
- The make_ave_bathy script was enhanced to allow users to select specific date ranges, a feature that proved useful during the cruise.

Oceanographic Data

Oceanographic and meteorological data were collected continuously throughout the cruise and loaded to RVDAS.

Table 7.3.2. List of oceanographic and meteorological sensors used on SD046, their location on the ship, and the RVDAS table names, as called in the *set_underway_params.m* script.

Data Stream on RVDAS	Measurement	Units	Sensor	Sensor Location
anemometer_ft_tech_ft702lt_ centremast1_wimwv	Wind speed and angle	degrees, m/s	anemometer	centre mast
anemometer_observator_omc11 6 _portmast1_wimwv	Wind speed and angle	degrees, m/s	anemometer	port mast
anemometer_observator_omc11 6 _stbdmast1_wimwv	Wind speed and angle	degrees, m/s	anemometer	starboard mast
flowmeter_litremeter_lmx24 _ucsw1_plmflow1	Flow speed (TSG)	L/min	flowmeter	hull (intake at depth 7m), instrumen t in UCSW lab
fluorometer_wetlabs_wschl _ucsw1_pwlfluor1	Chlorophyll	counts	fluorometer	hull (intake at depth 7m), instrumen t in UCSW lab
met_michell_optidew2_ aerosol1_pmdew1	Relative humidity	%	chilled mirror hygrometer	Port wing, deck 10
met_vaisala_hmp155e_ foremast1_pvtnh2	Relative humidity, Dew point temperature, wet bulb temperature, mixing ratio	%, degrees, Celsius, g/kg	hygrometer and thermometer	foremast
met_vaisala_hmp155e_ scimast1_pvtnh2	Relative humidity, Dew point temperature, wet bulb temperature, mixing ratio	%, degrees, Celsius, g/kg	hygrometer and thermometer	scimast

met_vaisala_hmp155e_ scimast2_pvtnh2	Relative humidity, Dew point temperature, wet bulb temperature, mixing ratio	%, degrees, Celsius, g/kg	hygrometer and thermometer	scimast
met_vaisala_ptb330_v2 _aerosol1_pvbar	Air pressure	hPa	barometer	aerosol lab
met_vaisala_ptb330_v2 _aerosol2_pvbar	Air pressure	hPa	barometer	aerosol lab
radiometer_heitronics_ ct15_85_port1_phsst	Sea surface temperature	Degrees Celsius	Radiometer	port
radiometer_heitronics_ ct15_85_stbd1_phsst	Sea surface temperature	Degrees Celsius	Radiometer	starboard
radiometer_kipp_zonen _smp22_foremast1_pkpyran	Total incoming radiation (TIR)	W/m^2	Radiometer	foremast
radiometer_kipp_zonen _smp22_scimast1_pkpyran	Total incoming radiation (TIR)	W/m^2	Radiometer	scimast
radiometer_satlantic_par _foremast1_pspar	Photosyntheticall y available radiation (PAR)	$\mu mol/m^2/s$	Radiometer	foremast
radiometer_satlantic_par _scimast1_pspar	Photosyntheticall y available radiation (PAR)	$\mu mol/m^2/s$	Radiometer	scimast
soundvelocity_valeport_ minisvs_ucsw1_pvsv1	Sound velocity	m/s	sound velocity probe	hull (intake at depth 7m), instrumen t in aux. machine room 2
thermometer_seabird_ sbe38_ucsw1_psbsst1	Water temperature	Degrees Celsius	thermometer	hull (intake at depth 7m), instrumen t in aux. machine room 2
thermometer_seabird_ sbe38_ucsw2_psbsst1	Water temperature	Degrees Celsius	thermometer	hull (intake at depth

				7m), instrument in aux. machine room 2 stb
thermosalinograph_seabird_sbe45_ucsw1_psbtsg1	Temperature, Salinity, Conductivity	Celsius, S/m, PSU	thermo-salinograph (TSG)	hull (intake at depth 7m), instrument in UCSW lab
transmissometer_wetlabs_cstar_ucsw1_pwltran1	beam transmission	%	transmissometer	hull (intake at depth 7m), instrument in UCSW lab

Processing oceanographic and meteorological (OCL) data

The underway oceanographic and meterorological data were processed in MATLAB (R2024b) on Windows (Windows 10 Enterprise). The scripts were provided by Povl Abrahamsen. All scripts are available under L:\work\scientific_work_areas\underway\underway-data-processing. For more details read the documentation present in the README.md file.

rvdas_tables.m	Makes use of the Database Toolbox 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 2 to the structure *nav_tables* which is called by any scripts loading, saving, or analysing the oceanographic and meteorological data.
load_daily_ocl.m	Given year and day and loads that day's 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*. Examples of daily plots are shown in Figures 5, 6, 7.
edit_daily_ocl.m	Graphical interface to remove erroneous data points / spikes to clean the data per day, an example of cleaned oceanographic data can be found in Figure 8.

append_daily_ocl.m	Appends the daily files within the directory L:\work\scientific_work_areas\underway\ocl
make_total_ocl.m	Concatenates all oceanographic and meteorological tables within the directory L:\work\scientific_work_areas\underway\ocl
plot_tot_ocl_map.m	Plot oceanographic data over the navigation path. Figure 7.3.9.
make_ave_ocl.m	Makes 1-s and 30-s averaged underway oceanographic and meteorological data files.
plot_ave_ocl.m	Plot averaged 30-s data of the full time series of oceanographic and meteorological data. Example plots are shown in Figures 7.3.9-12.
calibrate_temp.m	Compare underway temperature measurements from seabird 1 and seabird 2 to temperature measured on the CTD. Methods described below and shown in Figures 7.3.13-16.
calibrate_salt.m	Compare underway thermosalinograph conductivity and salinity to measured salinity from salinometer samples from the UCSW tap and to the CTD measurements. Shows time series of conductivity and salinity for whole cruise and offsets with the measured samples. Shown in Figures 7.3.17 – 19

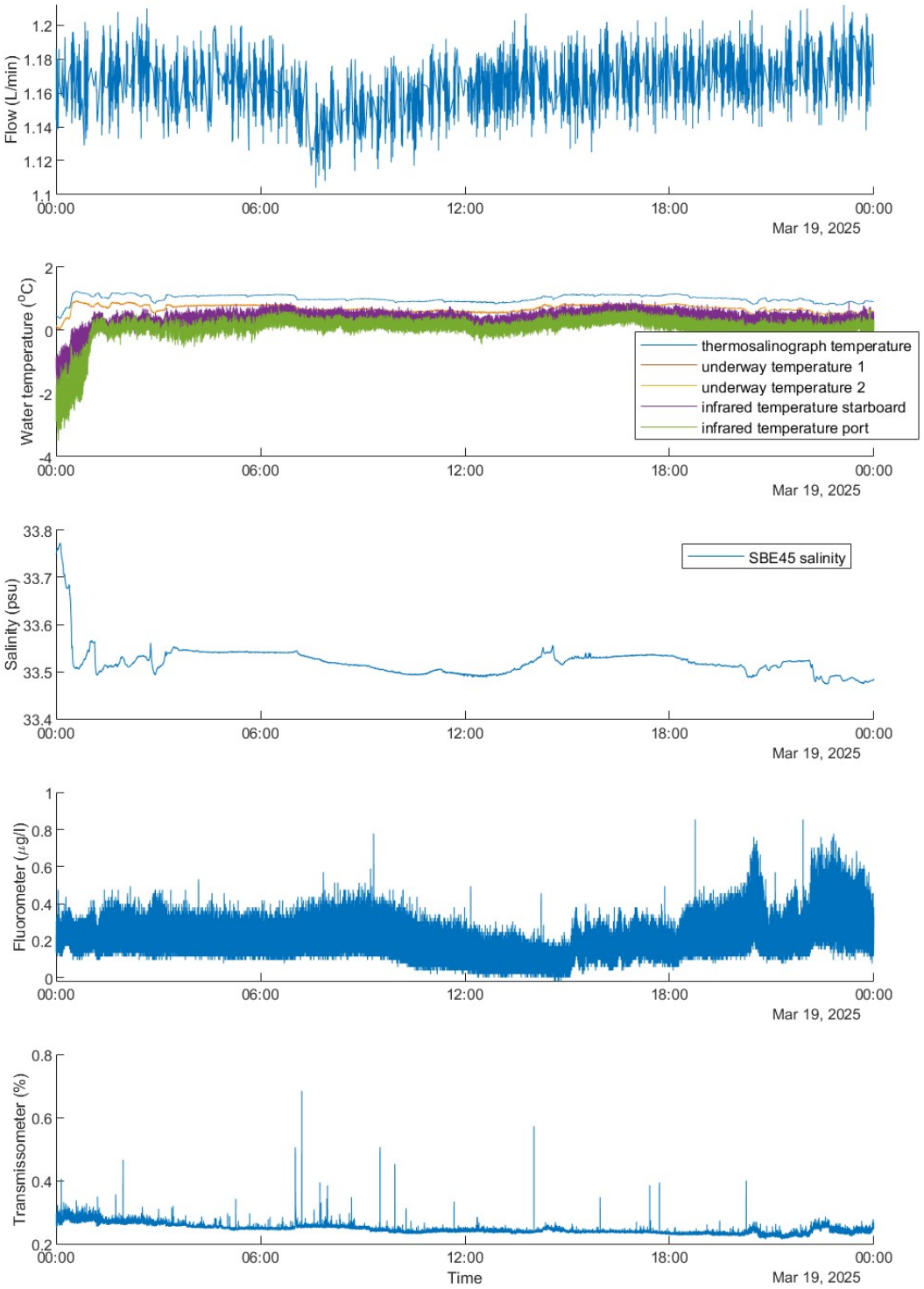

Figure 7.3.5. Example oceanographic (TSG) outputs data (flow rate, water temperature, salinity, fluorescence, transmission) for a single day (19 March 2025 / Julian Day 78).

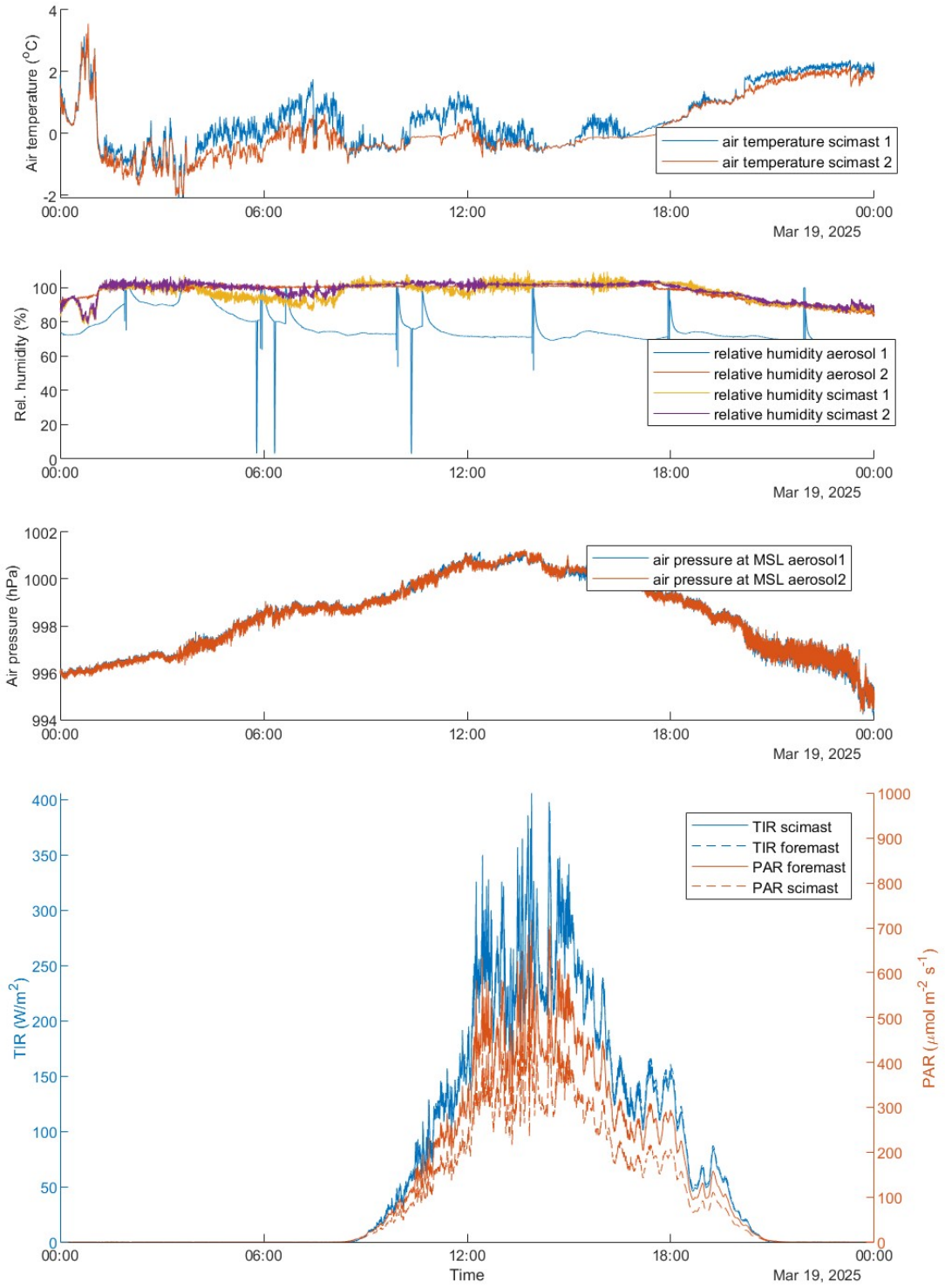

Figure 7.3.6. Example meteorological outputs (air temperature, relative humidity, air pressure and total incoming/photosynthetically available radiation) for a single day (19 March 2025 / Julian Day 78).

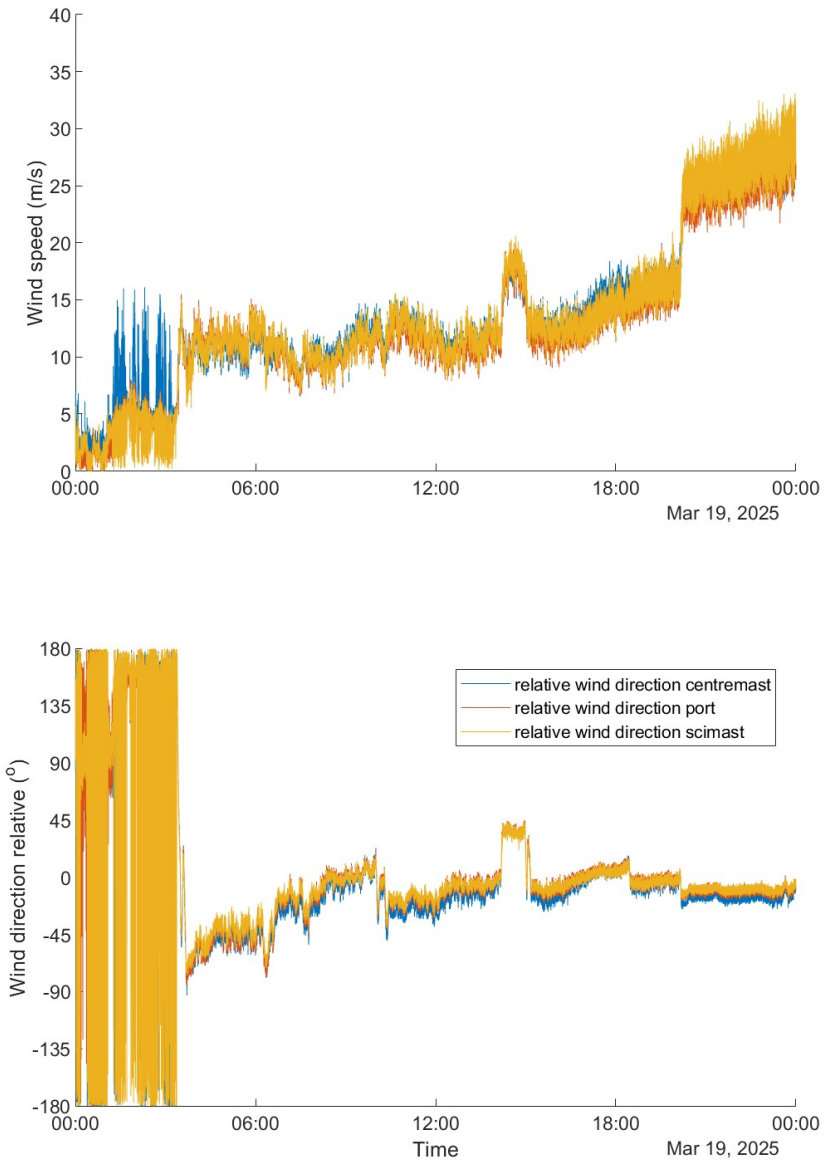

Figure 7.3.7. Example meteorological outputs (wind speed and relative direction) for a single day 19 March 2025 / Julian Day 78)

Editing the daily oceanographic data

For this cruise we added the script edit_daily_ocl.m which is a combination of dy158_edit_ocl.m and various scripts provided by Hugh Venables. This script acts much as the editing scripts for the bathymetry or the CTD profiles going through the oceanographic variables and allowing the user to edit these interactively. These scripts clean the data from the following sensors:

- thermosalinograph_seabird_sbe45_ucsw1_psbtsg1
- thermometer_seabird_sbe38_ucsw1_psbsst1
- thermometer_seabird_sbe38_ucsw2_psbsst1
- fluorometer_wetlabs_wschl_ucsw1_pwlfluor1
- transmissometer_wetlabs_cstar_ucsw1_pwltran1

We tried to maintain the same structures as those used in the other MATLAB scripts provided by Povl Abrahamsen, to aid any future additions of variables. An example figure is shown in Figure 7.3.8, showing the script highlighting areas where the flow drops below 0.7L/min as this was shown to be the value where data stopped being reliable on PICCOLO (Cruise Report SD035). The script then uses the interactive_edit scripts to edit out these points.

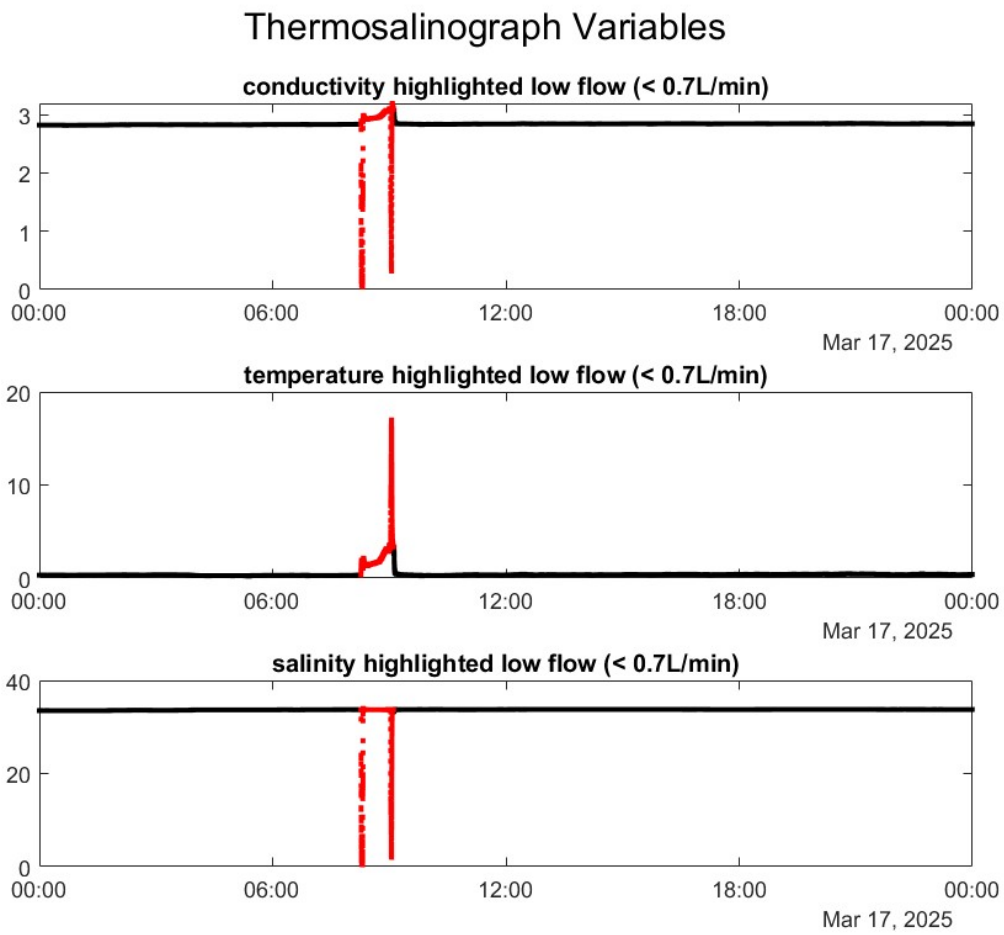

Figure 7.3.8. Example of a figure used in edit_daily_ocl.m the script highlights areas where the flow falls below 0.7L/min. The user can then interactively remove these points.

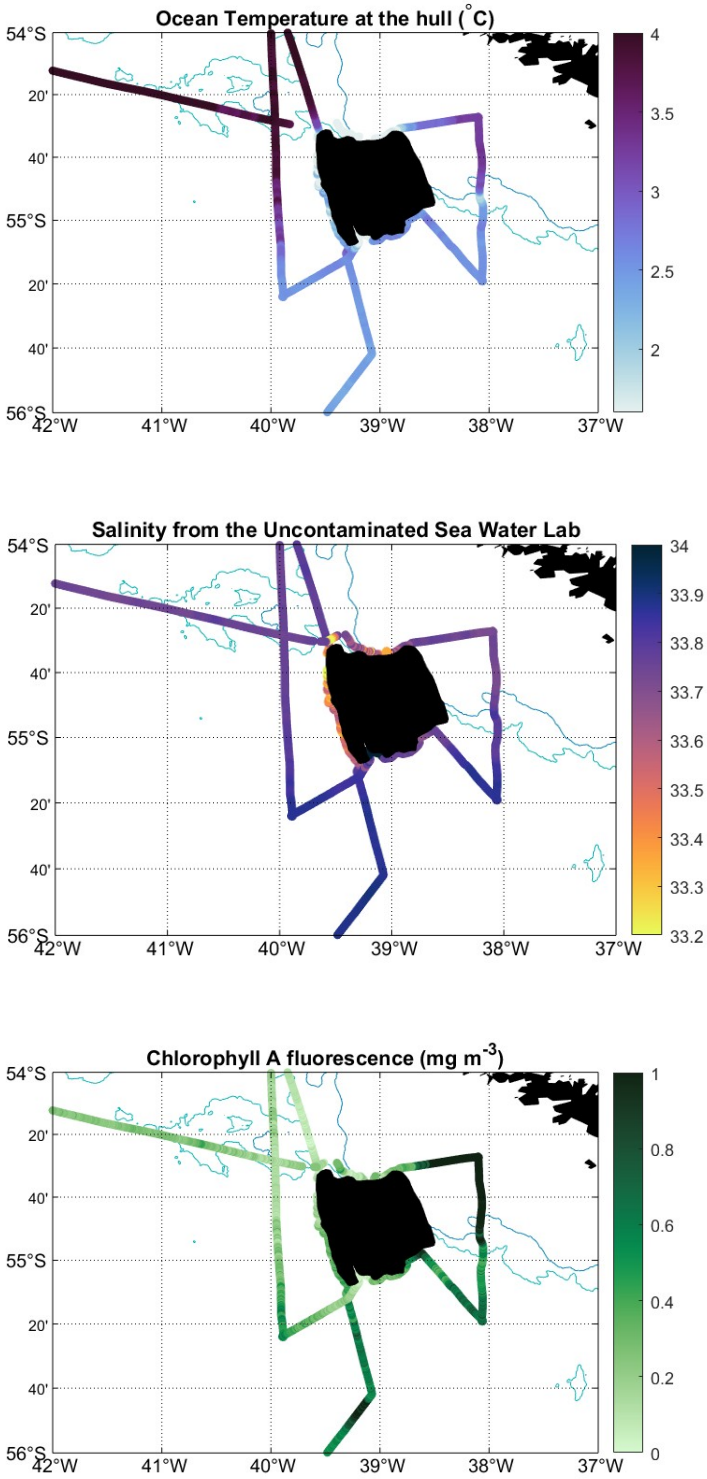

Figure 7.3.9 Temperature, salinity and chlorophyll fluorescence plotted over the ship's course, the dots are plotted every half hour which show a rough estimate of every point sampled

Averaging and calibrating the files

To calculate the temporal average, we use make_ave_ocl. This script was modified similarly to previous averaging scripts, enabling the selection of new interval periods and different averaging durations. The output files now include embedded navigation data, making them easier to read. Additionally, a wind rose was used to simplify the wind direction analysis.

New to this cruise is the plot_tot_ocl_map which plots the oceanographic data over nav over a period of interest (or over the entire cruise). An example is shown in Figure 7.3.9 which shows the cruise track around the A23a iceberg.

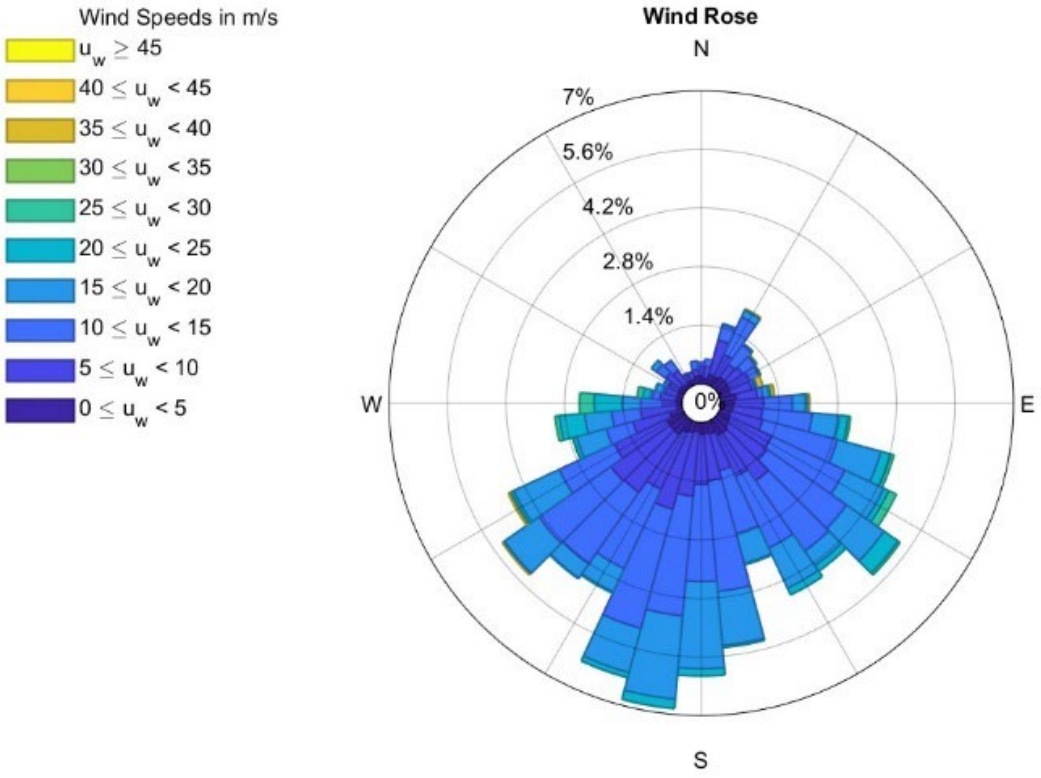

Figure 7.3.10. Absolute wind direction for the entire cruise with the averaged 30s files

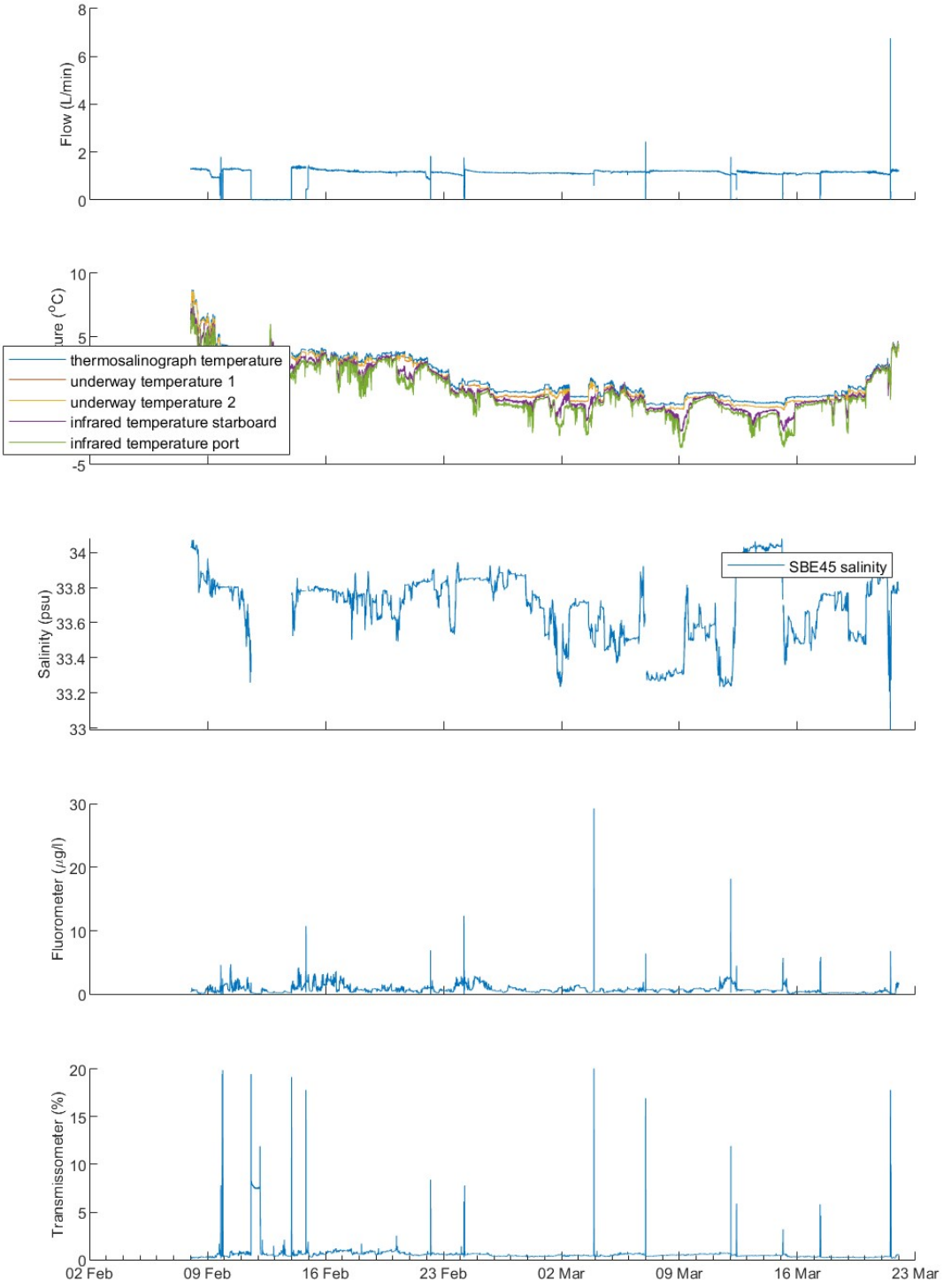

Figure 7.3.11. Time series of thermosalinograph oceanographic data (flow rate, water temperature, salinity, fluorescence, transmission) for the SD046 cruise, 9 February to 23 March 2025.

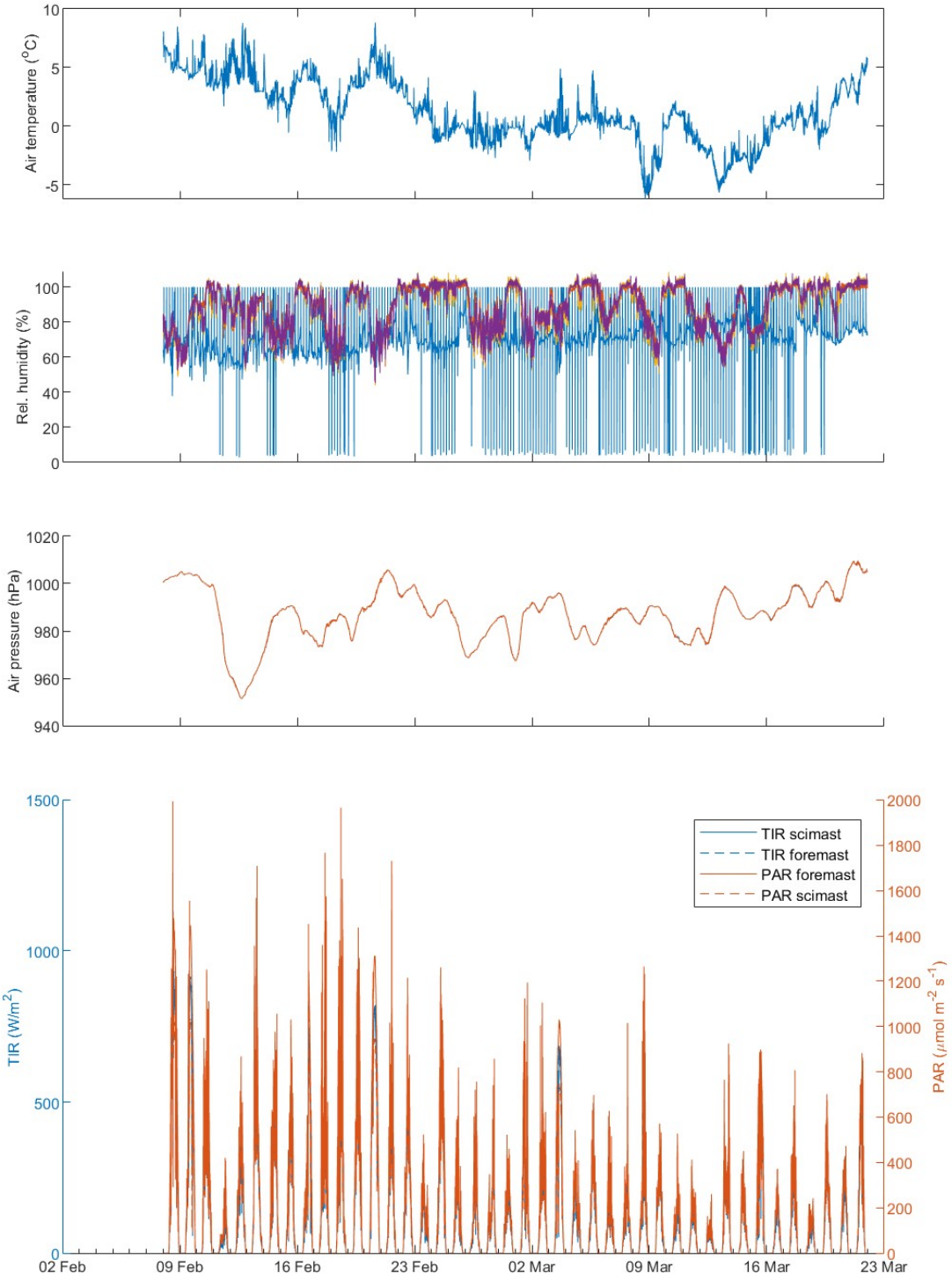

Figure 7.3.12. Time series of meteorological data outputs (air temperature, relative humidity, air pressure and radiation) for the SD046 cruise, 9 February to 23 March 2025.

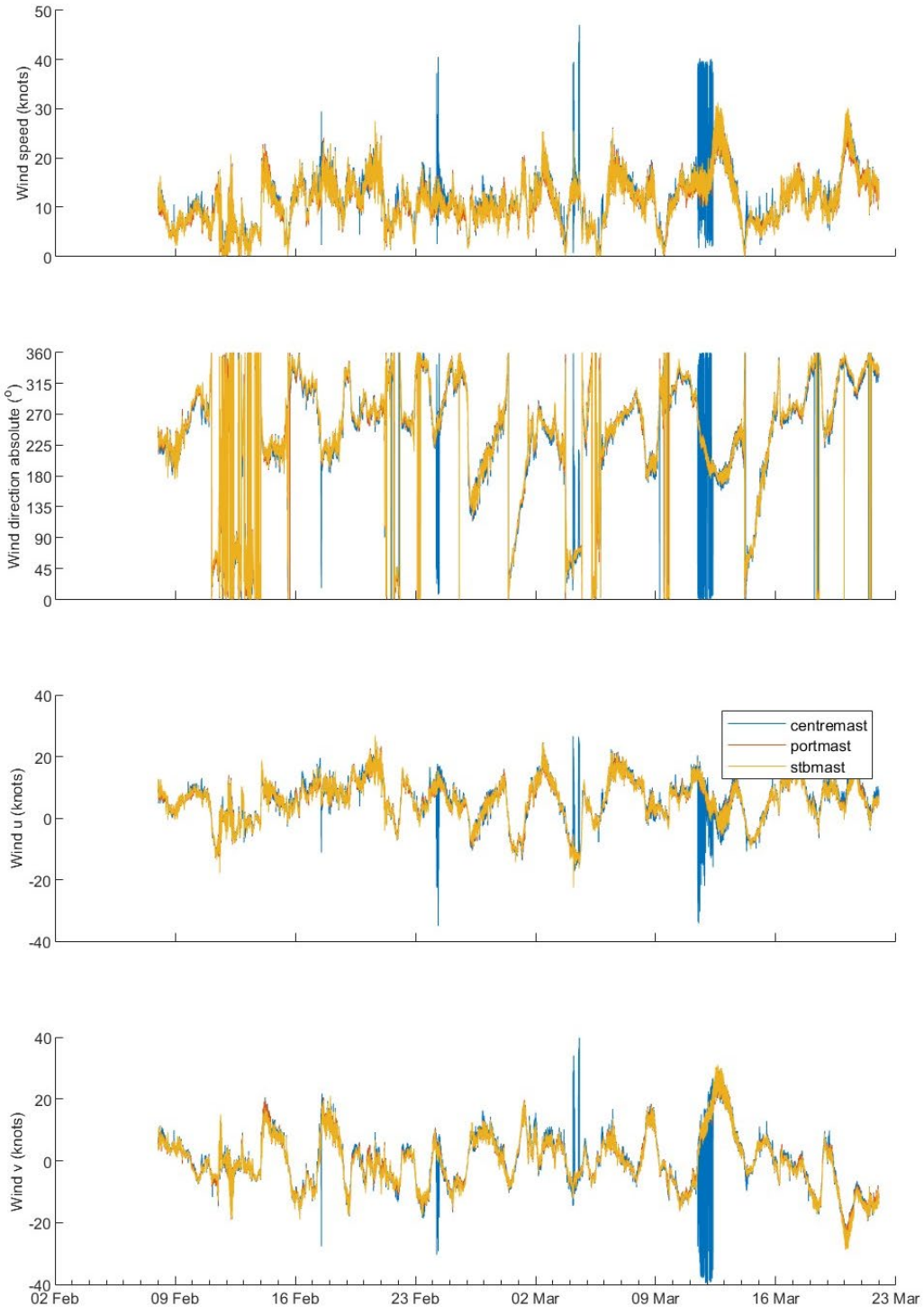

Figure 7.3.13. Time series of wind data (wind speed, absolute wind direction, wind speed u component, wind speed v component) for the SD046 cruise, 9 February to 23 March 2025.

Once the averaged data is obtained, it can be compared to the CTD and underway salt samples. The initial comparison is done through ctd7mUndComp.m which is in L:\work\scientific_work_areas\ctd\Code. This script takes the related underway

measurements and finds the corresponding CTD/salinity measurements, these are then saved to L:\work\scientific_work_areas\physics\Underway.

The temperature calibration was highly dependent on the temperature values themselves, with the calibration offset increasing with colder sea temperatures. This trend is due to position of the UCSW instruments in the hull where they get slightly warmed by the ship. Seabird 1, shown in Figures 14 – 17 as $UCSW_1$ is located closest to the inlet and therefore was the closest to the CTD values.

Figure 14 illustrates this relationship over time, showing the required calibration of the temperature sensors. The calibration needed decreases roughly linearly with temperature with a slope of 0.011 for $UCSW_1$ and of 0.0094 for $UCSW_2$ and intercept of -0.303 for $UCSW_1$ and -0.3344 for $UCSW_2$. With this calibration applied, the residuals remain stable over time [Figure 16]. The final calibration results are presented in Figure 7.3.16.

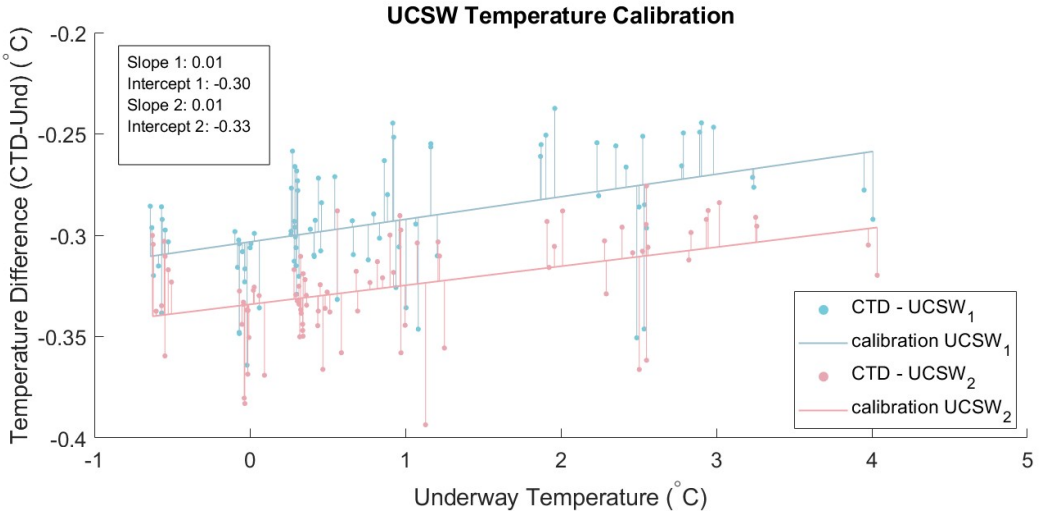

Figure 7.3.14 Temperature difference between the two underway sensors and the CTD temperature at 7m plotted over the underway temperature. Shown is the linear interpolation of the calibration needed with increasing temperature.

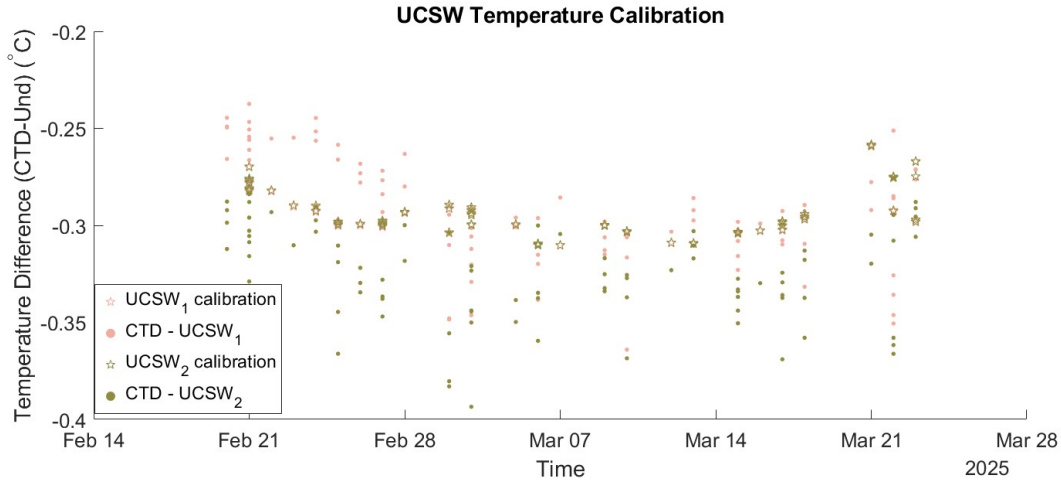

Figure 7.3.15 Temperature difference between the two underway sensors and the CTD temperature at 7m over time. The stars show the calibration applied at each point.

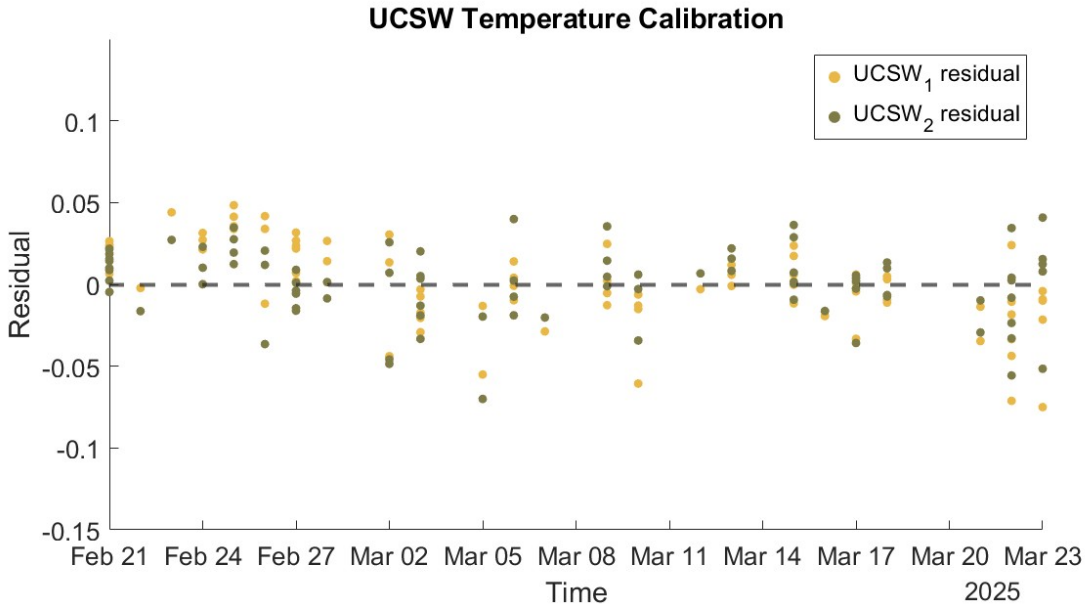

Figure 7.3.16 Residuals between the calibration applied to each sensor over time

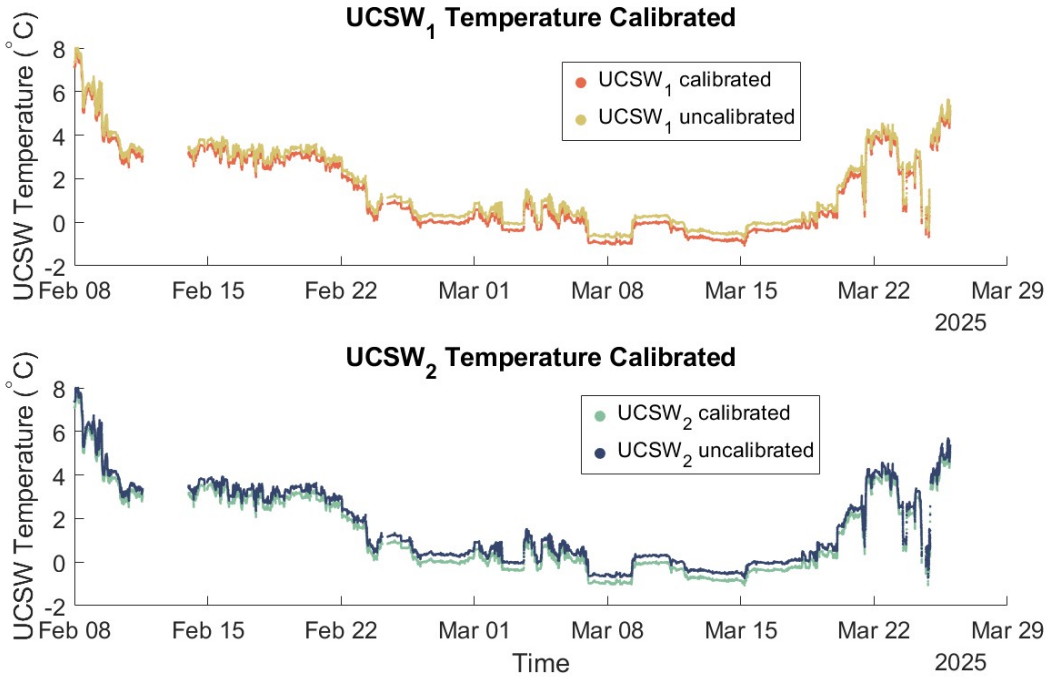

Figure 7.3.17 Final calibration applied to the two sensors shown over time

The SBE-45 thermosalinograph (TSG) salinity measurements were compared to salt samples collected from the uncontaminated seawater (UCSW) tap in the UCSW laboratory during the cruise, as well as to calibrated CTD salinity data. While we aimed to collect UCSW samples every four hours, this was not always possible during busy periods.

The calibration was determined as the average difference between either the bottle salinity or the calibrated CTD salinity and the TSG salinity. A shift in the calibration value occurred around March 12, 2025, coinciding with maintenance on the flow regulator performed that same day. This shift was observed in both the CTD- and bottle-based calibrations, yielding consistent values across both methods [Figures 18, 19]. The final calibration is shown in Figure 7.3.20

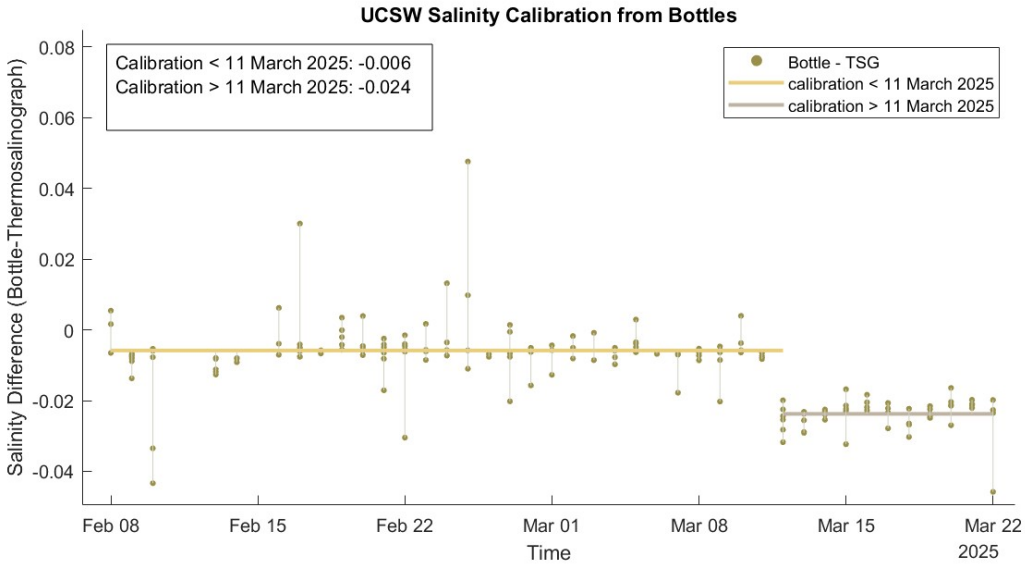

Figure 7.3.18: Salinity difference between the thermosalinograph salinity and the salinity readings from the underway samples over time. The lines show the calibration applied.

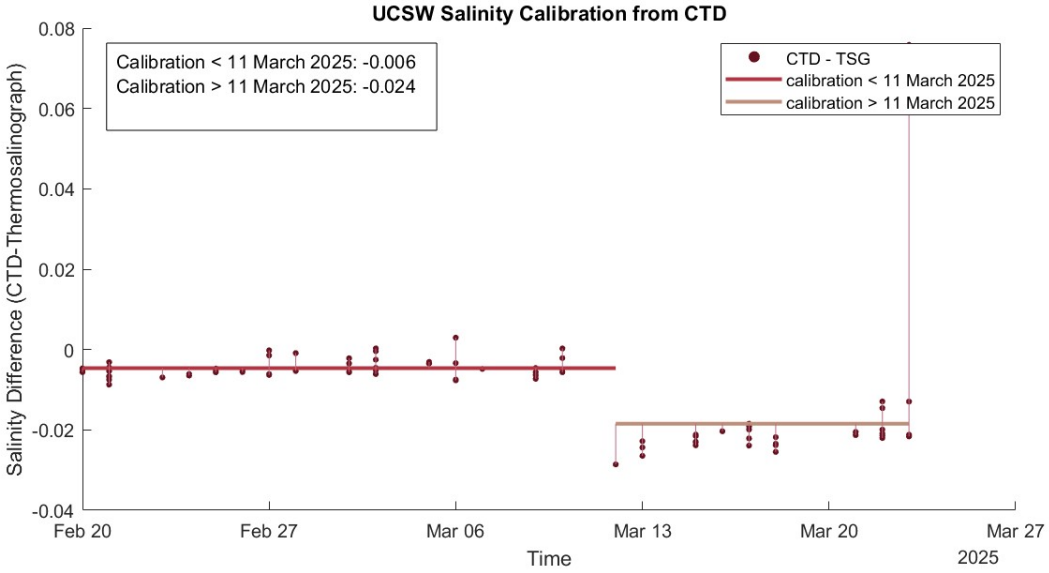

Figure 7.3.19: Salinity difference between the thermosalinograph salinity and the calibrated CTD salinity taken at 7m, over time. The lines show the calibration applied on which day.

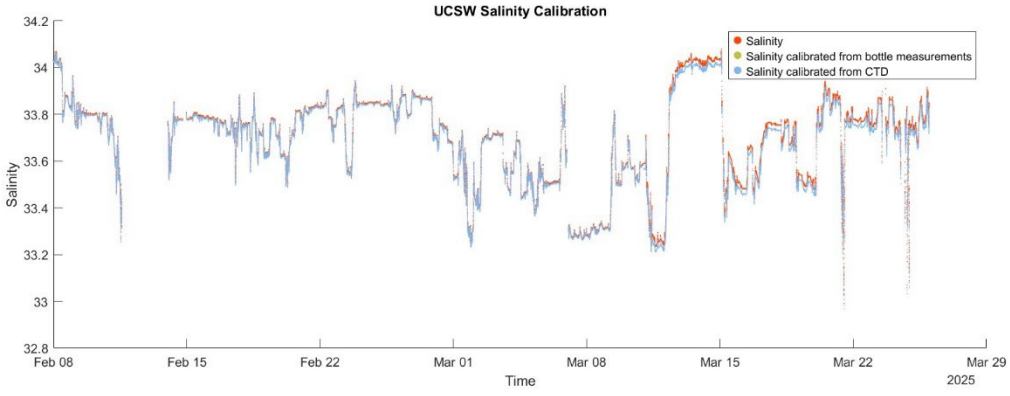

Figure 7.3.20: Calibrated salinity against the uncalibrated salinity.

Issues encountered

- **Intermittent UCSW supply due to ice conditions:** The inflow for the UCSW tap had to be switched off whenever the ship was in regions of brash ice cover, to prevent ice clogging up the system which occurred while surveying A23a. These periods can be identified in the flow rate measurements. These periods were removed using the edit_daily_ocl script where data was removed when the flow rate was outside of the sensible limits as all recorded temperature, salinity, fluorescence and transmission values are incorrect during this time (as seen in Figure 7.3.9). This explains the gaps in the TSG time series in Figures 7.3.9 and 11.
- **Optidew humidity sensor**: As discussed in detail in the cruise report SD041, the humidity values recorded by the *met_michell_optidew2_aerosol1_pmdew1* sensor were greatly different to those recorded by the other three humidity sensors. We have continued to include the data for this sensor in the daily and averaged processed datasets (e.g. can be seen by the blue line in the second panel of Figures 7.3.6 and 12), but we could consider removing this in future.
- **TSG temperatures:** We note that the seawater temperatures recorded by the sensors fitted to the underway system are offset too warm. This is because the location of the sensors on the system means that water has to pass through some pipework and bulkhead before reaching the temperature sensor, during which time the water warms up.
- "**Heartbeat" pattern in the TSG sensor**: When the ship's thrusters were active, the thermosalinograph's conductivity and temperature measurements displayed a heartbeat pattern of about 80 minutes, which was not observed in the hull thermometers [Figure 7.3.21]. However, the salinity measurements appeared to remain unaffected. Further investigation may be worthwhile to determine whether this pattern has any impact on salinity data. It is believed that this comes from increased flow rate of the whole underway system, reducing the time and therefore heating between the intake and underway lab. This might be due to the aquarium cooling system.
- **Jump in the TSG salinity calibrations:** As previously mentioned, a calibration shift of -0.018 occurred on March 12, 2025, around the same time maintenance was performed on the underway system. This change in salinity coincided with the UCSW system's flushing periods (Figure 7.3.22), suggesting that the maintenance may have caused the shift. Since the salinity and temperature had previously reached these values, this indicates that the issue is not related to the instrument's actual calibration or factory settings (Figure 7.3.23).
- **Chlorophyll Calibration:** The calibration value was updated for the fluorometer WETStar s/n WSCHL-1498 14/02/2025, 2017 calibration certificate for s/n 1498 sensor swapped back in before 2024/25 season.
- **Transmittance:** We struggled to identify what conversion was being used on the transmittance data in earlier processing scripts so the formula used to calculate this was taken from https://ioccg.org/wp-content/uploads/2019/05/beamc_protocol_april-2019.pdf where calculated transmittance is given as a percentage by taking $\mathrm{T} = e^{-cl}$ where T is the transmittance, c is the beam attenuation coefficient, l is the path length.

- **Flow rate sensor logging at uneven periods:** The flow rate sensor logs data at irregular intervals, resulting in gaps in the recorded values. As Alex Tate (UK Polar Data Centre, BAS) previously noted, there are periods of up to eight minutes where no flow rate data is available in RVDAS.

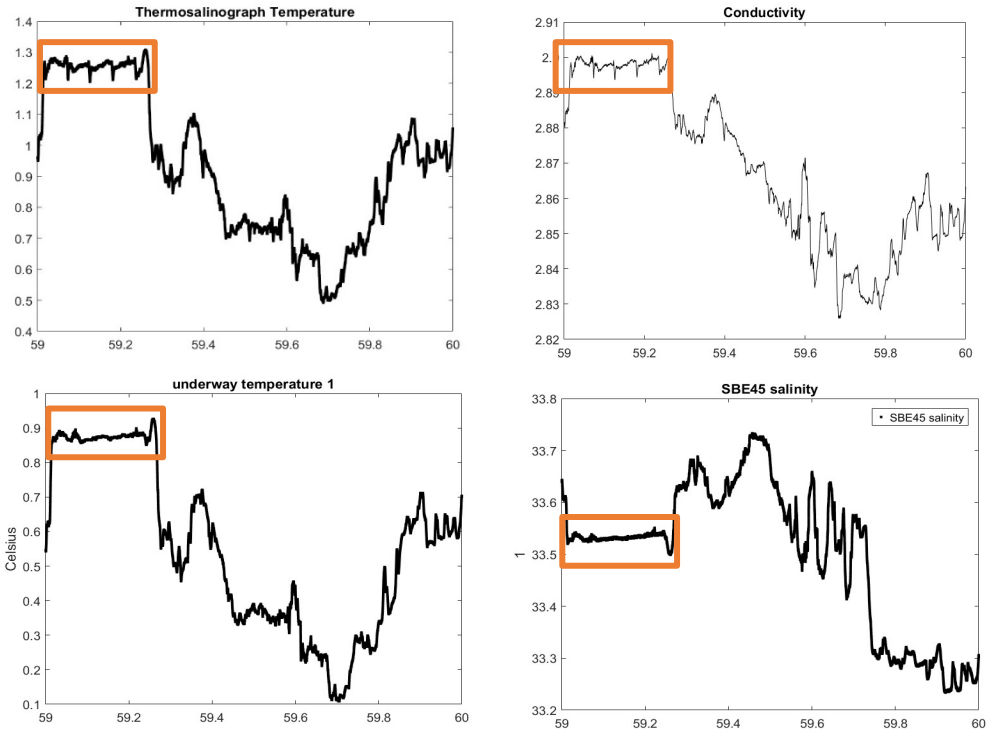

Figure 7.3.21: *Top left:* thermosalinograph temperature. *Top right:* thermosalinograph conductivity. *Bottom left:* seabird 1 temperature. *Bottom right:* Calculated salinity. Highlighted is the period during which the thrusters were turned on and the heartbeat signal emerges from the thermosalinograph temperature and conductivity measurements.

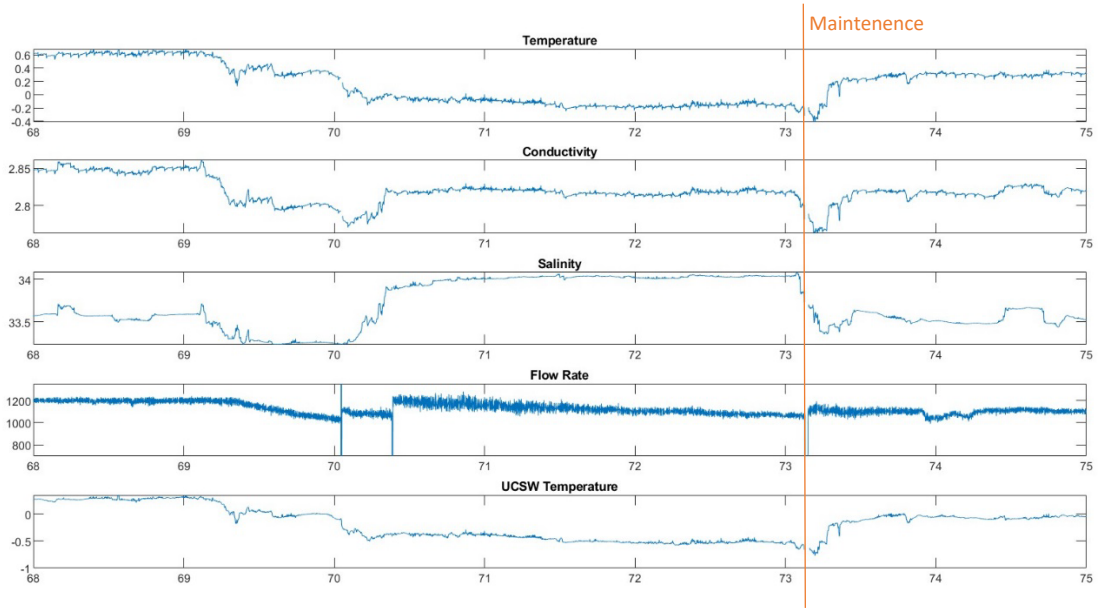

Figure 7.3.22: Analysis of parameters during the calibration jump. The jump occurs on day 73, (12th of March 2025) marked by the orange line, which also indicates the time of UCSW maintenance. The top three panels display TSG temperature, salinity, and conductivity, followed by the flow rate in the fourth panel. The bottom panel shows the Seabird temperature for comparison.

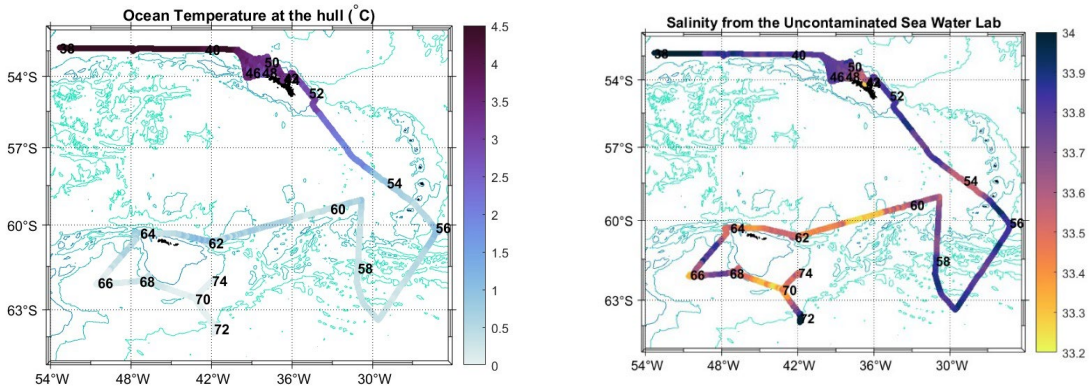

Figure 7.3.23: Cruise track with temperature and salinity with julian day overlain. Shows how similar temperatures and salinity were measured in previous days of the cruise and did not affect the calibration number.

7.4 Salinometry

Authors: Sally Thorpe, Hugh Venables, Michael Haigh, Rachael Sanders, Kat Turner, Shenjie Zhou

Introduction

Salinity samples were taken throughout SD046 to calibrate the CTD and underway salinity data sets. The salinometer generally worked well throughout the cruise apart from some issues with bubbles in one of the conductivity cells on sporadic occasions.

Methodology

Salinity samples were taken from CTDs throughout the cruise (Table 3.2). The number of salinity samples varied by CTD cast according to the depth of the cast. Salinity samples were taken from the surface and below the halocline, avoiding depths with strong salinity gradients, where the comparison with the CTD sensors is inevitably poor. Underway samples were taken from the uncontaminated seawater supply (UCSW) using the blue pipe, which is the exit for water that has passed through the sensor wall. UCSW samples were taken at approximately 4 hourly intervals between 9 February 2025, after reaching international waters having departed from Punta Arenas, and 25 March 2025. Salinity samples were reduced in frequency while stopped at some of the science stations.

Salinity samples were taken in the same way for both purposes: rinse the bottle three times, fill to the bottle shoulder, dry the neck with blue roll, seal the bottle with a stopper and then screw on the cap. Salinity samples were stored in crates in the salinometer lab so that the salinity samples could reach room temperature prior to measurement.

Salinometer instrument and standardisation

The conductivity of all salinity samples was measured with a Guildline Autosal 8400B salinometer (serial number 73104), with the salinometer water bath set to 21°C for SD046 (couple of degrees above lab temperature). Conductivity is measured at very high precision, with the readout being twice the conductivity ratio between the sample and standard seawater with salinity 35 PSU at 20°C, and 1 atmospheric pressure (known as the Vienna Standard). The instrument was standardised at the beginning of the cruise with the resistor set to 436 giving a standby reading of between 5962-5964. Once the instrument had been standardised, it was left like this for the rest of the cruise. Calibration readings of IAPSO standard seawater batch number P168, supplied by Ocean Scientific International Ltd. (OSIL), were made before and after each crate of 24 salt samples. This allows a correction to be applied to the intermediate measurements of the salinity samples should there be drift within the measurements during the processing of each crate. As on other cruises, whenever possible two or three crates were run through the salinometer back-to-back so that we could minimise use of seawater standards; in this case, the standard seawater reading at the end of the first crate was taken as the reading for the start of the second crate, rather than measuring another seawater standard.

Standard procedure for measuring salts

Each crate of 24 salinity samples was left in the salinometer lab for at least 24 hours before being analysed to allow all samples to acclimatise to the room temperature (18°C - 20°C for SD046). The salinometer water bath was set to a temperature of 21°C to be a couple of degrees above the lab temperature. At the start of each analysis, the lab air temperature and the standby and zero readings on the salinometer were recorded. The lab temperature was also monitored during hourly underway checks and remained stable through most of the cruise.

At the start and end of each crate, the salinometer was flushed with an old (previously opened) standard to remove any traces of milliQ, before taking a salinity reading from a new standard. The standard operating procedure for measuring the sample/standard salinity was: 1) gently agitate each sample/standard seawater bottle a few times to mix the water and remove stratification whilst avoiding the introduction of air bubbles into the sample; 2) flush the salinometer four times with each sample/standard to remove any traces of the previous sample; 3) after flushing, take a minimum of three readings, flushing between each reading and allowing sufficient time for the readout value to stabilise on a final value. Once there are three measured values within a max range of 0.0003, the mean reading is taken as the accepted value for that sample.

After completing the analysis for each crate, the room air temperature, instrument standby and zero readings were recorded. When the salinometer was not being used, it was flushed with milliQ and left with milliQ inside the cells to avoid the build-up of salt crystals in the system.

The accepted mean readout for each sample was transferred from the logsheet into an Excel spreadsheet to convert the readout values to practical salinities via the TEOS-10 gsw_SP_salinometer script in Matlab. These were then used in the subsequent CTD and underway salinity calibrations, as detailed in the corresponding sections of the cruise report.

Issues encountered

The salinometer lab initially struggled to maintain temperature but that was resolved by the engineers. The number of initial flushes of a sample was increased from three to four to give more stable readings. The salinometer generally performed well and gave stable readings apart from occasions where bubbles entered the right-hand conductivity cell after the pumps were turned off for reading the measurement. This was solved either by re-flushing the cell or by leaving the pump running on its lowest speed while taking the reading. It was not clear what leads to these bubbles.

7.5 Oxygen isotope sampling

Authors: Rachael Sanders

Introduction

Samples for $\delta^{18}O$ were collected from both the CTD and uncontaminated seawater to determine the proportion of meteoric water and sea ice-derived water in the samples. The depths of CTD samples were chosen to cover as many water masses as possible following previous cruises. The underway samples were taken approximately every four hours during transit, with the frequency increased to hourly when close to South Georgia glaciers and around the A23a iceberg to capture the potential freshwater input from each source. Four samples were also taken from brash ice close to A23a to use as a meteoric $\delta^{18}O$ endmember in freshwater fraction calculations.

Methodology

When sampling, 50 ml glass bottles were rinsed three times, before being filled with minimal air gap. The bottles were then closed with rubber stoppers and metal caps that were sealed with hand crimpers. The samples were stored at +4°C once sampling was complete.

Sampling from the uncontaminated seawater began on February 10th on approach to South Georgia. When in range of glaciers, sampling frequency was increased to hourly. Away from South Georgia, sampling continued approximately every four hours when in transit.

Along the A23 section, samples were taken at specific depths that had been sampled on previous transects, provided by Povl Abrahamsen. When a station was missed due to time constraints, the same depths were instead sampled on the nearest station. Samples were also taken from a variety of depths on each of the CTDs at the moorings, to give a good resolution of different water masses.

Around the A23a iceberg, samples were taken hourly on a transect going along the west of the iceberg, and at selected way points around the iceberg whenever biogeochemical samples were also taken. At CTD stations positioned at the different sites around the iceberg, samples were taken at five depths between the surface and 1000 m.

At two locations around the iceberg – one inside the fjord (55.079°S, 39.202°W), and at the edge (54.557°S, 39.042°W), pieces of brash ice were collected to obtain meteoric $\delta^{18}O$ end members. Two pieces were taken at each site from an inner part of the ice to avoid contamination with seawater, and put into sealed plastic bags, with the air removed as much as possible, and left to melt. The same sampling method was then used with the bottles rinsed three times and filled with minimal airgap. For two of the samples (ICE 2, ICE4), the bag had leaked and so was not airtight while the ice melted.

Recommendations

Some of the older bottles that were provided were very dirty, leading to bubbles being stuck on the inside of the bottle. The second batch of bottles were soaked in freshwater before use. Stronger bags would be better for taking ice samples to make sure the samples stay airtight as they melt.

7.6 VMADCP

Author: Michael Haigh

Introduction

An Acoustic Doppler Current Profiler (ADCP) is a hydrological instrument which measures flow using the Doppler effect. The ADCP emits acoustic signals and measures the return signal reflected by particles in the water column. From this flow velocities can be computed. A vessel-mounted ADCP (VMADCP) is mounted in the hull of a ship and can measure three-dimensional currents in the top few hundred metres of the water column.

The VMADCP on the RRS Sir David Attenborough (SDA) is a Teledyne Ocean Surveyor that operates on two frequencies, 150 kHz and 75 kHz. In this cruise 150 kHz frequency was used throughout, which can measure currents down to 400 m below the ship. It would be expected that the 75 kHz frequency would lead to useful measurements twice as deep as this (with half the vertical resolution), but as documented in past cruise reports, the 75 kHz frequency could not produce accurate currents deeper than 400-500 m. Therefore, the 75 kHz frequency was only used for testing its capability; see 75 kHz Outcomes section below. The paths to the code and data repositories are in the 'Data output structure' subsection.

Methodology

Configuration

The VMADCP is operated using the VMDAS software. See the VMDAS user guide for instructions using this software. VMDAS outputs raw ADCP data (.ENR files), short-term averages (.STA files) computed over 30-second intervals and long-term averages (.LTA files) computed over 120-second intervals.

VMDAS is configured using command files. For the duration of the cruise the command file os150nb_450m_wt_8mbins_thru_ksync.txt was used. In VMDAS, the Com Port (Program Options, Communications tab) "COM2" is used for the 150 kHz frequency. If the 75 kHz frequency is used "COM1" is required. VMADCP pings were controlled through the K-Sync software to minimise interference between different acoustic systems. For easier file management the VMDAS software was stopped and restarted daily.

Post-processing

VMADCP data is processed using the CODAS Python library. See the CODAS documentation here. With CODAS, the steps for processing the VMADCP data are very similar to those for the SD033 and SD035 cruises. Bash scripts based on those used in SD033 were used on this cruise. These scripts, which are included in the cruise archive, perform a sequence of CODAS operations as follows:

Copy VMDAS output from its output directory.

Remove corrupt/unwanted 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., 'SD046_vmdas'

User selects ‘Convert *.LTA Files’ to process long-term average files.

Make a post processing directory.

Remove ocean bottom using dataviewer.py -e [path to post-processing directory].

Calibrate using bottom tracking output with quick_adcp.py using the calibration data in os150nb_LTA_postproc/cals.txt.

Short-term average (STA) data is required to calibrate the LADCP. To generate this data, the above steps are repeated, but ‘Convert *.STA Files’ is selected. After calibration the following file is output for LADCP processing: ‘os150nb_STA_postproc/contour/os150nb.nc’.

Outcomes

150 kHz ADCP

The processed ADCP record begins 06/02/2025 23:35 UTC on and ends on 26/03/2025 at 12:00 UTC (although due to bad conditions, the final 48 hours of the post-processed data are masked). All data shown here are long-term averages.

Figure 1 shows currents along the four Western Core Box (WCB) transects, to the north and north-west of South Georgia. All four transects start at approximately the same time (08:00 UTC) in four consecutive days (15/02-18/02). The currents along the shelf break north of South Georgia may be expected to be westward as the Southern Antarctic Circumpolar Current Front (SACCF) loops around the island anti-clockwise. A westward flow like this is clear in some transects, but not all. The local currents are influenced by tides which can explain the change in direction of the currents from one transect to the next: in this specific area Young et al. (2011) predicted the phase of the K_1 tide to oscillate with magnitude of ~30° in the along-slope direction.

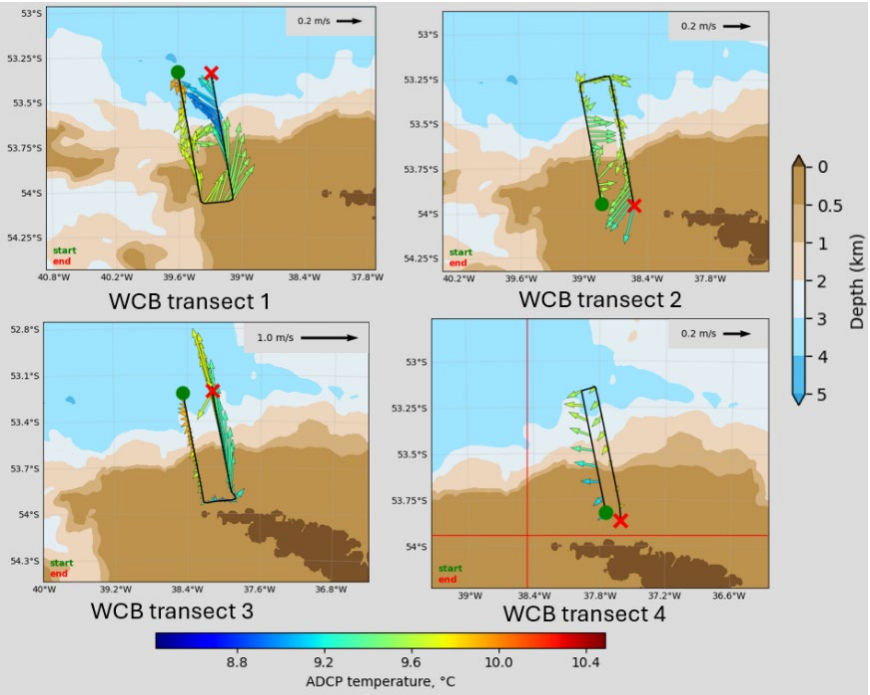

Fig 7.6.1. Currents along the four Western Core Box (WCB) transects. Currents are averaged over the upper 80 m.

Figure 7.6.2 shows the VMADCP currents (averaged over the top 80 m) measured along the A23 CTD transect. This transect was completed in two sections. The northern section (top panel) was conducted from south to north. The southern section (bottom panel) was conducted from south to north. Currents in the northern section are predominantly north-eastward, with the SACCF being the main large-scale flow in this area. The southern section of the A23 transect crosses the South Scotia ridge, separating the Weddell Sea to the South from the Scotia Sea to the north. A strong temperature gradient is measured here, but there is no clear difference (with this superficial analysis) in the currents either side of the ridge.

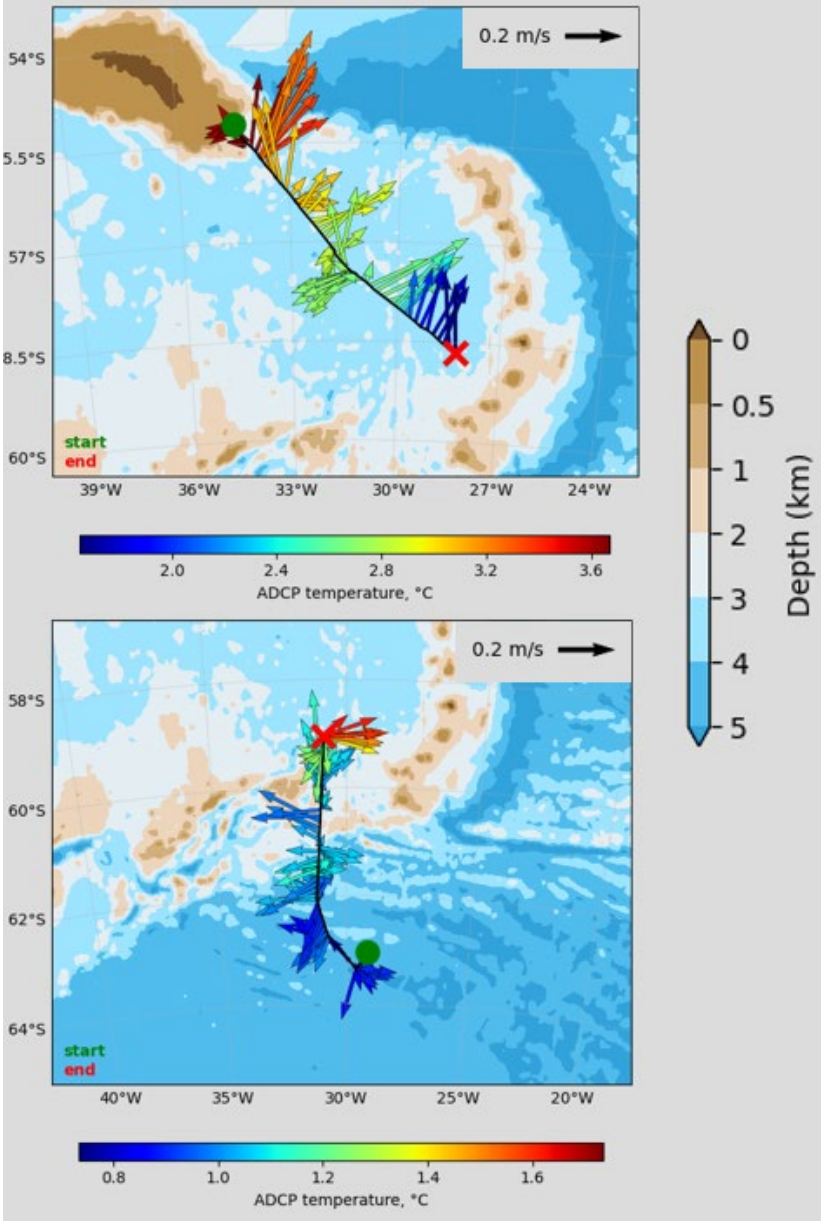

Fig 7.6.2. Currents along the A23 CTD transect, which was completed in two legs. The northern leg (top panel) was conducted from north to south. The southern leg (bottom panel) was conducted from south to north. Currents are averaged over the upper 80 m.

75 kHz ADCP

The 75 kHz ADCP was switched on while at the South Sandwich Trench mooring site. The aim of this was to test the 75 kHz ADCP's capability while no other acoustics were switched on and during calm conditions. Figure 3 shows the eastward and westward velocities

produced over a ~3-hour period. The main desired utility of the 75 kHz ADCP over the 150 kHz ADCP is that it can measure current velocities down to 800 m, rather than 400 m in the case of the 150 kHz ADCP. However, Figure 3 shows that the 75 kHz is not able to reliably measure currents below 500 m. This is consistent with previous cruises which have found the use of just the 150 kHz ADCP to be the best course of action until the 75 kHz ADCP performance is improved.

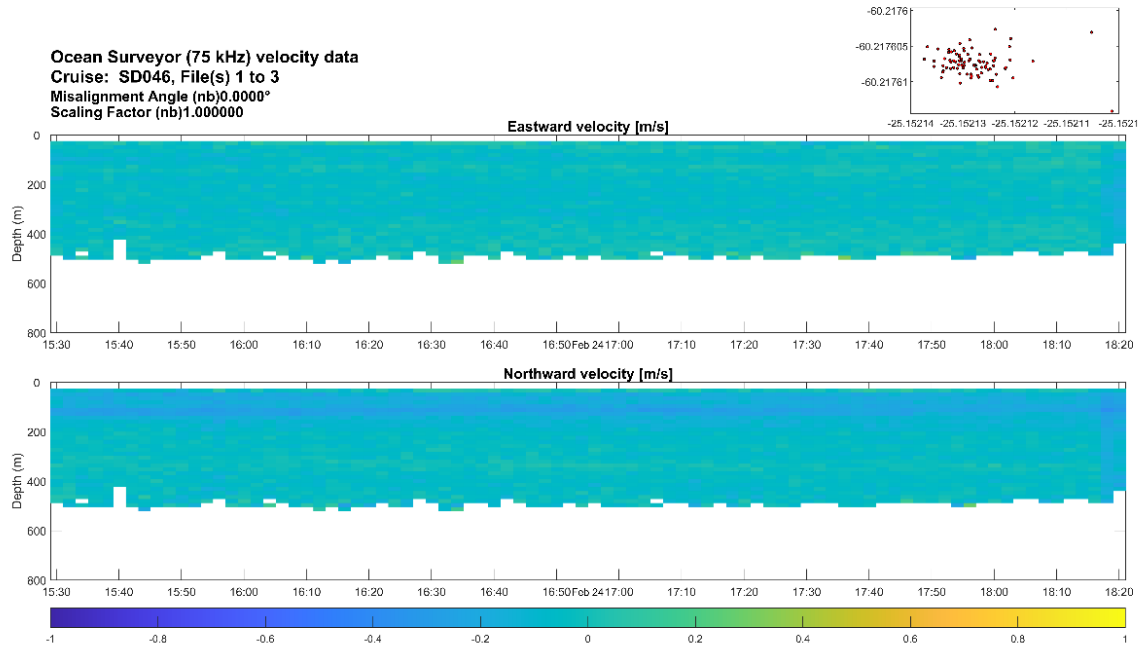

Fig 7.6.3. Eastward and northward velocities computed from using the 75 kHz VMADCP.

Recommendations

Below are simple operational recommendations based on experiences this cruise.

Use the 150 kHz ADCP as a default, but conduct further investigation into the 75 kHz ADCP. Having this as an option for reliable current measurements deeper into the water column are very desirable.

The ADCP measurements have been useful for mooring recoveries. If issues with the 75 kHz become resolved, this would be even more useful, especially for deep moorings.

Conduct regular (e.g., hourly) checks of the VMDAS software. This software freezes at times, having occurred three times on this research cruise. When this happens VMADCP data is likely no longer being collected.

Conduct investigation into the effects of pausing the K-Sync software. When K-Sync is paused and restarted, this causes the ‘ensemble number’ in the VMDAS software to restart from zero. After investigation of the data this has not caused an apparent issue on this cruise, but further confirmation of this would be worthwhile.

Data output structure

All raw cruise ADCP data are stored in:
/leg/system/adcp_teledyne_ocean_surveyor/acquisition

All processed data including the calibrated files are stored in:
/leg/work/scientific_work_areas/physics/VMADCP/processed

Scripts for post-processing using CODAS are stored in
/leg/work/scientific_work_areas/physics/VMADCP/Code/CODAS_scripts

References

Young EF, Meredith MP, Murphy EJ, Carvalho GR (2011) high-resolution modelling of the shelf and open ocean adjacent to South Georgia, Southern Ocean. Deep Sea Research Part II: Topical Studies in Oceanography 58

8. Phytoplankton
8.1 Sampling survey: CTDs & Underway

Author: Amanda Burson

Introduction

One of the main targets of the BIOPOLE program is to understand the relationship between the availability of (inorganic) resources (ie. silica, phosphorus, nitrogen, iron and other trace metals) and subsequent productivity within polar oceans. Primary production by phytoplankton is the linking factor between inorganic geochemistry, physical mixing and zooplankton trophic levels. Photosynthetic phytoplankton transform inorganic carbon to organic carbon, thus creating the foundation to the biological carbon cycling in the world's oceans. Understanding not only the net abundance but also the community composition of phytoplankton present is important for predicting carbon transfers to upper trophic levels due to selective feeding behaviours of zooplankton (e.g. Haberman et al., 2003; Pauli et al., 2021). In addition to the relative abundances of, e.g. large diatoms verses nanoflagellates within the phytoplankton community, the biochemical composition of the phytoplankton itself (particulate organic nitrogen, phosphorus and carbon content) impacts its suitability as prey material for higher trophic levels (Meunier et al. 2016). In general, mesozooplankton graze on larger phytoplankton cells, especially diatoms. By separating the micro- (>20 µm) particulate organic matter composition from the total phytoplankton community we can for focus on nutritional value of the phytoplankton most relevant to zooplankton.

The SD046 cruise is occurring in what should fall at the peak of the autumnal bloom for this region of the Southern Ocean. Although we expect most diapausing organisms will have already built required lipid stores during the spring primary production bloom, the phytoplankton present represent the food available to remaining diapausing zooplankton just ahead of their final winter decent. Thus, for the phytoplankton survey during SD046 we aim to (1) determine the abundance and community composition of the phytoplankton present within the top 100 m and (2) measure the particulate organic carbon, nitrogen and phosphorus and pigments in the phytoplankton community including size fractionation (at 20 µm) to elucidate the micro- vs. total community contribution.

Methodology

Water collection from the CTD

Water was collected from the CTD niskin bottles at 10 m, the chlorophyll max depth (as determined form fluorescence profile on the CTD downward cast) and 100 m. Water was transferred directly into 10 L carboys via acid washed tubing (see Fig.8.1.1) which were either filtered directly or stored at 4C and filtered within 3 hrs of collection.

Figure 8.1.1 Sampling from the CTD niskins into carboys.

Filtering for pigments: Chlorophyll *a* and HPLC

Phytoplankton utilise photosynthetic pigments to absorb the energy from light and transform inorganic carbon into organic carbon. All phytoplankton contain chlorophyll pigments, hence the use of chlorophyll fluorescence as a proxy for biomass in CTD and satellite sensors. However, different groups of phytoplankton produce different accessory pigments (i.e. carotenoids and phycobilins) to utilise sections of the light spectra not effectively captured by chlorophyll. The presence and relative ratios of these accessory pigments to chlorophyll *a* allow for a relatively quick assessment of the phytoplankton community composition as well as relative abundances. The analysis of these pigments is done via fluorometry (in the case of chlorophyll) and high performance liquid chromatography (HPLC; for accessory pigments). Analysis for both will occur back in the UK but the collection of the material onboard is described here.

At each sampling station (see Table 8.1.1 for full list of sampling station locations) water was collected via CTD from 10 m, the chlorophyll max and 100 m depth. For both HPLC and chlorophyll, 2 L of water from each depth was gently (no more than 30 psi) vacuum filtered onto 47 mm GF/F filters (nominal pore size of 0.45 µm). These were then gently folded in-half and placed inside individual small sample bags and labelled with pre-printed labels with individual sample IDs. The filters were stored in the -80˚C freezer.

For size fractioning, a separate 2 L of water from each depth was gently vacuum filtered onto 25 mm, 20 µm nylon filters. As these had a larger pore size, the vacuum was reduced to taper to a gentle flow using the ball valves attached to each individual filtration tower (see Fig. 8.1.2). This was to avoid too fast of filtration with too powerful of a vacuum thereby inadvertently pulling phytoplankton through the filter that would have otherwise been trapped. These filters were gently folded in half and placed inside 5 mL plastic sample vials before also being labelled with pre-printed unique IDs and stored in the -80˚C freezer.

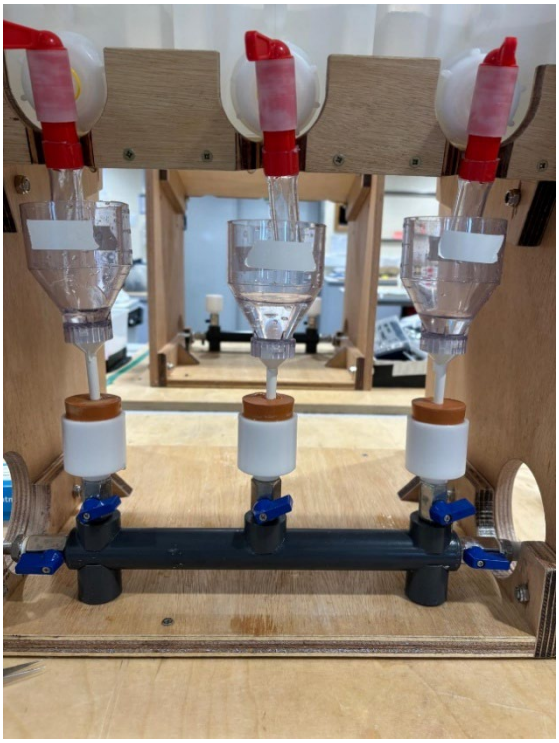

Figure 8.1.2 Filtration rigs with valves only partially opened to control speed through larger pore-size filters.

Filtering for particulate organic carbon, nitrogen and phosphorus

The particulate organic carbon, nitrogen and phosphorus (POC, PON, and POP) were filtered on combusted (450˚C for 4-5 hrs) then pre-weighed 25 mm, GF/F filters. Water was collected at 10 m, chlorophyll max and 100 m and 2 L was filtered on two filters; one POC/PON (which is analysed via CHN elemental analyser in Cambridge) and one for POP (which is analysed via wet digestion into inorganic phosphorus then on the auto-analyser, also in Cambridge). For size fractionation, water was gravity filtered through an in-line filter capsule attached to the water carboys. Within the filter capsule was a 47 mm, 20 µm polycarbonate filter (Fig.8.1.3). Two litres of the filtrate was then filtered onto a second set (one for <20 µm POC/PON and one for <20 µm POP) of combusted and pre-weighed 25 mm, GF/F filters. Filters were folded in half and placed inside individual plastic sample bags ensuring all of the filter paper was included as a post-collection dry weight is needed for later particulate g/L calculations.

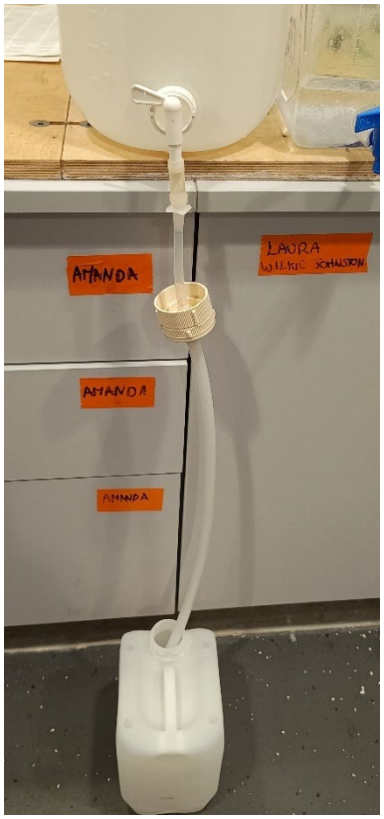

Figure 8.1.3 In-line gravity filtration for <20 um filtrate.

Preserving for taxonomy: Lugol's iodine and Flow Cytometry

We employed two different preservation methods for phytoplankton community composition analysis. The first is Lugol's iodine (acid) at 1% final concentration which will be used for microscopic analysis (enumeration and species identification) of cells of ~5 µm and larger. Water was collected at 10 m, chlorophyll max, and 100 m via the CTD. After a gentle inversion of the carboy to ensure it is well mixed, water was added to 125 mL opaque brown plastic bottles to the base of the neck. To this we added 3 mL of Lugol's iodine solution under the flow hood and wearing appropriate PPE. The bottle was capped, gently inverted, parafilm added around the lid and stored in the 4˚C walk-in fridge.

Flow cytometry allows for the analysis of smaller phytoplankton within the community; picoplankton and cyanobacteria (if present). Flow cytometry utilizes the combination of pigments which are excited by specific wavelengths of light via a lazer then the corresponding emission wavelength post-excitation is measured using sensors for specific wavelengths as well. The excitation/emission factors combined with information related to the size and complexity of cell allows for the separation and enumeration of different groups of phytoplankton. It also allows for post-hoc enumeration of bacteria if a secondary dye (Syber green) is added prior to analysis. Analysis is conducted on the Accuri C6 Plus flow cytometer from BD instruments located in Cambridge. Future programmes will be able to bring this on-board once the associated software has been pre-programmed and selection gates saved for common Southern Ocean phytoplankton groups. One ambition for the preserved samples collected on this cruise is to provide the baseline information required to prep for live analysis on future cruises.

For preservation, 4.5 mL of seawater was added to 5 mL cryo-vials. Then 0.5 mL of formaline-hexamine (10% w/v) was added and the vials are capped then gently inverted several times. Vials were kept in the 4˚C fridge in the deck lab for a minimum of 30 min and maximum of 12 hrs to ensure preservative has penetrated the cells. The vials then need to be flash-frozen in liquid nitrogen then stored in 5 mL cryovial boxes in the -80˚C freezer. There is special PPE specific to LN2 which includes an cryo-apron, cryo-gloves and eye protection. Additionally, specific training is required prior to any LN2 work and the person doing the work should always have a safety buddy present. The lab should be well ventilated and the O2 monitor working correctly.

Liquid nitrogen was generated on board using a LN2 generator and N2 compressed gas. The dewar onboard the SDA maintains the generated LN2 for multiple weeks if not opened and/or samples submerged, and it filled within a 15 hr period of initiation of LN2 generation. We did bring our own dewar which comes with submersible stainless-steel canisters for lowering sample vials into the liquid nitrogen. The dewar on the SDA did not have any canisters and the ones for the brought dewar were too large in circumference to fit. The lab manager assisted to attempt to use the transfer tap to move LN2 from the SDA dewar to our brought one, but this was not possible due to the size of the dewars limiting the proximity they needed to be to avoid immediate evaporation. We then tried taking both dewars to the open air of the hanger and pouring from one dewar to the other (all of this was done with full PPE). This effectively transferred the LN2 but the dewar brought from Cambridge was inefficient at maintaining the supply and it evaporated within days. Thus, we requested from AME/engineers on board to either reduce the diameter of one of the canisters or construct new ones from the supplies on board. They were very successful, and Hans Braten, deck engineer, made three canisters, one of which is engraved for myself and two that will remain on-board for future use with the liquid nitrogen. One caveat, these should be used for flash-freeze dipping then removal of samples not for leaving samples within the dewar as the lid does not fit securely with the canisters inside and evaporation of the LN2 would dramatically increase.

Underway sampling

During critical transition periods throughout the cruise underway uncontaminated seawater samples were collected to align with timepoints already being taken by the biogeochemical team. Water was collected from the larger uncontaminated seawater pipe directly into FCM cryovials and Lugol's bottles when needed and then into filtration carboys. Water was either filtered directly or stored at 4C for no more than 3 hours before filtering.

At most underway sampling timepoints, water was processed for chlorophyll *a* and HPLC pigments only. However, around the iceberg A23a where more parameters were collected. The extra parameters included FCM and Lugol's samples for species composition as well as Labstaf measurements. See Kate Hendry's report in the cruise report for SD025 for instructions on use and background of the equipment. We were unable to use the Labstaf from the beginning of the cruise and for early underway transects due to issues with the software. The original computer that was associated with the Labstaf seems to have been misplaced several cruises ago, resulting in a new one being borrowed on a previous cruise which was updated with the correct calibration files. Unfortunately, when that computer was returned to IT the calibration files were cleared when wiping the computer. This meant that before we could use the Labstaf, the company (Chelsea Technologies) had to be contacted and a new copy of the calibration files obtained. We have not had an opportunity to work up the full LabSTAF data during the cruise, but below is a table of the Fv/Fm photosynthetic yield value. Fv/Fm in phytoplankton typically ranges from 0.1 – 0.5 and is an indicator of the

photosynthetic yield of the phytoplankton present in the sample. The higher the Fv/Fm value the more “photosynthetically efficient” the phytoplankton are presumed to be. Unusually, lower Fv/Fm is indicative of nutrient limitation stress, however it is possible other environmental stressed (ie. salinity values at the upper or power limit of the cell’s physiology) can induce a response in the photosynthetic yield as well. See Table 8.1.2 for the Fv/Fm of the transects near and around the iceberg A23a.

Outcomes

Sampling survey_CTD

Phytoplankton Survey-CTD Collections											
		Parameters sampled									
Station	**Depths (m)**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ECB	10, 25, 100	x	x	x	x	x	x	x	x	x	x
P3	10, 30, 100	x	x	x	x	x	x	x	x	x	x
WCB1.2Sst	10, 25, 100	x	x	x	x	x	x	x	x	x	x
WCB2.2Nst	10, 75, 100	x	x	x	x	x	x	x	x	x	x
WCBmooring	10, 20, 100	x	x	x	x	x	x	x	x	x	x
WCB4.2Sst	10, 25, 100	x	x	x	x	x	x	x	x	x	x
ECBmooring	10, 15, 100	x	x	x	x	x	x	x	x	x	x
transitA23	10, 75, 100	x	x	x	x	x	x	x	x	x	x
A23_52	10, 35, `100	x	x	x		x		x		x	
A23_51	10, 50, 100	x	x	x		x		x		x	
A23_50	10, 25, 100	x	x	x		x		x		x	
A23_49	10, 75, 100	x	x	x		x		x		x	
A23_47	10, 50, 100	x	x	x		x		x		x	

A23_45	10, 35, 100	x	x	x		x		x		x	
A23_44	10, 20, 100	x	x	x		x		x		x	
SSTW	10, 20, 100	x	x	x	x	x	x	x	x	x	x
A23_25	10, 70, 100	x	x	x		x		x		x	
A23_27	10, 65, 100	x	x	x		x		x		x	
A23_29	10, 50, 100	x	x	x		x		x		x	
A23_31	10, 50, 100	x	x	x		x		x		x	
A23_33	10, 75, 100	x	x	x		x		x		x	
A23_35	10, 60, 100	x	x	x	x	x	x	x	x	x	x
A23_37	10, 50, 100	x	x	x		x		x		x	
A23_39	10, 70, 100	x	x	x		x		x		x	
A23_40	10, 20, 100	x	x	x		x		x		x	
BP2_3	10, 50, 100	x	x	x	x	x	x	x	x	x	x
BP2_7	10, 20, 100	x	x	x	x	x	x	x	x	x	x
BP2_8	10, 15, 100	x	x	x	x	x	x	x	x	x	x

BP2_6	10, 40, 100	x	x	x	x	x	x	x	x	x	x
M2/BP2_6	10, 20, 100	x	x	x	x	x	x	x	x	x	x
M3	10, 20, 100	x	x	x	x	x	x	x	x	x	x
BP2_4	10, 50, 100	x	x	x	x	x	x	x	x	x	x
BP2_1	10, 60, 100	x	x	x	x	x	x	x	x	x	x
SW2	10, 50, 100	x	x	x		x		x		x	
FJORD	10, 50, 100	x	x	x		x		x		x	
SE0	10, 20, 100	x	x	x		x		x		x	
SE2	10, 20, 100	x	x	x		x		x		x	
NE2_Shelf	10, 20, 100	x	x	x		x		x		x	
NE0_Benthic	10, 20, 100	x	x	x		x		x		x	

Table 8.1.1 List of CTD stations sampled and parameters taken. Parameter key: 1) Lugol's, 2) Flow cytometry, 3) POP (whole), 4) POP (<20 µm), 5) POC/N (whole), 6) POC/N (<20 µm), 7) Chlorophyll a (whole), 8) Chlorophyll a (20 µm), 9) HPLC (whole), 10) HPLC (20 µm)

UW Iceberg Sampling #	Fv/Fm	Lat.	Long.
1	0.2750	-55.6915	-39.0745
2	0.2807	-55.5313	-39.1490
3	0.2340	-55.3721	-39.2198
4	0.2084	-55.2215	-39.2911
5	0.3062	-55.0800	-39.3695
6	0.3557	-54.9417	-39.4524
7	0.3225	-54.8164	-39.5665

8	0.2667	-54.6855	-39.5758
9	0.1615	-54.6855	-39.5758
10	0.1333	-54.4099	-39.6225
11	0.1194	-54.2533	-39.7031
12	NA	-54.0987	-39.7884
13	NA	-54.0039	-39.9985
14	0.2907	-54.1663	-39.9877
15	0.2671	-54.2880	-39.9780
16	0.3337	-54.4880	-39.9615
17	0.3451	-54.6563	-39.9529
18	0.3484	-54.8722	-39.9420
19	0.2525	-55.1016	-39.9141
20	0.2392	-55.3184	-39.8978
21	0.2541	-55.3317	-39.6901
22	0.2033	-55.2714	-39.5076
23	0.1374	-55.2166	-39.3420
24	0.2360	-55.1087	-39.0578
25	0.2374	-55.0693	-38.8208
26	0.2726	-55.0021	-38.7608
27	0.3043	-55.0563	-38.4692
28	0.2589	-55.1554	-38.3122
29	0.2922	-55.2300	-38.2035
30	0.3496	-55.0852	-38.0751
31	0.4656	-54.8602	-38.0875
32	0.4879	-54.6527	-38.0705
33	0.4178	-54.4769	-38.3962
34	0.3689	-54.5057	-38.7080
35	NA	-54.5399	-39.2929
36	0.2998	-54.4901	-39.5289
37	0.3032	-54.5009	-39.7432
38	0.3829	-54.4727	-39.9835

Table 8.1.2 Fv/Fm values from underway sampling near and around the iceberg A23a.

Recommendations

If planning to use the LabSTAF during your research, check with the lab manager ahead of the cruise that a computer with the necessary calibration files for the runSTAF software is available.

Citations:

Haberman KL, Ross RM, Quetin, LB (2003) Diet of the Antarctic krill (Euphausia superba Dana): II. Selective grazing in mixed phytoplankton assemblages. Journal of Experimental Marine Biology and Ecology 283:97-113.

Pauli NC, Metfies K, Pakhomov EA, Neuhaus S, Graeve M, Wenta P, Flintrop CM, Badewien TH, Iversen MH, Meyer B (2021) Selective feeding in Southern Ocean key grazers—diet composition of krill and salps. Communications biology 4:1061

Meunier CL, Boersma M, Wiltshire KH, Malzahn AM (2016) Zooplankton eat what they need: copepod selective feeding and potential consequences for marine systems. Oikos 125:50-58.

8.2 Experiments: Micrograzing & 13C Productivity

Author: Amanda Burson

Introduction

Grazing amongst and within the microplankton community is still a relatively unconstrained process, particularly in open oceans and especially in the Southern Ocean (Schmoker et al., 2013). Thus, carbon cycling in particularly is not well understood within this size fraction (<200 µm) and is not adequately represented in modelling within this region. In an effort to improve our collective understanding of the rates, relative importance and spatial changes of both, we sought to perform micrograzing experiments at as many locations as possible throughout the SD046 cruise.

Micrograzing experiments operate on the dilution serious concept first proposed by Landry and Hassett in 1982. The concept operates on the assumption that grazing rate is determined mostly by contact rate and that phytoplankton productivity is not influenced by proximity of other phytoplankton. Thus, if you dilute sample water with water which has filtered to removed both grazers and prey, the phytoplankton will grow relatively more in a more diluted system compared to undiluted where grazing contact is higher. If effective, you can plot a linear regression of the phytoplankton growth rate verses the dilution factor; the slope of which is the grazing rate.

To compare the microplankton (<200 µm) to primary production rates we conducted 13C-labelled uptake experiments at the same time as (most) of the micrograzing experiments. We followed the protocol of López-Sandoval et al. (2018) who found that 13C measurements were as effective as 14C (which is typically used for primary production) during their study. There is a risk that the biomass was too low for 13C as there is an argument it is not as sensitive as 14C experiments, but given the lower-risk of the non-radioactive carbon isotope we decided to try this method on SD046.

Methodology

Water was collected at 10 m depth from the CTD as per above but with the exception of a pre-filtration through 200 µm mesh contained within an in-line filter capsule (Fig. 8.2.1) to remove any grazers larger than micro-size. The CTDs from which the experiment water was collected were, whenever possible, on-deck about 30 min to 1 hour before dawn. This allowed for set-up of the dilution series and for bottles to placed in the on-deck incubator at or just before sunrise.

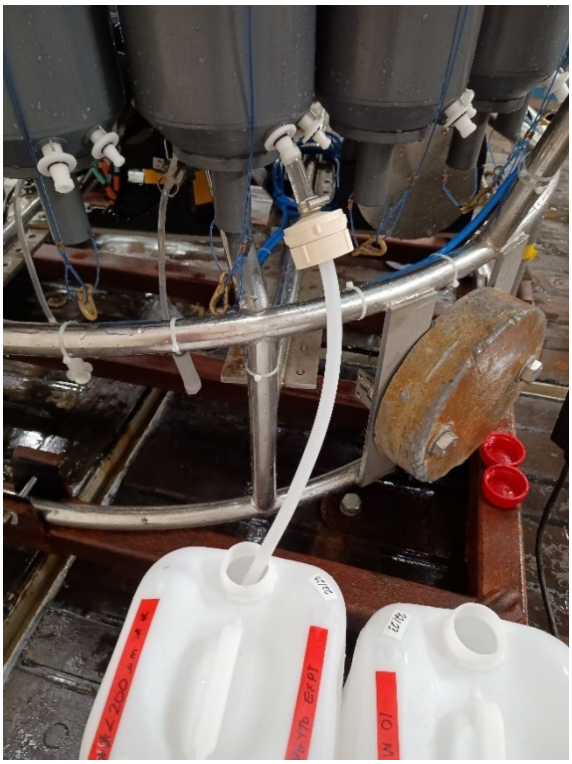

Figure 8.2.1 In-line 200 um pre-filter from CTD collections.

This water was immediately transferred into 1.2 L incubation bottles at the following dilutions: 1200 mL seawater; 900 mL seawater, 300 mL filtrate; 600 mL seawater, 600 mL filtrate; 300 mL seawater, 900 mL filtrate and 1200 mL filtrate (see Fig. 8.2.2). Filtrate was generated via a vacuum filtration serious of filters provided by Dan Mayor and Kathrine Cook which had a prefilter of 50 um followed by 0.2 um filter cartridge (see Fig. 8.2.3). Bottles were covered in a neutral mesh to replicate, as best possible, light climate at 10 m depth. Within the highly productive S. Georgia region, 2 layers of mesh were used as light attenuation was greatest. Throughout the rest of the cruise only 1 layer was necessary. Light attenuation was calculated by first determining the light attenuation coefficient (Kd) using the PAR measured at two depths (ie. just below surface and 20 m) and the following formula: $Kd=\ln(PAR_1/PAR_2)/(depth_2-depth_1)$. Once the Kd was determined we used the Beer-Lambert Law for calculating light at a certain depth (z) where surface is the light entering the incubator: $Light_z=Light_{surf} * e^{(-Kd*z)}$. The light entering the incubator was measured via a LiCOR handheld light meter under the incubator lid (see Fig. 8.2.3).

Incubations occurred for 48 hours and no nutrients were added to the incubations. This is one diversion from the usual dilution experiment design but has been done with previous micrograzing experiments within the Southern Ocean (Böckmann et al. 2024) with the expectation that the high ambient nutrients and the lack of metal-free collection would allow for replete nutrient conditions during the incubation. To confirm this, dissolved inorganic nutrients were collected and analysed at the end of each incubation.

After 48 hours of incubation, the experiments were processed as follows: 500 mL each for POC and Chl *a*. A 20 mL Lugol's iodine sample per bottle and a sample per bottle for flow cytometry. These will all be compared to T=0 values for growth rates. Typically, chlorophyll *a* and/or Lugol's would be sufficient but after communications with the authors of Böckmann et al. (2024) prior to the cruise POC and flow cytometry were added to capture bacterial and picoplankton grazing impacts.

Figure 8.2.2 Experimental incubation bottles with neutral mesh for reducing incoming light.

Figure 8.2.3 Filtration set-up to create filtrate for dilutions.

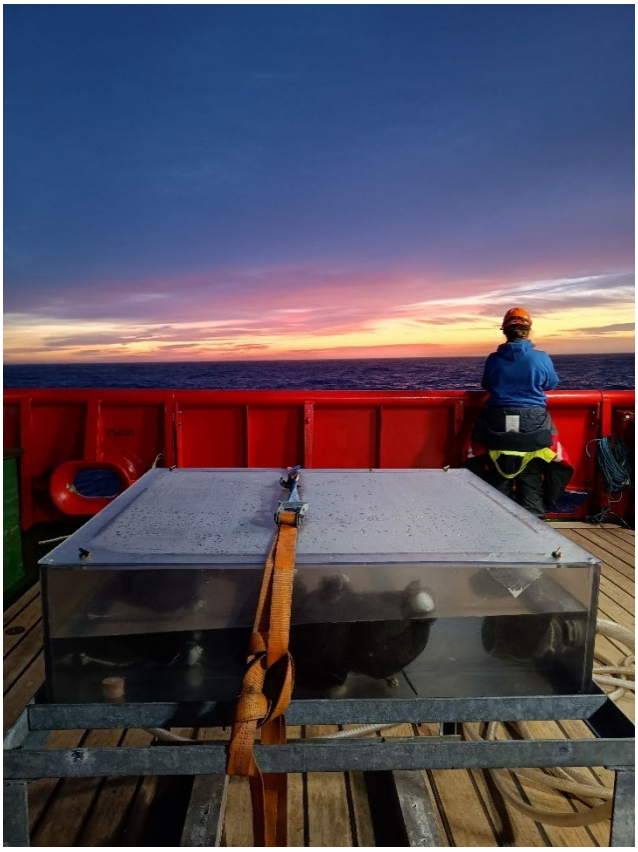

Figure 8.2.4 On-deck incubator at dawn in the starboard aft section of the deck.

Carbon-13 experiments were conducted at the same time as the incubation experiments. Three clear 2-L bottles and 1 dark 2-L bottle was used. All three bottles were filled with <200 um experiment water and spiked with 96 uM 13-C labelled sodium bicarbonate. These were incubated for up to 10 hours then filtered onto combusted and pre-weight 47 mm GFF filters and stored in -20 C.

Outcomes

All in we performed 15 micrograzing experiments at all four major sampling locations within the SD046 cruise:WCB/S.Georgia, A23 transect, Biopole, and the A23a iceberg. See table 8.2.1 for the full list of locations.

WCB/S. Georgia	A23 transect	Biopole	A23a Iceberg
WCB1.2Sst	A23-49	BP2_1	SE0
WCB2.2Nst	SSTW	BP2_3	NE2
transitA23	A23_35	BP2_4	
		BP2_6	
		BP2_7	
		BP2_8	
		M3	

Recommendations

For future on-deck incubations I would try to remove the lid as snow and ice sometimes accumulated on the lid and needed to be removed regularly (see Fig. 8.2.5). Previous users of this incubation tank secured bottles inside large tubes under the water. Unfortunately these

tubes were a) discovered in storage too late for this cruise and b) too narrow for my incubation volumes. But, future designs for micrograzing will likely adopt a similar set-up.

Figure 8.2.5 Snow accumulation on incubator lid that had to be removed regularly to allow light to come through.

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Schmoker C, Hernández-León S, Calbe A (2013). Microzooplankton grazing in the oceans: impacts, data variability, knowledge gaps and future directions. Journal of Plankton Research 35:691-706.

8.3 Black Carbon water collection and incubation experiments

Author: Laura Wilkie Johnston

Introduction

Black carbon is part of the organic carbon continuum, produced by incomplete combustion. Where its main natural source globally are wildfires (biomass burning), combustion of diesel engines contributes the highest anthropogenic input of BC into the environment. Black carbon is well studied within the aerosol, particularly in the Arctic. However, spatial resolution of BC in oceanic waters is limited. Being relatively resistant to degradation, when black carbon enters oceanic waters from riverine inputs and land run-off, it can remain within the water column for hundreds to thousands of years. DBC can adsorb onto sinking particles in the water column, sequestering into deep ocean sediments at a rate of 40-85TgC per year globally (Coppola et al., 2014). With a high surface area to volume ratio and nano porosity (Koelmans et al., 2006), PBC has been linked to increased radiative forcing, increasing ice/snow melt (Cordero et al., 2022), as well as an ability to absorb persistent organic pollutants (POPs) and other potentially toxic compounds (Coppola et al., 2022). Therefore, it is important to identify the presence and distribution of Black Carbon, in both dissolved and particulate form, within oceanic waters of the Southern Ocean (SO).

Dissolved organic matter, which contains DBC, has been studied in the SO before, (Dittmar & Paeng, 2009), but dissolved Black Carbon in marine water has been assessed only in eastern Antarctica (Fang et al., 2018). Additional studies on BC within the cryosphere have also been assessed only in eastern antarctica (Khan et al., 2017; Gogoi et al., 2018). Studies in the Western Antarctic Peninsula (WAP) are limited to PBC in snow (Cordero et al., 2022). Jaffe et al., (2013) found a strong coupling between DBC and PBC within riverine waters, hence why it was important to take both measurements from oceanic water samples simultaneously during this cruise.

A research gap, identified in Coppola et al., (2022)'s global black carbon cycle review, was identifying black carbon abundance in hadal zones. One of the stations targeted, at the South Sandwich Trench, captured Antarctic Bottom water, flowing through at a depth of ~6000m, within this zone.

Methodology

Dissolved and Particulate BC Collection

Dissolved and particulate BC were collected in tandem when sampling at the CTD. 5 depths at each CTD station were collected. Surface (10m), chl-max (variable), and bottom (variable) were 3 set depths at every station. The remaining 2 depths were selected during CTD descent, according to interesting features seen on the CTD profile (e.g. different water masses, oxygen minimum). Water was collected from each niskin bottle using pre-acidified tube and 1L plastic HDPE Nalgene bottles, then transported to the main lab.

The filtration methodology is as follows. A 4.5µm cellulose acetate filter was rinsed thoroughly in milli-Q, then placed on an acidified plastic filtration apparatus. 200ml of CTD water was filtered, retaining the filtrate in 250ml HDPE Nalgene bottles. The filter was then acidified using 2-3ml of 1% (v/v) hydrochloric acid (HCL), to remove inorganic carbon. The filtrate was also acidified to pH 2 using 3ml of 10% (v/v) HCL. Both filter and filtrate were then stored at -20˚C,

for transport back to Cambridge. For atmospheric PBC, each 1L bottle was filtered onto 0.2µm cellulose acetate filters, then acidified using same approach as explained previously.

Atmospheric black carbon sampling collected PBC only, using the microplastics air sampler on deck 10 (refer to Emily Rowland's section on the experimental set-up). This sampling was conducted in tandem with the underway, in an effort to understand PBC air-surface water transfer. This approach of measuring atmospheric particulate black carbon is similar to using Aethalometer, where PBC is drawn onto filter using a continuous vacuum, but instead of immediate spectral analysis, filters were acidified and frozen, to analyse at a later date in Cambridge.

Engine Soot BC phytoplankton incubation experiment

Soot was collected from an inspection hatch for the economiser, on deck 8, accompanied by third engineer Tom, or second engineer Josh. A washer from the door of the hatch was removed and plunged into milli-Q water, where it was taken back to the lab, then cleaned using a squeeze bottle of milli-Q and tweezers (see fig. 8.3.1 for washer and sampling location). This solution was transferred into a blue Nalgene bottle, with 500ml volume, gently shaken then placed in the walk-in fridge for storage. Engine 3 was used, as it is the engine that had the longest time since cleaning. The washer was collected and rinsed free of soot 3 times throughout the cruise (11/02/25, 03/03/25, 24/03/25), to get an idea of soot accumulation at the start, middle and end of this cruise. Soot collection from the middle and the end of the cruise were stored in 200ml solution in 250ml HDPE Nalgene bottles in the walk- in fridge.

NOTE: only soot collected at the start of the cruise was used in the incubation spiking experiments, to increase standardisation.

3 experiments were conducted, using phytoplankton collected from the chlorophyll max depth at station WCB4.2Sst, SSTW and BP2_8, from the CTD. Each 1200ml bottle of water was spiked with one of three treatments or left without spiking as a control. Treatment low (1ml of BC solution), treatment medium (3ml) and treatment high (6ml) were given to three bottles each, with 3 additional bottles left unaltered as a control. All 12 bottles were left in the incubator for 72 hours, then taken out and placed into the fridge, in the dark. ~15ml of each bottle was run through the LabSTAF active fluorometer, to determine a value of Fv/Fm, as a proxy of phytoplankton health. A user guide and background for using the LabSTAF fluorometer and runSTAF software written by Kate Hendry can be found in the cruise report from SD025.

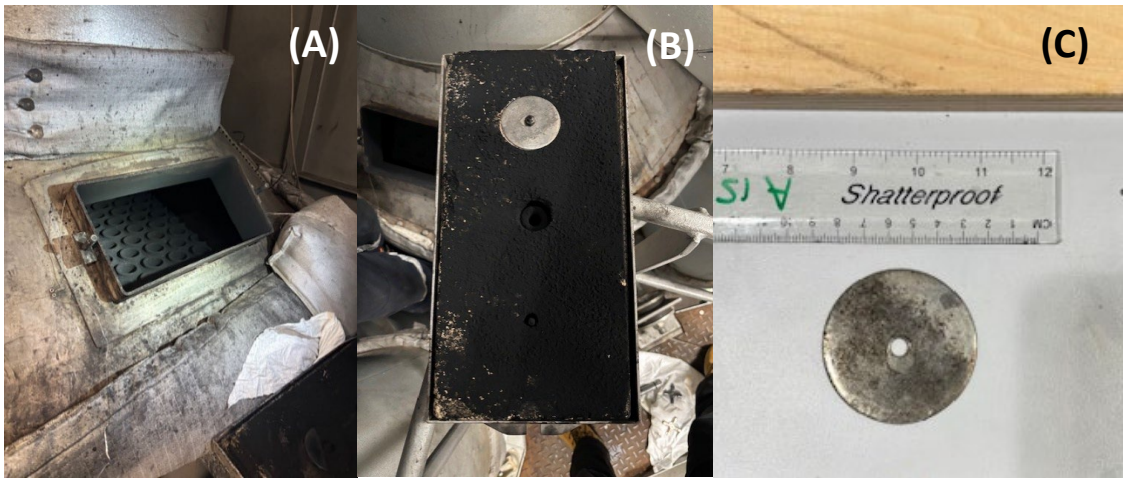

Figure 8.3.1: Collection site of engine soot showing (A) the door to the economiser of engine 3, (B) the inspection hatch door, where the sample washer is located, (C) the sample washer removed and rinsed.

Outcomes

DBC and PBC Sample Collection

5 CTD stations, which were determined to have the largest potential difference in water masses between them, were sampled successfully for DBC and PBC. A map of these stations is shown below (Fig. 8.3.2). 4 out of 5 of these stations were chosen to be at the same location as long-term moorings, so as to increase the resolution of historical data available. Test station number 2 was also sampled, as it was the only location where the CTD was deployed north of the Polar Front. However, all bottles fired at 30m, so only one sample (in triplicate) was taken for DBC and PBC.

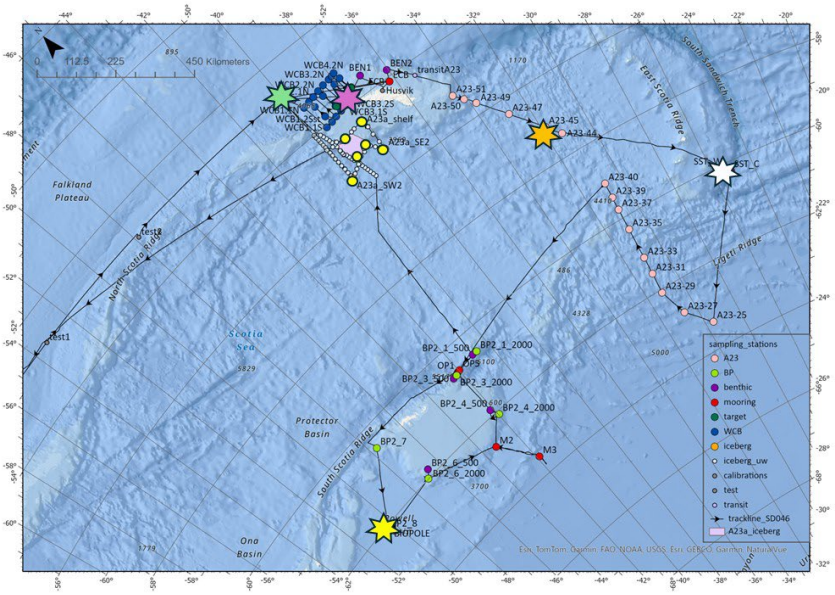

Figure 8.3.2 Map showing locations of CTDs sampled for PBC and DBC. Each star represents a station, with following colours representing green (P3), purple (WCB), orange (A23), white (SSTW) and yellow (BIOPOLE).

A further 6 CTD stations were opportunistically sampled during the final A23a phase. 5 of which were sampled at 3 depths: surface, ~100m and ~500m. The final station, benthic, was sampled opportunistically at 6 depths (10,50,75,100,180 and 210m). These depths were chosen to give an even spread of depths from the bottom to the surface of the water column. Underway water sampling for DBC and PBC was conducted over two survey transects, from CTD station SW2 to Fjord, and from SE0 to SE2. Each underway sample was collected at a pre-defined “waypoint”. 6 Underway waypoints were sampled in total (3 per transect). Figure 8.3.3 shows the sampling locations of each CTD and underway waypoint. During this phase, due to the opportunistic approach of sampling, all water collected was frozen at -20˚C unfiltered, and unacidified, for future analysis/separation at Cambridge.

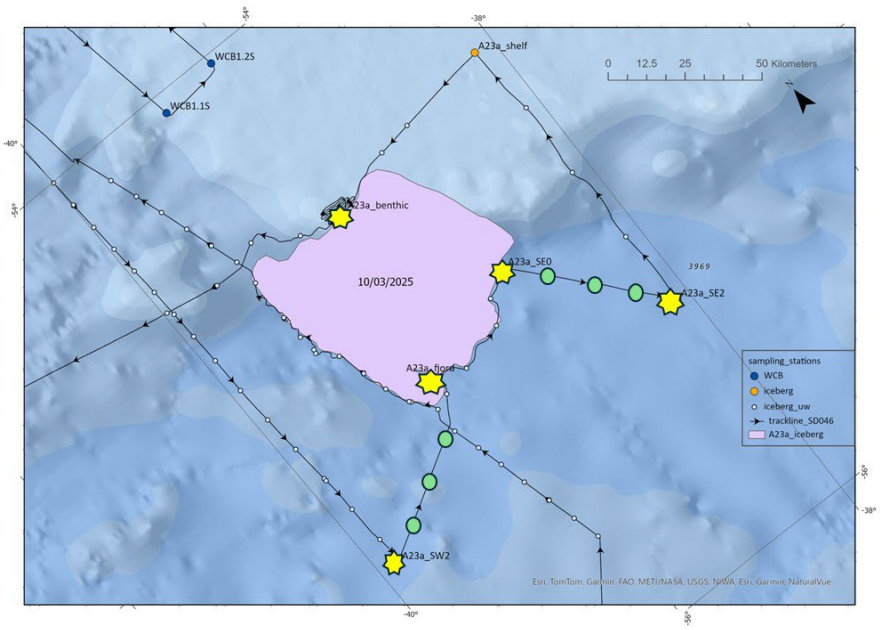

Figure 8.3.3: Map showing sampling locations for CTDs and underway, during the A23a phase. Yellow stars denote CTD stations, green circles denote underway "waypoints" sampled.

During CTD sampling at the SST station, 500ml was collected by external personnel at 500m due to a miscommunication instead of 1L, so duplicate instead of triplicate DBC and PBC were created. Additionally, the bottle used was noted as "opened", and still sampled, even though another bottle at the same depth (which was unopened) was available.

Engine Soot BC phytoplankton incubation experiment results

Experiment number	Treatment (C,L,M,H)	Fv/Fm	Bottle number
1	C	0.2125	10
1	C	0.2398	12
1	C	0.2452	11
1	L	0.2357	2
1	L	0.2691	1
1	L	0.2358	3
1	M	0.2028	6
1	M	0.2482	5
1	M	0.2665	4
1	H	0.2702	9
1	H	0.2699	7
1	H	0.2271	8
2	C	0.1064	10
2	C	0.1417	11
2	C	0.1088	12
2	L	0.1128	3
2	L	0.1151	2
2	L	0.108	1
2	M	0.0923	6

2	M	0.08434	5
2	M	0.1166	4
2	H	0.1267	8
2	H	0.1484	7
2	H	0.1131	9
3	C	0.3812	10
3	C	0.4094	12
3	C	0.3562	11
3	L	0.3799	2
3	L	0.3908	3
3	L	0.402	1
3	M	0.4152	6
3	M	0.4036	4
3	M	0.3801	5
3	H	0.3964	9
3	H	0.3657	8
3	H	0.3892	7

During experiment 1 and 2, the software was running under a continuous loop. Therefore, samples were run for 37 minutes each before being manually stopped and saved. It is now known that each loop is approximately 12 minutes 15 seconds long, therefore these samples were run 3 times. Experiment 3 was run with the loop function being switched off, so sample results were saved and taken after 12 minutes. This may explain the difference in Fv/Fm seen here, but further analysis will be carried out to investigate this, and any other potential trends with other fluorescence parameters.

Antarctic krill (*Euphausia superba*) collection for POP analysis

200 *E.superba* were collected during the WCB, then frozen and stored at -80˚C. Krill, at mix of life stages, were collected across 3 events. A summary of collection is shown below (table 8.3.1).

Collection Date	Event Number	Net	Collection Device	Number of Krill	Species name	Life Stage
17.02.2025	42	2	RMT8	25	Euphausia superba	subadults
17.02.2025	42	2	RMT8	25	Euphausia superba	juveniles
18.02.2025	47	1	RMT8	25	Euphausia superba	random
18.02.2025	47	1	RMT8	25	Euphausia superba	random
19.02.2025	53	1	RMT8	25	Euphausia superba	subadults
19.02.2025	53	1	RMT8	25	Euphausia superba	juveniles
19.02.2025	53	2	RMT8	25	Euphausia superba	subadults

19.02.2025	53	2	RMT8	25	Euphausia superba	juveniles

Table 8.3.1. Summary of krill collected during the western core box for POP analysis

These specimens will be used for persistent organic pollutant (POP) investigation, combining them with krill from the JR26 cruise in 1997, to determine if there are any long-term changes in POPs within krill tissues.

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9. Biogeochemistry

9.1 Biogeochemical sampling

Authors: Laura Taylor, Emily Rowlands, Lisa Friberg, Isabelle Cooper, Joana Fragão

9.1.1 Overview

The biogeochemistry team undertook sampling for six of the pre-agreed BIOPOLE key parameters, all of which are being stored for analysis upon return to the UK by one of the BIOPOLE centres.

The specific sampling strategies varied depending on the phase of the cruise.

Western Core Box (WCB) phase

The team undertook a high resolution underway transect on the approach to the P3 mooring site, taking samples once per hour from 40 nmi from the mooring to 40 nmi past the morning. A full set of samples was also taken from a CTD from the P3 mooring site on recovery of the mooring (14/02/2025), followed by a second set of CTD sampling on redeployment of the mooring on 22/03/2025 due to the time lapsed between recovery and redeployment.

During the WCB acoustic transect, underway samples were taken at 3-hour intervals during the acoustic transect (daytimes).

A23 transect phase

Underway samples were taken every 6 hours throughout the A23 phase, paused only while diverting off the transect to the South Sandwich trench moorings. 15 CTDs were sampled for biogeochemistry during the transect, covering over half of the full list of A23 stations, and all but one of the stations sampled on this cruise. Consideration was taken where possible to sample the same stations on the transect as were sampled for some of the biogeochemical parameters here on cruise DY158 in early 2023.

BIOPOLE phase

During the BIOPOLE phase, underway samples were taken every three hours during transit between stations across the region.

One full-depth CTD per station was sampled for the full set of biogeochemical parameters listed above. Care was taken to ensure the sampling profile at the BIOPOLE mooring station matched that of cruise SD033 for ease of comparison.

A23a iceberg phase

Opportunistic sampling around the giant iceberg A23a was completed on 23-24/03/2025 due to time fortunately becoming available. The biogeochemistry team aimed to capitalise on this experience by completing as much sampling as possible with the resources available on board.

6 CTDs (all deployed around the iceberg) were sampled for the full set of biogeochemical parameters, alongside sampling of surface seawater from the uncontaminated seawater system at either fixed time intervals or fixed waypoints on the transit around the iceberg, and towards and away from the iceberg.

Table 9.1.1.1 Overview of biogeochemistry parameters

Full name	Abbreviation(s)	CTD locations	Underway locations
Dissolved organic carbon and total alkalinity	DIC, DIC/TA	P3 mooring BIOPOLE phase A23a iceberg	BIOPOLE phase A23a iceberg
Dissolved organic carbon	DOC	P3 mooring A23 phase BIOPOLE phase A23a iceberg	P3 mooring transect WCB phase A23 phase BIOPOLE phase A23a iceberg
Dissolved silicon isotopes	δ^{30}Si, Si isotopes, SII (on sample labels)	A23 phase BIOPOLE phase A23a iceberg	BIOPOLE phase A23a iceberg
Particulate organic carbon	POC	P3 mooring A23 phase BIOPOLE phase A23a iceberg	P3 mooring transect WCB phase A23 phase BIOPOLE phase A23a iceberg
Total particulate carbon	TC, TOC (on sample labels)	P3 mooring A23 phase BIOPOLE phase	P3 mooring transect WCB phase A23 phase BIOPOLE phase A23a iceberg
Biogenic silica	BSi, BSI (on sample labels)	P3 mooring A23 phase BIOPOLE phase A23a iceberg	P3 mooring transect A23 phase BIOPOLE phase A23a iceberg

Sample labelling

All samples taken by the biogeochemistry group during SD046 to return to the UK for analysis have the same labelling system, whereby sample labels comprise of a six-digit ID code. The first three digits (letters) are 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 with marine permanent adhesive (BS5609 Part 2 Approved) 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 data manager.

Random sample ID codes were chosen for the cruise to minimise human error due to the relatively large number of scientists working on biogeochemistry, 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.

Table 9.1.1.2 ID codes for sample types

Sample type	**3 letter identifier**
Dissolved inorganic carbon / total alkalinity	DIC
$\delta^{30}Si$	SII
Dissolved organic carbon	DOC
Particulate organic carbon	POC
Total particulate carbon	TOC
Biogenic silica	BSI

9.1.2 CTD sampling

CTD sampling order

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

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

From this point on, there was not a GO-SHIP protocol requirements for a specific sampling order. However, the decision was made to place sampling for Black Carbon (see black carbon section) immediately after DOC (5) due to similarities in protocols, and sampling for microplastics (see microplastics section) last, so that there would be less traffic around the CTD.

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

Contamination at the CTD

Vinyl gloves were worn by all scientists participating in the earlier stages of CTD sampling until dissolved nutrients samples had been completed to avoid contamination of nitrogen species from nitrile gloves. Separate tubing was used for each parameter, allowing for different tubing cleaning and storage requirements between CTD casts.

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 in chlorophyll concentration was considered significant for the aims of this project.

CTD sampling around the A23a iceberg was undertaken at different depths to the rest of the cruise, with the aim of capturing key features of the water column:

- Chlorophyll maxima
- Temperature minima
- Turbidity maxima
- Oxygen minima

Temperature minima were sampled as opposed to salinity minima, because this was always at the surface at this latitude. The depths of these key features were sampled at for all

biogeochemistry parameters, with additional depths added to increase coverage through the water column.

CTD sampling procedures

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.

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 pre-acid cleaned Nalgene bottles was rinsed three times with filtered seawater, then filled up to the top. 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. Chlorophyll maximum samples were taken when this depth differed from existing sample depths.

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.

Filtration samples: POC, TC, BSi

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, TC, and BSi. Carboys were stored in the +4 °C fridge in the dark prior to filtration.

The standard depth profile of samples for POC, TC, 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.

Note, in the A23a iceberg phase of the cruise, samples were not taken for TC from the CTD, as there was insufficient time to complete filtration for all parameters. TC samples were removed, as there is some flexibility in the analytical methods back in the UK for POC, and it may be possible to analyse both from one filter per depth.

9.1.3 Underway sampling

Underway seawater samples were taken from the uncontaminated seawater (UCSW) lab. Tubing was fixed to one of the seawater taps for taking samples, through which water was left running continuously to ensure there was no backlog of water in the pipes to the tap.

For the majority of the cruise, underway sampling was taken at fixed time points while in transit between stations, switching to fixed waypoints around iceberg A23a to allow for sufficient sampling between stations.

DIC/TA

Previously, there have been some issues with taking samples from the UCSW system for dissolved gases from the SDA, due to bubbling through the system resulting in gas contamination. The system has been improved during the ship's refit in summer 2024. As this was the first science cruise aiming to collect dissolved gas samples from the underway system after improvements, an experiment was carried out to test the integrity of this system (see Gas Sampling on UCSW System section).

DIC samples were taken via allowing a 250 ml borosilicate glass bottle to overflow three times the bottle volume before being filled to the brim making sure no bubbles were present in the sample. Samples were taken from the blue instrument outflow tube as opposed to the tap, as this flow has far less bubble contamination due to tap pressure variations. Samples were spiked within 15 minutes of sample collection by pipetting out 2.5 ml of seawater to allow headspace for 50 µl of mecuric 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.

DOC

Water from the UCSW tap was filtered through an in-line GF/F filter into pre-acid cleaned 50 ml HDPE bottles. The filter housing was swapped and cleaned in a 10 % HCl acid bath after every three sampling points. After soaking and when ready for re-use, the filter housing was rinsed with Milli-Q before being assembled with a new filter paper. 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.

Silicon isotopes

Water for $\delta^{30}Si$ samples was filtered directly from the underway tap using an in-line Acropak filter (0.8/0.45 µm) attached using pre-acid cleaned silicone tubing. A 250 ml pre-acid cleaned Nalgene bottles was rinsed three times with filtered seawater, then filled up to the top. Samples were stored at +4 °C.

Filtration samples: POC, TC, BSi

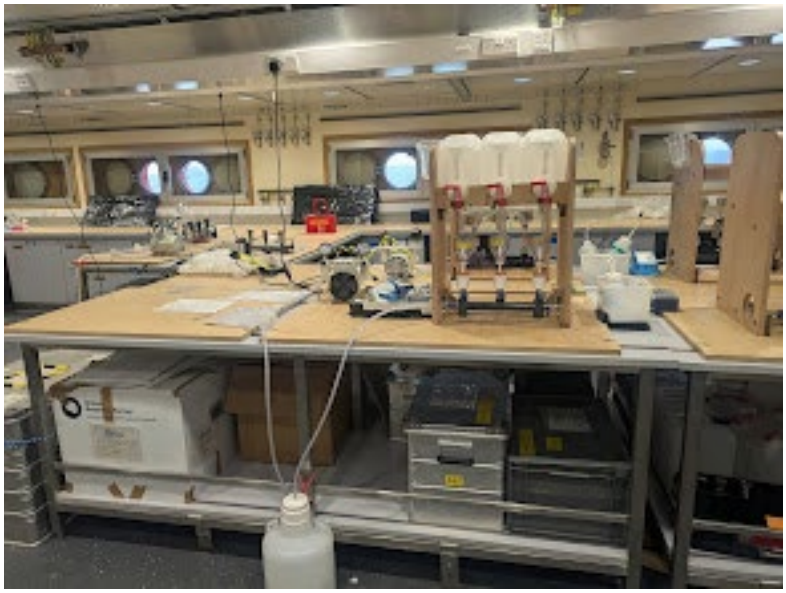
10 L carboys acid cleaned prior to the start of sampling were rinsed three times with seawater, then filled, where one carboy contained water for analysis of POC, TC, and BSi. Carboys were stored in the +4 °C fridge in the dark prior to filtration.

9.1.4 Filtration

Substantial investment was made prior to this cruise into upgrading filtration equipment to improve the capacity of the science team to filter large volumes of water between CTD casts. Members of the science team on this cruise, as well as other colleagues at BAS, worked with AME engineers to develop a new design of the filtration setup with the aim of improving efficiency.

This involved constructing a wood frame for the filtration rigs, within which 5L carboys sit on a shelf, facing downwards. These carboys are equipped with taps and tubing into the filtration rig cups, allowing the flow to be set such that water can be continuously added to the cup while filtering. Tubing attaching the filtration manifold to the vacuum pump and waste bottles was also replaced with new reinforced PVC tubing. These modifications to the filtration set up resulted in substantially shorter amounts of time needing to be allowed for filtering samples, resulting in a quicker turnaround between casts, and the ability to sample more CTDs during the A23 transect than would have been possible with the setup of previous BAS cruises in recent years.

The teams using the setup on this cruise (biogeochemistry and phytoplankton) can see potential for further enhancements, which will be discussed in preparation for future cruises.



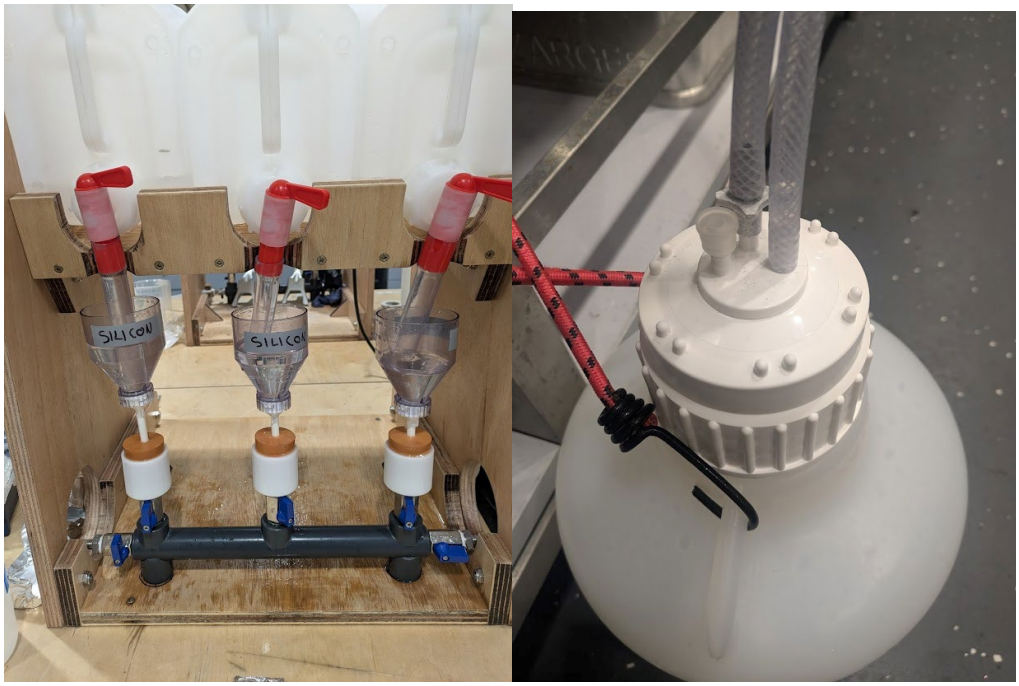


Fig 9.1.4.1.: Images of one of four new-build filtration rigs used on this cruise.

Filtration for POC and TC

Pre-ashed 25 mm GF/F filters were placed on the filter holder and the cup twisted to secure in place. A small amount of filtered seawater was run through before adding sample water to ensure there were no leaks in the filter seal. 2 L of water was then poured from the sampling carboy into the smaller 5 L filtration carboys. Filtration for POC was carried out at a pressure of at or below 40 kPa.

2 L of water was filtered for all samples in the WCB, A23, and BIOPOLE phases of the cruise, as this volume consistently resulted in enough material being collected in surface samples to colour the filter paper clearly. If for any reason less than 2 L was filtered, this was recorded on the filtration log sheet.

Around the A23a iceberg, 1 L of water was filtered for all CTD and underway samples due to the time constraints posed by a very fast turnaround time between sampling. This appeared to produce sufficient material on the filters.

Once the water had filtered, filters were removed from the stand using forceps rinsed with filtered seawater, folded in half twice, and placed in pre-labelled foil packets.

Filtration for POC analysis was done onto pre-weighed GFF filters, for which the ID code on the foil packet was transcribed to the filtration log sheet. TC samples were on pre-ashed, but unweighed, GFF filters.

Filtration was always carried out within 12 hours of sampling.

Filtration for BSi

25 mm Isopore™ 0.4 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.

For the WCB, A23, and BIOPOLE phases of the cruise, 500 ml of water was filtered for samples in the surface layer (underway, 10, 20, 50, 100 m), and 1 L of water for deeper samples. Around iceberg A23a, 1 L of water was filtered for all samples.

Filtration for BSi was always carried out within 12 hours of water collection.

Table 9.1.4.1: Total sample numbers

Parameter	**Number of samples**
DIC/TA	161
$\delta^{30}Si$	219
DOC	334
POC	345
TC	257
BSi	324
Total samples taken	**1640**

9.1.5 Gas sampling

Authors: Lisa Friberg, Ed Mawji, Gabriele Stowasser, Laura Taylor

To determine whether gases, primarily dissolved oxygen (DO) and dissolved inorganic carbon (DIC), can be reliably sampled from the underway system, we conducted an experiment focusing on DO, as DIC could not be measured onboard. As water travels from the underway pole (~7 m depth) to the uncontaminated seawater laboratory (deck 3), it warms due to pumping, potentially affecting gas concentrations. Additionally, rough conditions and pole flushing may introduce air bubbles, leading to contamination. Given these challenges, we aimed to assess whether the underway system provides reliable gas samples.

We found that the oxygen sensor brought on the cruise (RBRduet3T.ODO) was uncalibrated and unsuitable for comparative analysis. Instead, we compared underway samples with CTD-collected water from the same depth (7 m). In coordination with the CTD operator, underway samples were taken simultaneously with Niskin bottle firings to ensure comparability.

Gas sampling was conducted during six events. Water was collected in 250 mL glass bottles from the blue water tube (Figure 1), chosen over the larger main tap tube due to fewer air bubbles and a more continuous flow. Bottles were rinsed and overflowed for ~15–20 s before sealing. A handheld thermometer recorded water temperature. Samples were then fixed with manganous sulfate and alkaline-iodide-azide, shaken for 30 seconds to form a precipitate, and later analysed using the Winkler titration method (see DO section). CTD samples were collected using the same method, with flexible plastic tubing attached to the Niskin bottle taps to minimize air bubble formation.

DO concentrations were measured using a Metrohm 916 Ti-Touch compact titrator (Figure 9.1.5.2, Table 9.1.5.1). Results show good agreement between underway and CTD samples, except for Event 163, where one underway duplicate deviated beyond the error range (0.3 µmol/L). We conclude that DO sampling from the underway system provides accurate gas concentration measurements.

Figure 9.1.5.1. Sink in the underway lab, red circle shows the blue tube used for DO sampling.

Table 9.1.5.1: Concentrations of dissolved oxygen (DO)for the six events tested for gas sampling.

Date	Event number	Underway DO concentration	CTD DO Concentration
		(μmol/L)	(μmol/L)
13/03/2025	event 163	352.332	352.045
13/03/2025	event 163	349.321	351.743
14/03/2025	event 167	348.771	349.496
14/03/2025	event 167	349.899	349.594
16/03/2025	event 178	359.861	359.861
16/03/2025	event 178	359.982	359.916
16/03/2025	event 179	359.368	360.271
16/03/2025	event 179	359.259	359.438
16/03/2025	event 183	359.468	359.222
16/03/2025	event 183	359.065	358.956
18/03/2025	event 191	354.636	354.629
18/03/2025	event 191	354.566	354.666

Figure 9.1.5.2. Average dissolved oxygen concentration (μmol/L) in seawater samples collected from the underway and CTD, both at 7m water depth.

9.2 Dissolved oxygen

Author: Edward Mawji

A total of 30 CTD casts were sampled for dissolved oxygen during SD044 in order to calibrate the two CTD oxygen sensors (primary and secondary).

Sample collection
Seawater was collected directly into pre-calibrated 125 ml Pyrex Iodine titration flasks with flared necks. Before the sample was drawn, bottles were washed with seawater for several seconds (approximately 3 times the volume of the bottle) while the temperature of the water was recorded (Hanna Instruments). Throughout the sampling process, care was taken to avoid bubble formation inside the sampling tube and sampling bottle. The fixing reagents (i.e. manganous chloride and sodium hydroxide/sodium iodide solutions) were then immediately added, and the bottle sealed with a glass stopper, taking care not to introduce any air bubbles. Sample bottles were then thoroughly mixed by shaking in order to homogenise the contents, and were then stored in a dark plastic crate for 30 to 40 minutes to allow the precipitate to settle. After collection, a Milli-Q water seal was applied to the neck of the sample flasks in order to prevent ingress of air. Analyses were carried within four to eight hours of sample collection.

Analysis
The chemical reagents were prepared in advance at NOCS following the procedures described by Dickson (1994). 2 litres of each reagent were prepared and homogenised. Thiosulfate was weighed into 27.4 g portions and all solutions were made during the cruise. Thiosulfate solutions were prepared at least two days in advance.
When ready to titrate, the Milli-Q seal was dried and the stopper of the flask carefully removed. A 1 ml aliquot of 5 M sulfuric acid was dispensed into the flask, immediately followed by a clean magnetic stirrer.
The flask was placed on the stir plate and the electrode and burette were carefully inserted to place the tips in the lower-middle depth of the sample flask. The initial volume of sodium thiosulfate ($Na_2S_2O_3$) for each sample was 0.3 ml before continuing to be titrated at 0.0005 ml intervals using an electrode with amperometic end-point detection (Culberson and Huang, 1987) with an end current of 0.1 x 10^{-6} A. The resultant volume of titrant was recorded both by manual logging and on the Ti-Touch 916 (Metrohm), S/N 32728).

Following this the value was converted to a DO concentration. Thiosulfate calibrations and reagent blank checks were carried out for each sampling station following the GO-SHIP protocols (Langdon, 2010). At least 3 blank checks of the reagents and 3 standardisations of the sodium thiosulfate were completed using a 1.667 mol l^{-1} certified iodate standard (OSIL) for every cast.

Results
Blanks and standards

During SD046 the reagent blanks ranged from 0.0026 to 0.0048 mL, with a medium 0.0034 mL, n=75. Two batches of $Na_2S_2O_3$ were used during SD046. The standardisation volumes ranged from 0.4567 to 0.4555 mL with a mean of 0.4561 mL, SD of 0.0004 (batch 1) and 0.4560, Sd 0.0008 (batch 2). The average of each batch of $Na_2S_2O_3$ standardisation measured was used to calculate the finial DO concentration.

Precision and accuracy

Replicate measurements of randomly selected Niskin bottles were carried out to test for reproducibility. In total 56 pairs of duplicate samples from the same Niskin bottle or the same depth were taken. Duplicates titrations had a mean absolute difference of 0.362 umol O_2 L^{-1}.

References

Culberson, C.H. and Huang, S. (1987). Automated amperometric oxygen titration. Deep-Sea Res. Pt A 34(5-6), 875-880. doi:10.1016/0198-0149(87)90042-2

Dickson, A.G. (1994). Determination of dissolved oxygen in seawater by Winkler titration. Technical report, WOCE operations manual, WOCE report 68/91 Revision 1 November 1994.

Langdon, C. (2010). Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. The GO-SHIP repeat hydrographic manual, IOCCP report 14, version 1.

9.3 Inorganic nutrients

Author: Edward Mawji

A 4-channel Seal Analytical (QuAAtro 39) segmented flow-analyser with XY autosampler was set up in the General-purpose lab of the RRS Sir David Attenborough for the analysis of micro-molar concentrations of dissolved inorganic nutrients (silicate, phosphate, nitrate plus nitrite and nitrite).

9.3.1 CTD Sampling and Analysis

Samples were collected directly from the 24 x 20 L stainless steel rosette after gas sampling into pre-labelled 15ml centrifuge tubes (rinsed three times with water from the same Niskin). Samples were analysed directly from the collection tubes within 8 hour and measured from the lowest to the highest concentration (surface to deep) to reduce any carry over effects. Milli-Q water was used for the baseline and wash solution during each run. All unique sampling depths were sampled and analysed. Samples were also analysed from the incubation experiments.

Seal Analytical chemistry and cleaning procedure protocols used during SD046 were

1. Silicate in seawater method No. Q-066-05 Rev. 5
2. Phosphate in water method No. Q-064-05 Rev. 8
3. Nitrate and nitrite in seawater method No. Q-068-05 Rev.11
4. Nitrite in seawater method No. Q-070-05 Rev. 6

9.3.2 Underway Sampling

During SD046 an extensive underway samples campaign was carried out, with inorganic nutrient been collected every hour (when the ship was in transit). Around the A23 iceberg the frequency of sampling increased to approximal every 20 min. In total 510 samples were collected from the underway system and measured for inorganic nutrients. A massive thanks goes out to the physics team which made this possible (Sally, Hue, Rachel, Michal, Shenjie and Kat) who collected the majority of all underway nutrient samples.

9.3.3 Standards

Standards were prepared for every day of analysis by diluting the stock solutions of the different nutrients in aged low nutrient seawater (LNSW).

Each run of the system had an 8-point calibration series (first value was LNSW + 7 working solutions). Prior to analysis all samples and standards were brought to room temperature of

~22◦C. Concentrations of the working standards were based upon the concentrations range of the nutrients expected.

9.3.4 Quality Controls (QCs) of analyses

In order to test the accuracy and precision of the analyses, CRMs from The General Environmental Technos Co., Ltd., (KANSO) were measured in throughout every run. During SD046 KANSO CRMs lot CL, CJ, CP, CC and CB were used; certified concentrations against the run concentrations are shown in Table 1.

Table 1. Certified concentrations converted from **µ**mol kg^{-1} to **µ**mol L^{-1} (using salinity provided and 20 deg) of KANSO CRMs used during SD046 and measured results for each lot (in umol L^{-1}), n=232 CL and CJ, n=211 CP, n=144 CC and n=178 CB.

	Nitrate	Nitrite	**Silicate**	**Phosphate**
KANSO CL	5.604 ± 0.154	0.015 ± 0.008	14.14 ± 0.307	0.435 ± 0.019
KANSO CJ	16.2 ± 0.2	0.032 ± 0.007	39.43 ± 0.41	1.219 ± 0.02
KANSO CP	25.4 ± 0.307	0.318 ± 0.072	62.582 ± 0.307	1.794 ± 0.018
KANSO CC	31.63 ± 0.246	0.119 ± 0.006	88.25 ± 0.41	2.13 ± 0.019
KANSO CB	36.659 ± 0.277	0.116 ± 0.006	111.85 ± 0.635	2.58 ± 0.023
Measured CL	5.667 ± 0.106	0.038 ± 0.006	14.262 ± 0.14	0.425 ± 0.021
Measured CJ	16.643 ± 0.106	0.065 ± 0.006	39.643 ± 0.186	1.219 ± 0.011
Measured CP	25.573 ± 0.133	0.32 ± 0.004	62.615 ± 0.235	1.777 ± 0.012
Measured CC	31.716 ± 0.179	0.143 ± 0.004	88.043 ± 0.289	2.139 ± 0.014
Measured CB	36.688 ± 0.212	0.151 ± 0.004	111.225 ± 0.391	2.589 ± 0.02

9.4 CTD: microplastics

Authors: Joana Fragão, Lisa Friberg

Microplastics have been detected in various components of the Southern Ocean ecosystem, including water column, surface waters and sea floor. These particles pose a significant threat to aquatic organism, which can easily ingest them along with their associated chemical additives. In the marine environment, microplastics can act as vectors for contaminants and microorganisms by adsorbing pollutants such as heavy metals and persistent organic pollutants (POPs) while also providing stable habitats for various species, including bacteria. This can lead to long-term toxic effects on organisms, drive ecological changes, and ultimately impact biodiversity and ecosystem services.

Seawater from 20 stations (see table below) were collected using a CTD cast equipped with Niskin bottles. To compare the presence of microplastic particles in seawater with their occurrence in macrozooplankton (fish, krill, and cephalopods) collected using RMT8 nets, we sampled water at two depths: ~200 m at onshore stations and 500 m at offshore stations. Samples were stored in sterilized bottles (4 bottles of 1L each) in the fridge at 4°C for later processing. Samples (4L per station) were filtered in a clean lab (aerosol lab) using glass rigs and cups, pre-cleaned in Milli-Q and ethanol, and preserved at -20°C for later analysis. During all the filtration processes, two blank controls filters were placed in the lab and the duration of each filtration was registered.

In Portugal, microplastic extraction will be conducted using sterilized materials (Petri dishes, filters, microtubes, trays, and forceps). Forceps will be systematically rinsed in ethanol and flamed between handling each particle. Particles will be characterised visually according to their colour and type (i.e. foam, pellet, fragment or fibre). Then, microparticles will be sorted into sterile microtubes at -80°C until DNA extraction. DNA extraction will be performed on the plastic particles in order to profile the bacterial communities that are present on the surface of the plastic particles. Post DNA extraction all particles will be characterised according to shape (i.e. foam, pellet, fragment or fibre), colour and measured in their largest cross-section (mm). Their chemical composition will be also investigated using a FTIR (Fourier Transform Infra-Red spectroscopy).

EVENT Nº	NISKIN Nº	DEPTH (m)	DATE	STATION	WATER (L)
25	4	200	13/02/2025	ECB	5
27	8	500	14/02/2025	P3 mooring	5
37	17	500	15/02/2025	WCB	5
39	7	200	16/02/2025	WCB	5
41	18	195	16/02/2025	WCB	5
44	9	500	17/02/2025	WCB	5
46	20	125	17/02/2025	WCB	5
51	8	200	18/02/2025	WCB	5

55	9	118	19/02/2025	WCB	5
56	9	500	19/02/2025	WCB	5
58	12	500	19/02/2025	WCB	5
63	4	200	20/02/2025	A23-51	5
77	9	500	22/02/2025	A23-47	5
87	13	500	26/02/2025	A23-25	5
94	7	500	28/02/2025	A23-33	5
101	6	500	01/03/2025	A23-40	5
108	5	500	03/03/2025	BP2-3	5
127	9	500	07/03/2025	BP2-8	5
152	10	500	10/03/2025	BP2-6	5
179	10	500	16/03/2025	BP2-4	5

Table 9.4: Summary of water samples collected for microplastic analysis during SD046 science cruise

9.5 POM sampling for stable isotope analysis $\delta^{13}C$ and $\delta^{15}N$

Authors: Gabriele Stowasser, Fadhili Malesa, Emily Rowlands, Joana Fragão

In order to establish an isotopic baseline for POM across the Atlantic sector of the Southern Ocean particulate organic matter (POM) was collected at the Western and Eastern Core Box Mooring stations, on-shelf and off-shelf in the Western Core BOX, along the A23 transect, in the Weddell Sea (Biopole Stations), and in the South Orkney Passage. POM samples were obtained through filtering waters collected by Niskin bottles deployed via a CTD rosette. From the CTD, water was taken from various depths at each station (see Table 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 9.5.1: POM samples collected for $\delta^{13}C$ and $\delta^{15}N$ stable isotope analysis on SD046

Station	Event	sample depths
P3	27	10m, Chlmax (35m), 75m, 125m, 200m, 400m, 750m, Bottom (3795m)
WCB 2.2N	44	10m, Chlmax (15m), 75m, 200m, 500m, 750m
WCB Mooring	51	10m, Chlmax (20m), 75m, 125m, 200m, Bottom (288m)
ECB Mooring	63	10m, Chlmax (15m), 75m, 125m, 200m, Bottom (260m)
A23-51	72	10m, Chlmax (50m), 125m, 200m
A23-47	77	10m, Chlmax (30m), 75m, 125m, 200m, 500m, 750m
A23-44	79	10m, Chlmax (20m)
South Sandwich Trench	85	10m, Chlmax (20m), 75m, 125m, 200m, 500m, 750m, 2000m
A23-25	87	10m, Chlmax (66m)
A23-27	88	10m, Chlmax (65m)
A23-29	90	10m, Chlmax (50m), 75m, 125m, 200m, 500m, 750m
A23-31	91	10m, Chlmax (50m)
A23-33	94	10m, Chlmax (75m), 125m, 200m, 500m, 750m
A23-35	95	10m, Chlmax (60m)

A23-40	101	10m, Chlmax (20m)
B2_3 South Orkney's Trench	108	10m, 75m, Chlmax (85m), 125m, 200m, 400m, 750m
B2_7 BIOPOLE Mooring	123	10m, 25m, 75m, Chlmax (20m), 125m, 200m, 400m, 750m
B2_8	127	10m, Chlmax (20m), 75m, 125m, 200m, 400m, 750m
B2_6	152	10m, Chlmax (45m), 125m, 200m, 400m (bottle for 750m did not fire)
M2 Mooring	159	10m, Chlmax (20m), 75m, 125m, 200m, 750m
B2_4	179	10m, Chlmax (50m), 75m, 125m, 200m, 400m, 750m
OP_1	189	10m, Chlmax (50m)
B2_1	198	10m, Chlmax (50m), 75m, 125m, 200m, 400m, 750m
Iceberg A23a Run-up to P3		Underway clean seawater supply (7m). Sample numbers: 1-12
Iceberg A23a Transect from P3 and around iceberg		Underway clean seawater supply (7m). Sample numbers: 13-26
A23a_SW2	207	10m, Chlmax (50m), 75m, 125m, 200m, 400m, 750m
A23a_Fjord	208	10m, 75m, 125m, 200m, 400m, 750m (no Chlmax detected)
A23a_SE0	211	10m, Chlmax (20m), 75m, 125m, 200m, 400m, 750m
A23a_SE2	212	10m, Chlmax (20m), 75m, 125m, 200m, 400m, 750m
A23a_Shelf	213	10m, Chlmax (20m), 75m, 125m, 200m, Bottom (212m)
A23a_Shelf	216	10m, 20m, 75m, 125m, Bottom (210m), (no Chlmax detected)
A23a Iceberg piece	210	surface

10. Zooplankton

10.1 Zooplankton Community

Authors: Nadine Johnston, Gabriele Stowasser, Ryan Saunders, Jen Freer, Geraint Tarling, Sophie Fielding (BAS), Dan Mayor, Kathryn Cook, Elodie Jacobs, Fadhili Malesa (University of Exeter), Matt Hood, Simon Wright (AME, BAS)

Objectives

To determine dynamics (community composition, distribution, and abundance) of the late season (autumn) mesozooplankton community, particularly the copepod Calanoides acutus, and their relationships with oceanography and nutrient dynamics.

BIOPOLE is seeking to understand the community composition, distribution (vertical and horizontal) and abundance of the zooplankton community and the proportion of the copepod *C. acutus* within it. 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 respiration experiments (collected from the upper water column (200-0 m) and also from depth (up to 2,000 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 benthic communities, nutrient recycling, and carbon sequestration. This cruise focused on the zooplankton community during late season, autumn and complements work carried out on SD033 (BIOPOLE I) during the spring.

Sampling

The zooplankton community was examined through a combination of Bongo, and Mammoth net deployments within the Western Core Box Stations, along the A23 Transect and the BIOPOLE Megastations and Gigastations.

Trial station: See Sampling Overview Chapter 3 - Nets for the location of the trial stations for the Bongo and Mammoth net deployments.

Sampling stations: See Sampling Overview Chapter 3- Nets for a list of sampling stations

After completion of Bongo and Mammoth net deployments, each net was examined for live copepod samples, which were picked for CHNTO and lipid analyses.

Core requirements of Bongo and Mammoth netting deployments for zooplankton community analyses included:

- Trailing of Bongo and Mammoth before arriving at stations
- Bongo and Mammoth deployed every day for zooplankton community analyses, preferably during daylight hours

- Deployed of Mammoth nets to a depth of >/=1200m (to allow for lock pressure depth of 1,100m), and to a maximum of 2000m (plus lock pressure depth).

Bongo netting:

To determine the composition of mesozooplankton community (including copepods) in the upper layers of the study site, a Bongo net containing a spring-tensioned motion compensation unit was deployed at various stations along the cruise transect. In general, 2 deployments were made per station for one sample to be preserved and the remainder to be sampled for copepods for physiology experiment. The first Bongo sample was generally picked, and the second preserved complete in 4% formaldehyde for further taxonomic analyses in the UK. See Chapter 3- Nets for full details of sampling sites and analyses.

Mammoth netting:

To determine the composition of mesozooplankton community (including copepods across discrete depth layers in the study area, a HydroBios MAMMOTH multinet was deployed at various stations along the cruise transect. After a trial deployment to 250m, the MAMMOTH was deployed to 1500m at all further stations, and 2,000m on the final station. Samples from shallow and deep nets were sampled for copepod respiration experiments (see Chapter 10 Zooplankton Respiration Direct for further details). For all nets, where possible, 10 representatives of each developmental stage of *C. acutus*, (i.e. CIII, CIV, CV, females) were picked for CHNT0 (then photographed, stored in tin capsules within microwell plates which were then dried at 50 C for 4hrs and stored at +4 C) and 15 samples of CV for lipids (5 per vial, stored at -80 C). The remainder of all the net samples were then preserved in 4% formaldehyde for future taxonomic analysis of community composition back in the UK. A record was kept of ALL specimens extracted from the mammoth catches (including individual copepod stages, and the weight of any Atolla or Periphylla taken) and placed both on the sample label within the sample bottles, and recorded in a separate logbook by NMJ. NOTE: Send taxonomist a copy of all picked samples in an excel spreadsheet when back in Cambridge so there is absolutely no confusion over what was taken from each net. See Chapter 3- Nets for full details of sampling sites and analyses.

10.2 Macrozooplankton – Western Core Box

Authors: Gabriele Stowasser, Ryan Saunders, Sophie Fielding, Fadhili Malesa, Joana Fragao, Nadine Johnston, Geraint Tarling.

Gear

The RMT8 was used to characterise the macrozooplankton community in the Western Corebox (WCB) in 200m oblique trawls and target trawls. Target trawls were undertaken on krill swarms identified from the EK80. In oblique trawls net 1 was opened near the surface (10-20m) and the net deployed to 200m (where water depth was sufficient) before closing and net 2 opened at 200m depth and closed near the surface (10-20m). The choice of deployment type depended on the task. Target hauls were made to supply the WCB team with *Euphausia superba* (Antarctic krill) for length frequency measurements and the collection of legacy samples for future scientific projects. Joana Fragao (PhD, University of Coimbra, Portugal) sampled krill and myctophid fish specimens for a study on the transfer of microplastics across the Southern Ocean. Krill, fish and other invertebrates were furthermore sampled for energetics (Fadhili Malesa, PhD, British Antarctic Survey). Oblique trawls within the Western Core Box were only undertaken at the CTD positions. All RMT8 hauls are listed in Table 3.4.4.1 (Chapter 3)

Catch sorting and processing

Oblique hauls WCB

For the oblique hauls the total catch of net 2 (200m – surface) was sorted and quantified. Numbers caught and total weight were obtained for each species. For some groups species specific identification was not possible and identification will be verified through re-examination in the laboratory. All material collected in net 1 (surface – 200m) was preserved in 4% formalin. All data were recorded in an Excel database.

Targeted hauls

The catch of targeted hauls was sorted and quantified. In hauls, where sufficient numbers of *E. superba* were caught, length-frequency data was collected (see chapter on krill length frequency, Fadhili Malesa and Sophie Fielding, BAS). Krill total length was measured on 100 fresh krill, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest mm (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described by Morris et al. (1988).

10.3 Zooplankton activity: spatial and vertical comparisons in *Calanoides acutus*

Author: Jen Freer, BAS

Introduction

Diapausing copepods can be expected to show differences in swimming behaviour and oxygen consumption compared to non-diapausing copepods. This was shown to the case in the North Atlantic species *Calanus finmarchicus* (Grigor, Freer et al. 2022) but has not yet been studied for any Southern Ocean copepod. Here we use Locomotor Activity Monitors (LAMs) to study the activity of *Calanoides acutus*, a diapausing Antarctic copepod, that we sampled from both mesopelagic and epipelagic depths and across a wide range of latitudes. Ultimately the data collected from monitoring copepod activity will help us to determine if *C. acutus* were or were not in diapause at the depths sampled during SD046.

Methodology

Sample collection

The activity of the calanoid copepod *Calanoides acutus* (CIV-CVI) was measured using Locomotor Activity Monitors (LAMs; TriKinetics Ltd.). Activity measurements using LAMs yield activity as a proxy for swimming, quantified as the number of beam breaks across the experimental chamber per specified unit of time. Each monitor can hold up to 32 animals enclosed inside small acrylic tubes. At each sampled station, copepods were collected from bongo and MAMMOTH net deployments (see Table 10.3.1 for list of stations and event numbers). From bongo nets, typically the catch from the 200um mesh net was used. From MAMMOTH nets, the catch from one shallow (<200m) and one deep (>500m) net was used.

On deck, cod ends were placed in buckets and immediately covered with black rubble sacks. Buckets were either taken directly to the dark lab for sorting, or else placed in CT1. If the latter, cod ends were assessed under red light to select which stratified sample to take to the dark lab.

Incubation set-up and post processing

Sorting, identifying and preparation of the incubations took place under red light in the dark lab. Copepods were placed in individual 5ml acrylic tubes pre-filled with 0.2µm filtered seawater (using surface seawater from the same station as net deployments). To keep samples cool while working in the dark lab, the sample bucket and glass tubes were placed on trays of ice. A chiller-system with chilled petri dish was used to keep samples at ambient SST while under the microscope (see Fig X for dark lab set up). When all tubes were occupied, tubes were transported to CT2 (under a black rubble sack) and placed within one of the prepared LAMs.

LAMs were then incubated within a large ESKI box in CT2 (at the aft end of the room to minimize noise from fans) with activity monitored at 10 second intervals via TriKinetics software (See Figs 10.3.1 and 10.3.2 for incubation set up). The lid of the ESKI box

remained ajar to maintain circulation of cold air, however the LAMs were covered in black rubble sacks to maintain darkness. Tinytag temperature loggers were placed both inside and outside the ESKI box. Incubations were stopped after 72 hours, and individual copepods that remained in good condition were photographed for prosome area (i.e. body size) and lipid sac area. Species, stage and photo ID were recorded. Approximately half of the samples were placed in eppendorfs and stored at -80 for subsequent genetic analysis. The other half were placed within pre-weighed tin capsules and dried at 50 degrees C for subsequent CHN analysis.

Outcomes

A total of nine incubations were run from eight sampling stations taken from 13 net events (Table 10.3.1). A total of 787 *C. acutus* were collected, comprising mostly of stage CV copepodites, with fewer younger and mature females collected from surface and deep nets, respectively. Approximately 70% of copepods incubated survived the 72 hours and remained in good enough condition to retain for future analysis in either cool (+4°C) or frozen (-80°C) store (Table 10.3.1).

Table 10.3.1 Summary of *C. acutus* activity experiments

Date	Event	Station	Net type	Net depth (m)	Total picked	*C. acutus* stage				Kept for analysis	
						CIII-IV	CV	CVIf	Unknown/ Loss	+4°C	-80°C
15/02/2025	29	P3	MOCNESS	875-1000	47		22		25	14	8
15/02/2025	32		BONGO	0-200	48		43		5	21	22
21/02/2025	69	A23 transit	BONGO	0-200	80		71		9	34	37
23/02/2025	82	A23-44	BONGO	0-200	91		82		9	42	40
03/03/2025	105	BP2_3	BONGO	0-200	50	11	2		37	0	13
08/03/2025	131	BP2_8	BONGO	0-200	6		2	1	3	0	3
	134		MAMMOTH	750-1000	29		13	7	9	0	20
				125-250	5				5	0	0
	135		MAMMOTH	750-1000	43		11	14	18	25	0
				125-250	2		1		1	1	0
10/03/2025	148	BP2_6	MAMMOTH	500-625	43		10	28	5	23	15
				125-250	38		16	18	4	15	19
	151		BONGO	0-200	2		1	1	0	2	0
16/03/2025	175	BP2_4	MAMMOTH	625-700	62		11	49	2	30	30
				125-250	62	24	16		22	17	23
18/03/2025	188	BP2_3	MAMMOTH	750-1000	20		6	14	18	2	0
				125-250	66	14	19	5	46	20	0
22/03/2025	203	P3	BONGO	0-200	93	4	79		10	52	31
TOTAL					**787**	**53**	**405**	**137**	**228**	**298**	**261**

Fig 10.3.1 Dark lab set up for *C. acutus* activity experiments

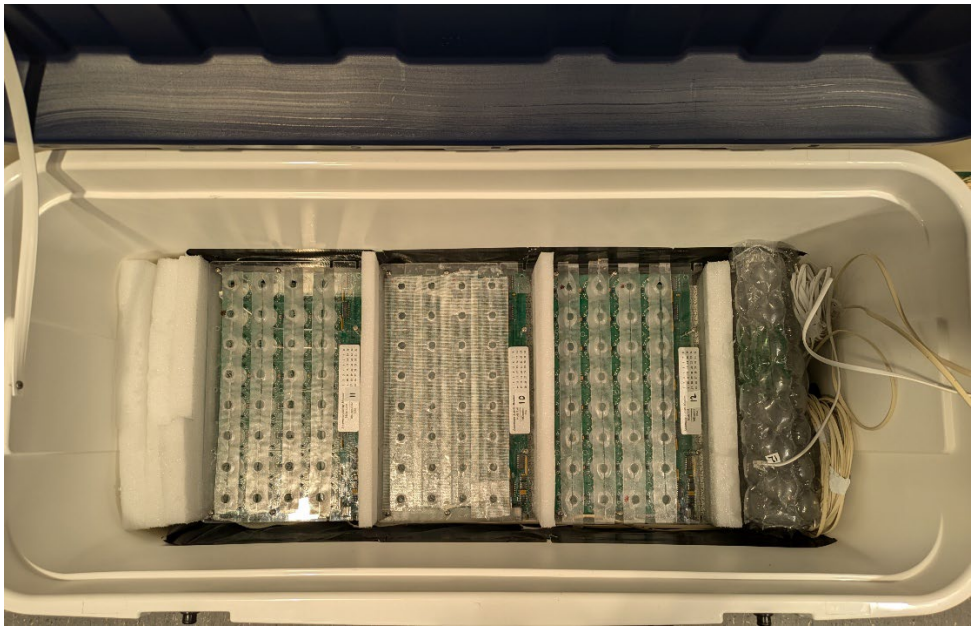


Fig 10.3.2 An example LAM incubation set up for *C. acutus* activity experiments.

Recommendations

High wind and/or swell conditions can influence the activity monitor data collection if LAMs were not fully secured within the ESKI box. We recommend using anti slip matting on the feet of each monitor

and arranging the monitors in such a way as to prevent any movement (e.g. with foam padding as shown Figure 10.3.2). Alternative methods, such as building a gimble for each monitor may also be required. Extracting maximum and averaged heave, roll and pitch data from the ship Grafana system (Position and Attitude) at 30 minute intervals during the incubation period also proved useful to check for unintended movement following rough sea conditions.

High mortality rates of copepods after incubation were often associated with condition of the catch on arrival on deck. Efforts to improve sample quality would help towards LAMs being used more efficiently in the future.

The temperature in CT2 lab often fluctuated between 3-5°C, with some infrequent and short periods at higher temperatures, though this was dampened somewhat by the containing LAMs within the ESKI box. Efforts to reduce this variability would improve incubation conditions, or alternatively, future incubations can be carried out within incubators with precision temperatures.

References

Grigor JJ, Freer JJ, Tarling GA, Cohen JH, Last KS (2022) Swimming Activity as an Indicator of Seasonal Diapause in the Copepod Calanus finmarchicus. Frontiers in Marine Science, 9

10.4 Copepod experiments: Direct respiration

Author: Nadine Johnston

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 (SD033) 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 this cruise (SD046) focussed on respiration experiments during 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 reliably at < or = 0°C). Once fridges had settled, 3x PreSens SensorVials and Sensor Dish Readers (SDRs) (see Figure 10.4.2) 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 Chapter 3 – Nets, from Bongos (0-200m) and various Mammoths nets (from 2000-05m) (see Figure 10.4.1). 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, or alternative developmental stages if CVs were not available. For each station, where possible 15x specimens were immediately collected for lipid analyes, 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). SensorVials were washed with milliQ inbetween experiments, and with

ethanol a number of times throughout the cruise to remove the possibility of contamination (and rinsed several times thereafter with millliQ).

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 of CIVs. Nets from the deeper layers of the water column from mammoth nets at all stations were dominated by females, with very few CVs. At the deepest mammoth station (2,000m) however, the deep nets were dominated by CVs. For this reason, respiration experiments were conducted on a range of developmental stages from the Bongo net samples and a range of mammoth nets. 2) Females were significantly larger in body size and lipid sac. There was a proliferation of CVs in the Bongo net at the A23a Shelf station. Samples of *C. acutus* copepods from mammoth nets at all stations were of a similar abundance to BIOPOLE I, however not in as good a physical condition, possibly owing to the rougher water conditions during net deployments at this time of year. The CVs and females collected from the deep nets were very inactive, compared with those collected from shallower nets, possibly reflecting the proximity to diapause for the former. 3) Check correct event numbers for '40', '140' (bongo) and 194 (should be 195) (mammoth).

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 10.4.3). For details of sample stations see Chapter 3 - Nets.

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. CIIIs were encountered rarely.

Lipid Analyses

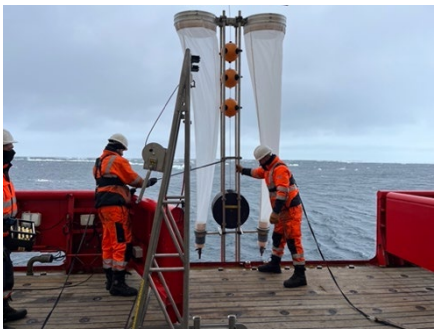
Rationale: *C. acutus* contain lipid sacs as an energy store, potentially to allow successful overwintering. This sac will comprise a varying amount of C and lipid within an individual depending on its proportional size. Specimens were collected to measure the amount of lipid per individual to complement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

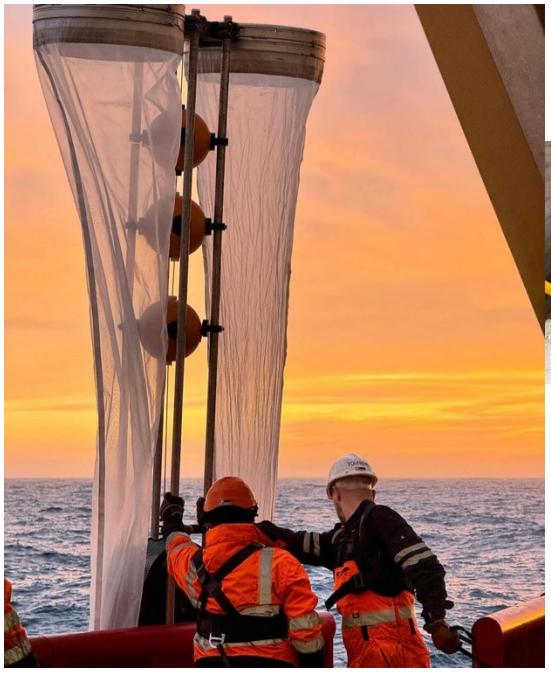
amounts can be related to visual analyses of individual photographs from which a number of dimensions can be measured.

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 Chapter 3 - Nets.

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. Eppindorfs are not a space efficient way of storing samples. Lipid samples were only collected from 2 stations and stored in epindors. Dan Mayor and Kathryn Cooke preserved lipids thereafter in cryovials (so as to avoid contamination from plastic epindorfs). Sample vials of previous BIOPOLE lipid samples must therefore be reviewed when back in Cambridge.

Figure 10.4.1. Collection of *Calanoides acutus* and mesozooplankton samples on SD046 using Bongo (top, - centre image courtesy Dan Mayor https://www.instagram.com/oceanplankton, note purpose-built frame designed by Thomas Gillum-Webb) and Mammoth nets (bottom).





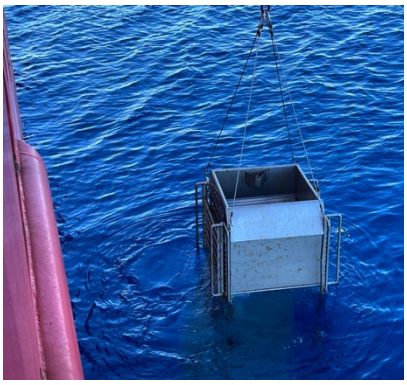


Figure 10.4.2. Respiration experiment set up on *Calanoides acutus* using SensorVials and SDRs on SD046

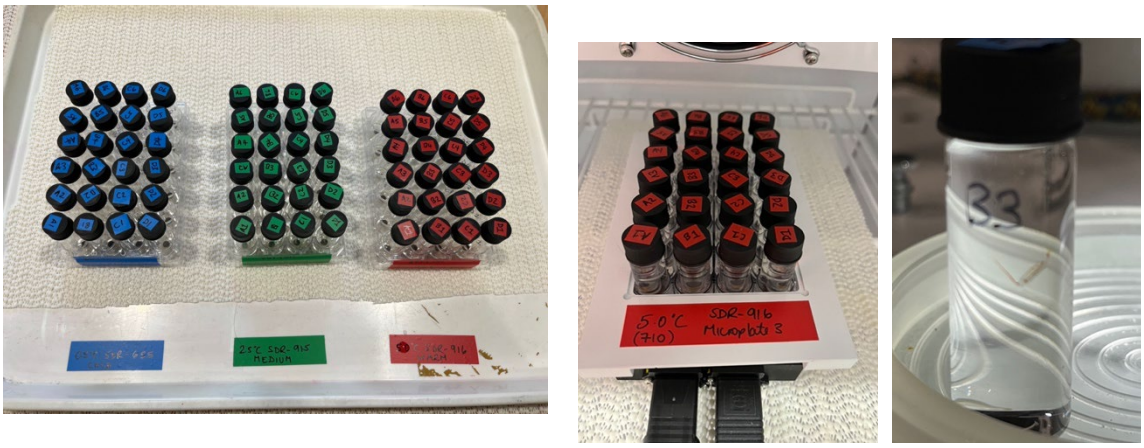


Figure 10.4.3. *Calanoides acutus* stage CV pictured in a calibrated rimmed petri under an Olympus SZX Light microscope using a Canon 60D camera.

10.5 Environmental DNA (eDNA)

Author: Jasmine (Zhengxin) Yang, University of Bristol

Introduction

Diel vertical migration (DVM) by myctophid fishes plays a critical role in the Southern Ocean ecosystem (Saba *et al.*, 2021). However, existing survey methods, namely net trawl catch and acoustic method, have limited capacity to observe their DVM pattern (Kaartvedt *et al*., 2012; Dornan *et al*., 2022*)*. Myctophid fish readily avoid nets, which is especially prominent in the daytime when visibility is high, making it difficult to assess whether a low net catch is due to DVM or net avoidance (Collins *et al.*, 2008). While acoustic methods are not limited by net avoidance, it has difficulty discerning fishes from other organisms and cannot identify individuals to a species level (Dornan *et al.*, 2022). Recently, Allan et al. (2021) have shown that environmental DNA (eDNA) may be used to detect the DVM pattern of myctophid fishes. This is a technique that involves analysing trace DNA in the environment released by organisms through mucus, faeces, skin cells etc. Recent advancements have made it possible to infer not only the identity but also the abundance of each species from the quantity of the eDNA (Rourke *et al.*, 2022). Here, I will collect eDNA from water of different depths and times to study the DVM pattern of myctophid fishes.

Methodology

Sampling location

Water samples were collected from 4 regions: WCB, A23, BIOPOLE and A23a. Of which, DVM was analysed at WCB and BIOPOLE, where water was collected at four depths at each sampling station: chlorophyll max, 200m, 500m and 1000m. For WCB, samples were taken at all four northern (offshore) stations, and two samples were taken at P3 at daytime and dawn respectively. For BIOPOLE, four stations were chosen that allowed repeated daytime and nighttime sampling from the same location, though in some cases the repeat sampling did not happen at exactly the same position. A23 was sampled to study the latitudinal differences in species composition so only water from 100m and 1000m depth were collected to compare shallow and deep-dwelling species. Five stations were chosen across the A23 transect with an additional station sampled at the South Sandwich Trench mooring site. Opportunistic samples were taken around A23a (giant iceberg) from two sites: 200m at the fjord and 50m and bottom water from the northern ‘benthic’ site (shelf region). In addition to my own study, eDNA samples were taken for Katrin Linse (benthic team) at three shallow stations in the WCB and bottom waters from the four BIOPOLE stations. A surface sample (10m) was taken from all of the above stations for Mar Benavides (NOC) to study the composition of nitrogen-fixing phytoplankton. A total of 105 samples were collected (excluding negative control), of which 72 were for myself, 10 for Katrin and 23 for Mar. The sampling location, depth and time are summarised in table 10.5.1.

Water collection and filtering

Water was collected from the CTD using 2L Nalgene rectangular PE bottles (figure 10.5.1). A prefilter was used to prevent larger particles from entering the bottle, which consisted of a modified 250ml circular PE Nalgene bottle lined with 200um mesh (figure 10.5.2). For each sampling depth, 6 bottles of Nalgene bottles were filled to obtain triplicates of 4L samples (12L in total). The only exception to this is the surface sample for Mar, which only consisted of one replicate of a 2L sample. The bottles were then stored in the fridge until filtering and were typically filtered within 3h from collection.

The water was filtered through a Millipore 0.22 um Sterivex pressure filter (Merck; SVGP01050) to collect the DNA using a peristaltic pump. Three pumps were brought on the cruise: two from the University of Bristol (Watson Marlow Sci-Q 323 series drive with 313 DW roller head; Cole Palmer Masterflex peristaltic pump with an Easyload II roller model 77200-69) and one from BAS (Cole Palmer Masterflex peristaltic pump with an Easyload II roller model 77200-62). Because the BAS roller required 24” sized silicone tubing (L/S 6437-24: 6.4mm inner diameter), which was too wide to be connected to the Sterivex filter, the tubing had to be extended with a 25” sized tubing (figure 10.5.4; Fisher brand 10335111: 4.8mm inner diameter). The 25” sized tubing was directly used on the university pumps. Water was pumped by attaching the tubing to the Sterivex filter on one end and the other end inserted into the Nalgene bottle (figure 10.5.3). Another Nalgene bottle was placed underneath the filter to catch the filtered water. Since this catchment bottle was in contact with the filter, a new bottle was used for each sample from different depths to avoid contamination. Water was pumped at a speed of ~180ml/min, which roughly took 20min to filter through 4L on the university pumps and 30min on the BAS pump. Cable ties had to be used to secure the tubing to the filter on the university pumps (figure 10.5.3). Once the 4L of water was pumped, the pump was left to run for another 5min to remove residual water from the filter, though some water still persisted after the drying period (figure 10.5.5). Extending the drying to 10min made no difference. The start and end times of pumping were recorded for every 2L of water passed. The same tubing was used to pump all triplicates, and the tubing was changed between samples from different depths.

Once the pumping was completed, the narrow end of the filter was sealed with flame by heating the tip with a lighter and pressing it against a hard surface. 1mL of RNAlater was added to the filter as preservatives using a 1mL syringe inserted through the wider end of the filter. The end was then sealed with a combi stopper. In later samples when I ran out of syringes, the RNAlater was put into a contact lens solution bottle and dripped into the filter through the wider end without touching the filter itself. All triplicate filters were placed in the same whirl pack with a label showing sample ID, date and time, event number, Niskin bottle number and whether negative samples were taken (figure 10.5.6). The samples were then stored in the fridge overnight to allow the RNAlater to saturate the filter before being moved to the -80°C freezer. Samples for Mar were treated differently with no RNAlater added and the filter ends unsealed. These filters were given to Amanda Burson for flash-freezing in liquid nitrogen.

A negative sample (blank control) was taken at almost every sampling station (table 10.5.1), roughly corresponding to every 5 samples (every 15 Sterivex filters). This involved using the same pre-filter and tubing to collect and pump milliQ water as the chlorophyll max layer samples (or 100m in the case of A23 and 50m in A23a). The equipment was always used on negative samples first. The negative control filter was stored in its own whirl pack.

All equipment (Nalgene bottles, pre-filter, and tubing) were soaked in 2% domestic bleach (Girando SOL; roughly 15L in the bleach bath) for 1h between use, followed by rinsing in

milliQ water bath and a final rinse under the milliQ tap. A water bath was used to avoid discarding rinsed bleach into the tap and the water was changed once during WCB, once after WCB and once after A23. For the tubing, it was pumped with 1L of bleach followed by 1L of milliQ to clean the interior of the tube after the bleach soak (figure 10.5.7). All lab surfaces and interior of the fridge were wiped with bleach between each sampling station. PPE, including nitrile gloves and hair cover (shower cap), was worn at all times. A separate lab coat was worn inside the lab and on deck during water collection from CTD. These lab coats were never worn outside their designated location to avoid contamination from biological samples from other labs.

All Sterivex samples (except those for Mar and part of the Katrin sample) will be taken back to the University of Bristol for DNA extraction, sequencing and quantification. These samples were taken by the MOD flight straight back to the UK with the sample covered by ice packs during transit.

Recommendations

1. The most time-consuming part of the protocol was the bleach bath. Only 4 Nalgene bottles could fit into the bleach bath at one time so at least 6h was needed to clean all bottles used at a DVM station. It is recommended to bring at least one more bleach bath to allow for more bottles to be cleaned simultaneously.
2. Water collection at CTD also took a long time due to the large volume that needed to be collected (up to 62L at BIOPOLE station). Part of the problem is that the small spigot was used in most of the Niskin bottles, so the flow rate was quite slow, though this was inevitable as the small spigot was required by the BGC team. Another problem is that the water was collected 2L at a time, which fills quite quickly individually, so the Nalgene bottle had to be supervised at all times and water couldn't be collected from multiple depths simultaneously. It may help in future to have larger bottles that can be filled with tubing and left unattended. The physics team often helped with sampling which allowed water collection from multiple depths at once and helped to speed up the process.
3. The door to the General Purpose lab leading from Park Avenue doesn't hold open by itself, which made it difficult to go through when carrying multiple bottles back from the CTD.
4. Filtering time could be shortened by having additional rollers stacked onto the peristaltic pump to allow simultaneous filtering.

Table 10.5.1 A summary of the sampling station, event number, date and time, sampling depth, and whether a negative control was taken. The colour in the depth column indicates who the samples were for (black: myself, blue: Katrin, red: Mar) with bold indicating the depth for which the negative control equipment was used for. Please refer to the PDF file (eDNA sample sheet.pdf) for a detailed log of the samples.

Station	Event#	Date	Time	Depth	Negative control
ECB	25	13/02/25	Dusk	10, 50, bottom	
P3	27	14/02/25	Day	10, **chl max**, 200, 500, 1000	Y
WCB1.2Nst	37	15/02/25	Night	10, **chl max**, 200, 500, 1000	Y
WCB1.2Sst	39	16/02/25	Dawn	10, **50**, bottom	Y
WCB2.2Sst	41	16/02/25	Night	10	
WCB2.2Nst	44	17/02/25	Dawn	10, **chl max**, 200, 500, 750	Y
WCB4.2Sst	55	19/02/25	Dawn	10, **chl max**, bottom	Y
WCB3.2Nst	56	19/02/25	Day	10, **chl max**, 200, 500, 1000	Y
WCB4.2Nst	58	19/02/25	Day	**Chl max**, 200, 500, 1000	Y
A23-51	72	21/02/25	Day	10, **100**, 1000	Y
A23-45	78	22/02/25	Dusk	10, 100, 1000	
SSTC	84	25/02/25	Night	10, **200**, 1000	Y
A23-25	87	26/02/25	Day	10, 100, 1000	
A23-31	91	27/02/25	Day	10, **100**, 1000	Y
A23-39	98	28/02/25	Night	10, 100, 1000	
BP2_3	108	03/03/25	Dawn	Bottom	
OP2	114	04/03/25	Night	10, **chl max**, 200, 500, 1000	Y
OP5	118	04/03/25	Day	10, **chl max**, 200, 500, 1000	Y
BP2_8	127	07/03/25	Night	10, **chl max**, 200, 500, 1000, bottom	Y
BP2_8	142	08/03/25	Dusk	10, **chl max**, 200, 500, 1000	Y
BP2_6	149	10/03/25	Dawn	**Chl max**, 200, 500, 1000	Y
BP2_6	152	10/03/25	Day	10, **chl max**, 200, 500, 1000, bottom	Y
M2	159	11/03/25	Day	10, **chl max**, 200, 500, 1000	Y
BP2_4	183	16/03/25	Night	10, **chl max**, 200, 500, 1000, bottom	Y
P3	205	22/03/25	Dawn	**Chl max**, 200, 500, 1000	Y
A23a_fjord	208	23/03/25	Day	10, 200	
A23a_benthic	216	24/03/25	Day	10, **50**, bottom	Y

Fig 10.5.1 Water collection from the CTD. Water was filled into the Nalgene bottle through the prefilter. There were 6 Nalgene bottles of 6 colours (blue, red, green, black, grey, white) marked by tapes (grey bottles in photo). Bottles of the same colour were used to sample one depth. Those with the same number of tape lines were treated as one sample (e.g. the two bottles in the photo with a single line of tape were used as replicate 1).

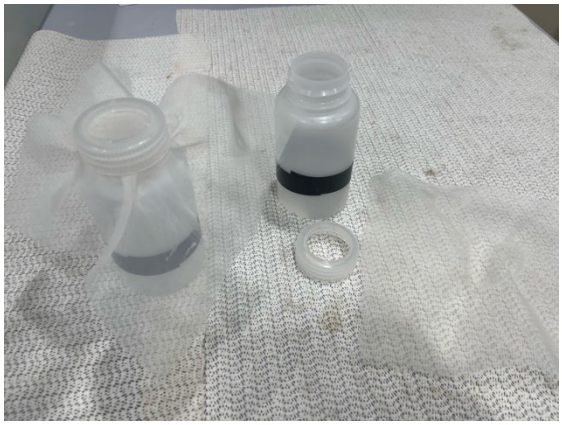


Fig 10.5.2 Prefilter setup. The base of the 250 ml circular PE Nalgene bottles was cut out and a hole drilled in the screw top lid. A 200 µm mesh was screwed tight beneath the lid, creating an improvised funnel. This was placed on top of the 2L bottle with the mouth side facing each other. Each prefilter bottle had a coloured tape corresponding to the Nalgene bottles and the same-coloured items were used together.

Fig 10.5.3 Filtration set up. Nalgene bottles with the CTD water were placed on the table with one end of the tubing inserted. The other end has the filter attached and was placed over another Nalgene bottle below the table (except the Cole Palmer pump that had both bottles on the table). The filter had to be secured to the tubing by a cable tie (2nd photo). Only cable ties <=3mm wide were flexible enough to fully wrap around the tubing (thicker cables left gaps between the cable and the tubing).

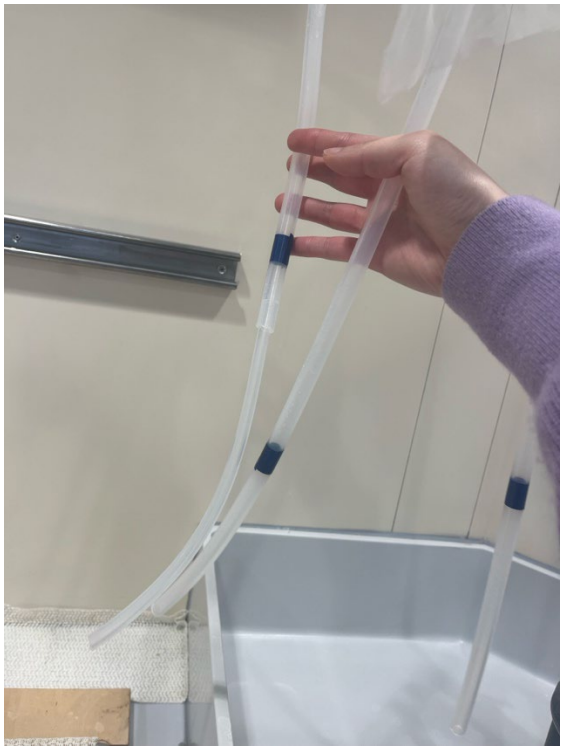


Fig 10.5.4 Extension of the tubing used on BAS pump. When in use at the pump, the joint between the two tubings had to be secured with cable ties to avoid the narrower tube from popping out.

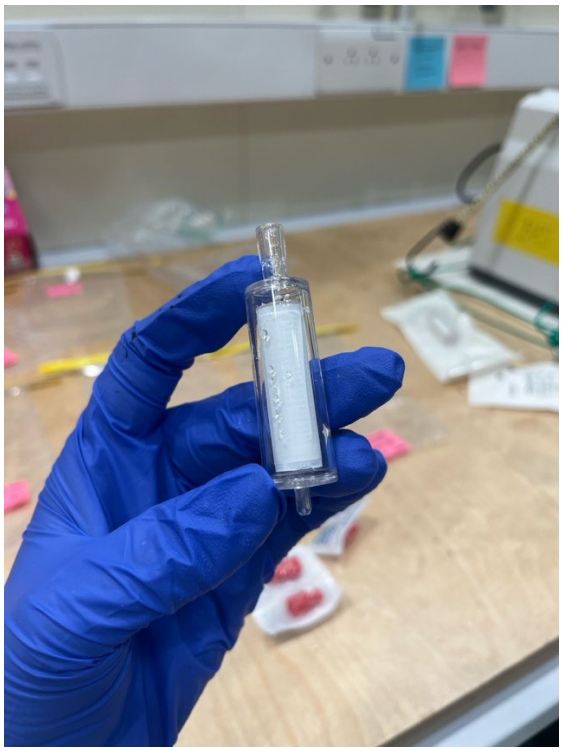


Fig 10.5.5 Some water droplets remained in the filter after the 5min drying pumping.

Interestingly, no droplets remained in those pumped by the BAS pump.

Fig 10.5.6 Samples packed in whirl pack (right: 3 replicates from one depth, left: a negative control sample).

Fig 10.5.7 Drying of the tubing and prefilter mesh. Nalgene bottles and prefilter bottles were placed on the table with the mouth side facing down to dry.

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10.6. Length–frequency distributions and maturity stages of Antarctic krill (*Euphausia superba*) in South Georgia.

Authors: Fadhili Malesa

Introduction

Antarctic krill (*Euphausia superba*) play a crucial role in the Southern Ocean ecosystem, serves as a key prey species for a variety of marine predators such as fish, seabirds, and marine mammals i.e seal and whales. One among the goal for BIOPOLE II was to understand and examine the growth and reproductive pattern of *E. superba* in the WCB and ECB region. Understanding the length frequency distributions is vital for analysing patterns, population dynamics, and the potential impacts of climate change. We collected the krill samples using RMT8, measured the length (mm) and identified the maturity stages for each haul type across different stations during SD046 BIOPOLE II research cruise.

Methodology

Sample collection

Krill samples were gathered using a Rectangular Midwater Trawl (RMT8), which has a mouth opening of eight square meters. The RMT8 was towed for approximately one hour, equipped with RMT 1 + 8 nets (8 m²: mesh size 4.5 mm; 1 m²: mesh size 300 mm) (Everson and Bone, 1986). When deployed from the RRS Sir *David Attenborough*, the RMT8 reached depths of 200 meters for various target haul types (oblique 0-200 m). This deployment was conducted efficiently and precisely, using acoustic data to guide the net towards specific krill swarm targets.

Length frequency and krill staging

Once on board, the cod ends were removed, and the nets were thoroughly washed in clean buckets to ensure that all collected samples were transferred. Initially, all samples were weighed and sorted by species. Each individual krill was then sexed and classified into one of the following stages: adult female (FA1, FA2, FA3, FA4, and FA5), adult male (MA1 and MA2), sub-adult female (FS), sub-adult male (MS1, MS2, M3), and juvenile (J) (Makarov and Denys (1984). Finally, body morphometric characteristics, including total length (mm) and wet mass (g), were measured following Makarov and Denys (1984) handbook.

Outcomes

Length Frequency and maturity stage distribution

The distribution of *E. superba* length frequency varies significantly among maturity stages. Juvenile and subadult male krill predominantly fall within a smaller size range (30–45 mm), while mature and spawning male and female exhibit larger body sizes (45–60 mm). The distributions of maturity stages collected across all stations showed significant variability with high proportion of juveniles and sub adult males across all stations.

Spatial variation of length frequency

Sampling stations, particularly those labelled as WCB2.2, WCB3.2 and ECB, show a higher frequency of mature and spawning *E. superba*. This suggests that these locations may serve as important spawning grounds or areas where environmental conditions favour reproductive activity. From the preliminary observation, the dominance of different maturity stages across sampling stations underscores the importance of localized environmental conditions in shaping krill population structure. These findings contribute to our understanding of *E. superba* population dynamics and can inform conservation and management strategies in the region.

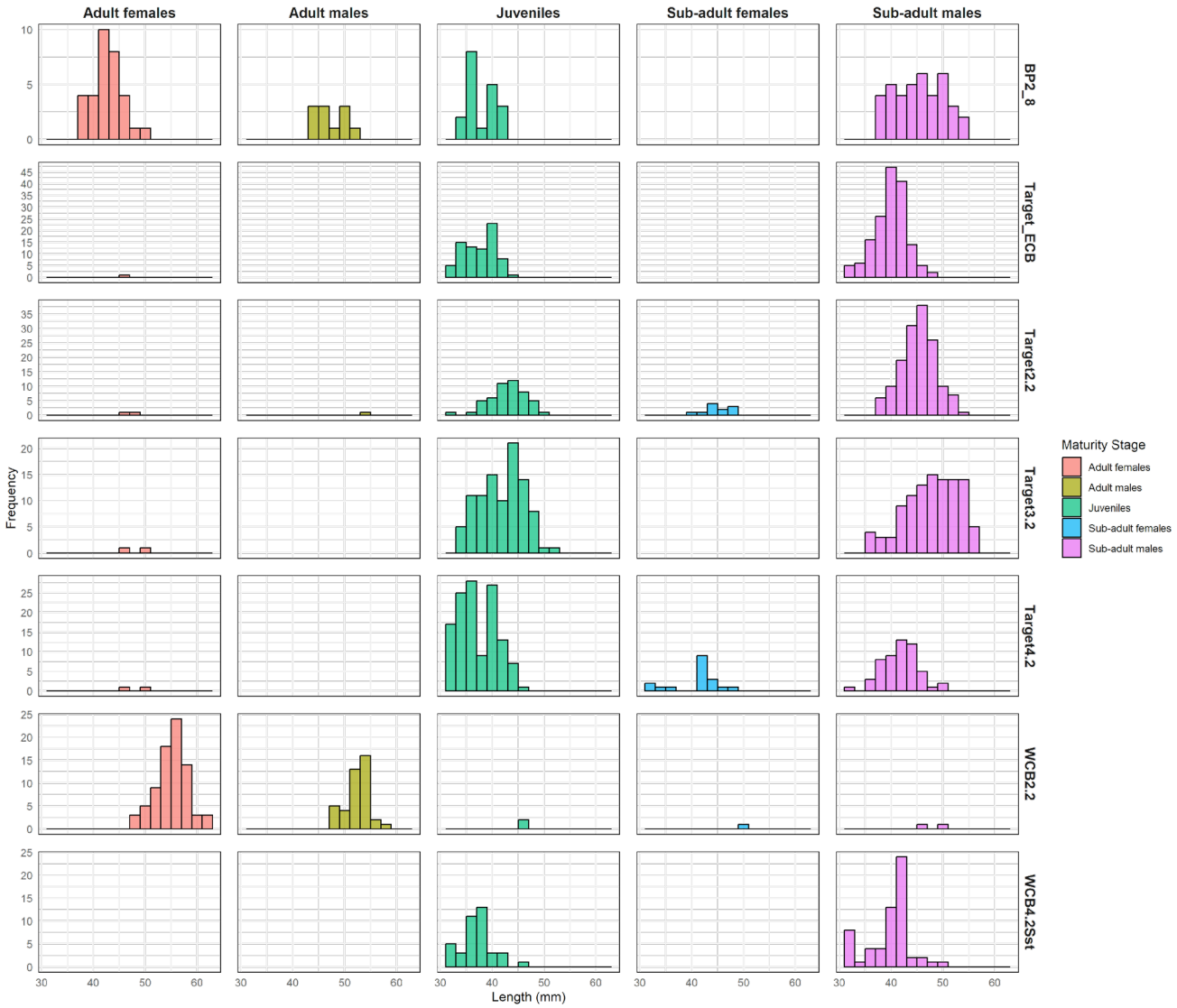

Figure 10.6.1: Shows the length-frequency distributions of Antarctic krill *E. superba* categorized by maturity stages across multiple sampling stations during SD046 BIPOLE II research cruise.

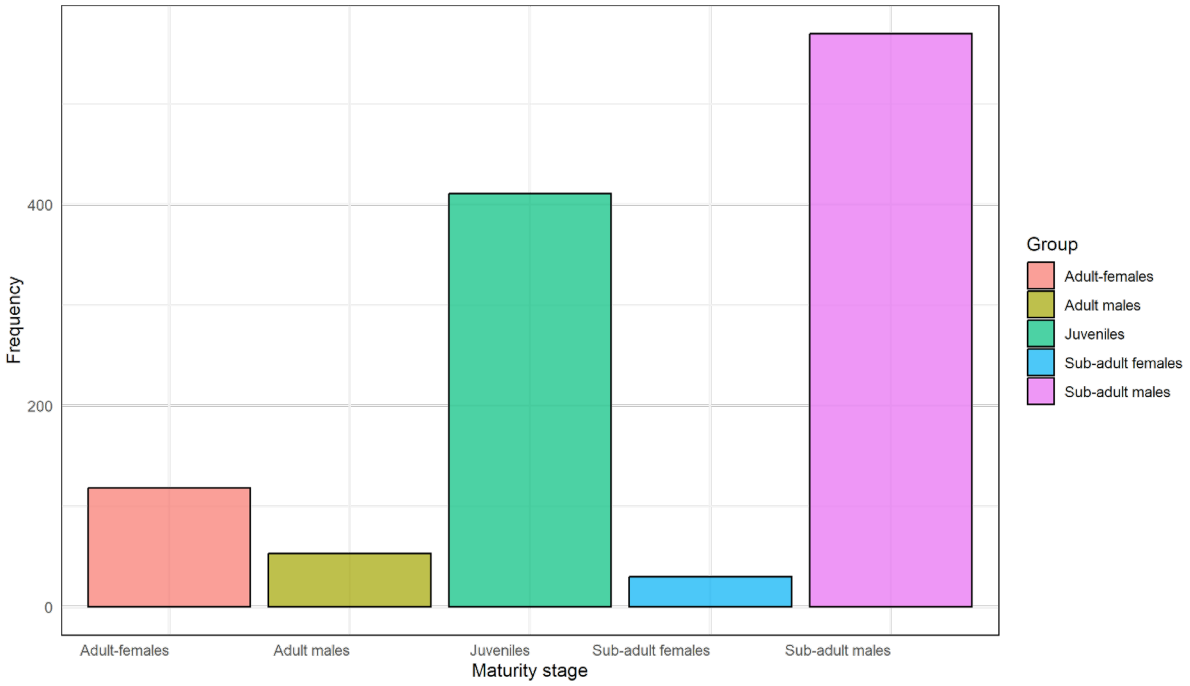

Fig 10.6.2. Bar chart of pulled length frequency of maturity stage identified regardless of the sampling stations.

Fig.10.6.3 Identification and length measurement of Antarctic krill *E. superba* during BIOPOLE II research cruise.

References

1. Cataldo-Mendez C, Kawaguchi S, Cox MJ, Melvin J, Rae V and Swadling KM (2024) The energy content and demographic composition of Antarctic krill (*Euphausia superba*) swarms in East Antarctica. *Front. Mar. Sci.* 11:1337080. doi: 10.3389/fmars.2024.1337080.

10.7 Plankton Energetics

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Introduction

To develop a dynamic ecosystem model that simulates the flow of energy through the Southern Ocean food web, it is essential to compile comprehensive data on biomass, production, consumption, and feeding relationships for various functional groups i.e phytoplankton, copepods, krill, fish etc (Hill *et al.,* 2012). These key parameters are fundamental for the Ecopath with Ecosim framework, a widely used Ecopath food web modelling framework (Christensen and Walters, 2004). Phytoplankton, being primary producers, form the foundation of the marine food web, and their energy content directly influences higher trophic levels. In addition, copepods, Antarctic krill (*Euphausia superba*), and myctophids fish populations are important in the Southern Ocean ecosystem; however, the amount of energy that contain is limited (Cataldo-Mendez *et al,* 2024) which bring uncertainty and inconsistencies in the data for exploring plausible modelling scenarios of change (Hill *et al.,* 2012). Our aim is to establish a comprehensive energetics dataset for top-predators prey, which will serve as a critical reference point for bioenergetic modelling efforts.

Methodology

Phytoplankton sampling and filtration

Phytoplankton samples were obtained by filtering chlorophyll maxima seawater collected using Niskin bottles mounted on a CTD rosette. From each CTD cast on the selected station, a total of 10 L of water was retrieved using two acid-washed polycarbonate carboys (5 L each), specifically from the chlorophyll maximum layer. All carboys were thoroughly rinsed twice with ambient seawater to minimize potential contamination prior collecting water from the Niskin bottle. Samples were then stored in a dark, -20 °C freezer until processing (Barnett et al., 2022). Prior to filtration onboard the SDA research vessel, all filter cups and holders were meticulously cleaned using Milli-Q water. Between successive samples, filtration equipment was rinsed with filtered seawater to prevent cross-contamination. Chlorophyll filtration was performed using a filtration apparatus equipped with glass/plastic filter cups and holders. For each sample, 1.5 L of whole seawater (>20 µm fraction) was filtered from a 5 L sample. A second set of 5 L was first pre-filtered through a <20 µm mesh before being processed using a filtration unit equipped with a GF/C filter (<20 µm fraction). The volume of water processed through the filters was recorded for each sample and documented in a log sheet. Once filtration was complete, filters were carefully removed using forceps rinsed in filtered seawater, folded in quarters, and placed in pre-labelled foil packets. These packets were then sealed in

a zipped bags and stored at -20 °C freezer for subsequent energetics analysis (see details of the collected samples in Table 1). Initially, the target filtration volume per sample was 2 L each; however, due to high organic matter content and time constraints for some station, the protocol was adjusted to process 1.5 L for whole sea water samples and 2 L for pre-filtered (<20 µm) samples.

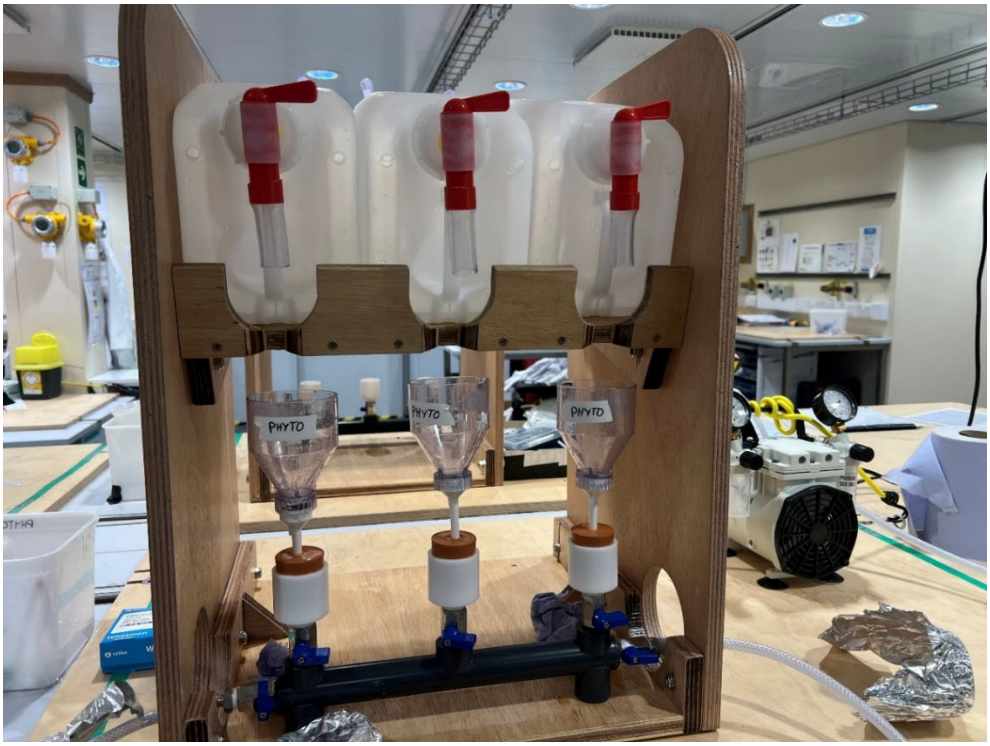

Fig 10.7.1. An example of phytoplankton filtration set up in the main lab SDA 046 BIOPOLE II research cruise.

Zooplankton Samples collection for energy content analysis

At each sampled station, copepods (*Calanoides acutus* and *Rhincalanus gigas*) were collected using Bongo, MOCNESS, and MAMMOTH net deployments (refer to Table 10.7.2 for a detailed list of stations and event numbers). Bongo nets is made up of 2 x 61 cm diameter metal rings, with one 200 µm mesh and one 100 µm mesh). For this study the samples were typically collected using the 200 µm mesh net, covering depths from 0 to 750 m. MAMMOTH nets provided samples from one shallow net (<200 m) and one deep net (>500 m). MOCNESS nets collected samples from depths ranging between 625 and 750 m. Overall, samples were collected from depths ranging from 0 to 750 m using Bongo (0-200 m), MOCNESS (625-750 m), and MAMMOTH (125-750 m) nets. At each deployment nets the cod ends were placed in 20L buckets and transported to the controlled temperature lab (CT 1) before processing. Copepods were removed using a fine mesh hand-held filter and examined under the microscope to select for *C. acutus* and *R. gigas* individuals. For each station, where possible 10x specimens were immediately collected for cleaned in filtered seawater, divided between 5x (2 ml) and transferred to Eppendorf tubes, sealed in a plastic bag, and stored at -80 °C in a 2L plastic container for further analysis in Cambridge.

Antarctic krill (*Euphausia superba*) and Myctophids fish samples collection

To detect krill swarms, active acoustic data were collected using a calibrated downward-facing split-beam echosounder (Simrad EK60) operating at 38 and 120 kHz. Krill samples were gathered using a Rectangular Midwater Trawl (RMT8), which has a mouth opening of eight square meters. The RMT8 was towed for approximately one hour, equipped with RMT 1 + 8 nets (8 m²: mesh size 4.5 mm; 1 m²: mesh size 300 mm) (Everson and Bone, 1986). When deployed from the RRS Sir *David Attenborough*, the RMT8 reached depths of 200 meters for various target haul types (oblique 0-200 m). This deployment was conducted efficiently and precisely, using acoustic data to guide the net towards specific krill swarm targets.

Once on board, the cod ends were removed, and the nets were thoroughly washed in clean buckets to ensure that all collected samples were transferred. Initially, all samples were weighed and sorted by species. Each individual krill was then sexed and classified into one of the following stages: adult female (FA1, FA2, FA3, FA4, and FA5), adult male (MA1 and MA2), sub-adult female (FS), sub-adult male (MS1, MS2, M3), and juvenile (J) (Makarov and Denys (1984). Finally, body morphometric characteristics, including total length (mm) and wet mass (g), were measured following Makarov and Denys (1984) handbook. In addition, *Euphausia triacantha*, *Themisto gaudichaudii, Salpa sp.* and Myctophids fish (Table 10.7.4) samples were sorted, and identified for further analysis using Martin Collins (2016) guide. All specimens were individually placed in sealed bags, snap-frozen in liquid nitrogen SDA deck lab, and stored at -80 °C freezer for further individual energy content analysis based on sex and maturity stages at BAS in Cambridge.

Outcomes

Table 10.7.1: Phytoplankton filter samples collected for Bomb calorimeter analysis on SD046.

Cruise	Date_Time	Event	Latitude	Longitude	Chlmax_ (m)	Label_GC_Filter	Filter_type	Water (L)	Station
SD046	06/03/2025 06:32	123	-60.8209	-48.1141	20	B11-550	whole	1.5	BP2_7
SD046	06/03/2025 06:32	123	-60.8209	-48.1141	20	B11-549	whole	1.5	BP2_7
SD046	06/03/2025 06:32	123	-60.8209	-48.1141	20	B11-4	<20µm	2	BP2_7
SD046	06/03/2025 06:32	123	-60.8209	-48.1141	20	B11-23	<20µm	2	BP2_7
SD046	07/03/2025 07:03	128	-62.0689	-50.4734	20	B11-32	whole	1.5	BP2_8
SD046	07/03/2025 07:03	128	-62.0689	-50.4734	20	B11-16	whole	1.5	BP2_8
SD046	07/03/2025 07:03	128	-62.0689	-50.4734	20	B11-546	<20µm	2	BP2_8
SD046	07/03/2025 07:03	128	-62.0689	-50.4734	20	B11-554	<20µm	2	BP2_8
SD046	10/03/2025 08:01	149	-61.9946	-47.0167	20	B11-21	whole	1.5	BP2_6
SD046	10/03/2025 08:01	149	-61.9946	-47.0167	20	B11-9	whole	1.5	BP2_6

SD046	10/03/2025 08:01	149	-61.9946	-47.0167	20	B11-13	<20µm	2	BP2_6
SD046	10/03/2025 08:01	149	-61.9946	-47.0167	20	B11-3	<20µm	2	BP2_6
SD046	11/03/2025 15:40	159	-62.6285	-43.2601	40	B11-20	whole	1.5	M2
SD046	11/03/2025 15:40	159	-62.6285	-43.2601	40	B11-16	whole	1.5	M2
SD046	11/03/2025 15:40	159	-62.6285	-43.2601	40	B11-25	<20µm	2	M2
SD046	11/03/2025 15:40	159	-62.6285	-43.2601	40	B11-27	<20µm	2	M2
SD046	14/03/2025 01:51	163	-63.5205	-41.7335	20	B11-14	whole	1.5	M3
SD046	14/03/2025 01:51	163	-63.5205	-41.7335	20	B11-548	whole	1.5	M3
SD046	14/03/2025 01:51	163	-63.5205	-41.7335	20	B11-551	<20µm	2	M3
SD046	14/03/2025 01:51	163	-63.5205	-41.7335	20	B11-33	<20µm	2	M3
SD046	16/03/2025 06:45	178	-62.0834	-41.9616	50	B11-553	whole	1.5	BP2_4
SD046	16/03/2025 06:45	178	-62.0834	-41.9616	50	B11-11	whole	1.5	BP2_4
SD046	16/03/2025 06:45	178	-62.0834	-41.9616	50	B11-7	<20µm	2	BP2_4
SD046	16/03/2025 06:45	178	-62.0834	-41.9616	50	B11-22	<20µm	2	BP2_4
SD046	19/03/2025 07:06	194	-60.5472	-40.6936	60	B11-28	whole	1.5	BP2_1
SD046	19/03/2025 07:06	194	-60.5472	-40.6936	60	B11-545	whole	1.5	BP2_1
SD046	19/03/2025 07:06	194	-60.5472	-40.6936	60	B11-34	<20µm	2	BP2_1
SD046	19/03/2025 07:06	194	-60.5472	-40.6936	60	B11-552	<20µm	2	BP2_1
SD046	22/03/2025 07:58	-52.8	-40.0754	205	30	B11-547	whole	1.5	P3
SD046	22/03/2025 07:58	-52.8	-40.0754	205	30	B11-10	whole	1.5	P3
SD046	22/03/2025 07:58	-52.8	-40.0754	205	30	B11-1	<20µm	2	P3
SD046	22/03/2025 07:58	-52.8	-40.0754	205	30	B11-30	<20µm	2	P3

Table 10.7.2: Zooplankton copepods samples collected for Bomb calorimeter analysis on SD046.

Date	Latitude	Longitude	Event	Station	Net type	Net no.	Net depth	Species	No. picked
21/02/2025 08:21	-54.3401	-35.2497	69	transitA23	BONGO	2	0-200	*Calanoides acutus*	25
22/02/2025 08:21	-54.3401	-35.2497	69	transitA23	BONGO	2	0-200	*Rhicalanus gigas*	25
16/03/2025 04:05	-62.0842	-41.961	175	BP2_4	MAMMOTH	8	125-250	*Calanoides acutus*	30
16/03/2025 04:05	-62.0842	-41.961	175	BP2_4	MAMMOTH	8	125-250	*Rhicalanus gigas*	5
16/03/2025 22:02	-62.0744	-42.2011	182	BP2_4	MOCNESS	4	750-625	*Calanoides acutus*	33
16/03/2025 22:02	-62.0744	-42.2011	182	BP2_4	MOCNESS	5	750-626	*Calanoides acutus*	26
16/03/2025 22:02	-62.0744	-42.2011	182	BP2_4	MOCNESS	6	750-627	*Rhicalanus gigas*	5
18/03/2025 02:55	-60.6647	-42.1302	188	OP2	MAMMOTH	8	125-250	*Calanoides acutus*	20
18/03/2025 02:55	-60.6647	-42.1302	188	OP2	MAMMOTH	8	125-250	*Rhicalanus gigas*	22
19/03/2025 04:50	-60.5472	-40.6936	193	BP2_1	MAMMOTH	8	125-251	*Salpa sp.*	30
Total									**221**

Table 10.7.3: Show the summary of the Antarctic krill (*Euphausia superba*) samples collected during SD046 BIPOLE II research cruise.

Date	Latitude	Longitude	Event	Station	Net	Net type	Species	Ind. Count
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Euphausia superba*	7
2025-02-16T20:53	-53.6763	-37.6941	40	WCB 2.2S	2	RMT 8	*Euphausia superba*	10
2025-02-16T20:54	-53.6763	-37.6941	40	WCB 2.2S	2	RMT 8	*Euphausia superba*	10
2025-02-16T20:55	-53.6763	-37.6941	40	WCB 2.2S	2	RMT 8	*Euphausia superba*	10
2025-02-19T23:41	-53.6795	-37.6457	60	ECB	1	RMT 8	*Euphausia superba*	50
2025-02-17T00:43	-53.802	-38.5595	42	WCB 2.2	2	RMT 8	*Euphausia superba*	3
2025-02-17T00:43	-53.802	-38.5595	42	WCB 2.2	2	RMT 8	*Euphausia superba*	25
2025-02-18T01:03	-53.616	-37.6846	47	WCB 3.2	1	RMT 8	*Euphausia superba*	30
2025-02-18T01:03	-53.616	-37.6846	47	WCB 3.2	1	RMT 8	*Euphausia superba*	10
2025-02-18T01:03	-53.616	-37.6846	47	WCB 3.2	1	RMT 8	*Euphausia superba*	20
2025-02-19T03:32	-53.6666	-37.6126	53	WCB 4.2	1	RMT 8	*Euphausia superba*	10
2025-02-19T03:39	-53.6646	-37.6137	53	WCB 4.2	2	RMT 8	*Euphausia superba*	10
2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	25

2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	25
2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	25
2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	10
2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	10
2025-02-19T23:42	-53.6793	-37.6469	60	ECB	2	RMT 8	*Euphausia superba*	10
Total								**300**

Table 10.7.4: Show the summary of the *Euphausia triacantha*, *Themisto gaudichaudii, Salpa sp.* and Myctophids fish samples for energetics analysis collected during SD046 BIPOLE II research cruise.

Date	Latitude	Longitude	Event	Station	Net	Net type	*Species*	Ind. Count
2025-02-15T21:11	-53.4866	-39.2473	36	WCB 1.2N	1	RMT 8	*Electrona antarctica*	3
2025-02-15T21:11	-53.4866	-39.2473	36	WCB 1.2N	1	RMT 8	*Protomyctophum bolini*	2
2025-02-15T21:11	-53.4866	-39.2473	36	WCB 1.2N	1	RMT 8	*Muranolepis sp.*	1
2025-02-15T21:11	-53.4866	-39.2473	36	WCB 1.2N	1	RMT 8	*Protomyctophum choriodon*	3
2025-02-15T21:11	-53.4866	-39.2473	36	WCB 1.2N	1	RMT 8	*Notolepis sp.*	1
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Euphausia triacantha*	10
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Euphausia triacantha*	10
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Gymnoscopelus fraseri*	5
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Gymnoscopelus braueri*	5
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Protomyctophum choriodon*	4
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Electrona antarctica*	3
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Protomyctophum choriodon*	6
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Themisto gaudichaudii*	10
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Notolepis sp.*	1
2025-02-15T21:38	-53.4695	-39.2658	36	WCB 1.2N	2	RMT 8	*Themisto gaudichaudii*	10
2025-02-16T05:21	-53.8431	-39.1496	38	WCB 1.2S	2	RMT 8	*Protomyctophum choriodon*	3
2025-02-16T04:21	-53.8593	-39.1336	38	WCB 1.2S	1	RMT 8	*Protomyctophum choriodon*	6
2025-02-16T04:21	-53.8595	-39.1334	38	WCB 1.2S	1	RMT 8	*Muranolepis sp.*	3
2025-02-16T04:51	-53.8595	-39.1334	38	WCB 1.2S	1	RMT 8	*Gymnoscopelus nicholsi*	1
2025-02-16T05:21	-53.8431	-39.1496	38	WCB 1.2S	2	RMT 8	*Euphausia triacantha*	20

2025-02-16T20:52	-53.6763	-37.6941	40	WCB 2.2S	2	RMT 8	*Protomyctophum choriodon*	2
2025-02-16T20:56	-53.6763	-37.6941	40	WCB 2.2S	2	RMT 8	*Notolepis sp.*	1
2025-02-17T03:39	-53.4229	-38.7092	43	WCB 2.2N	2	RMT 8	*Euphausia triacantha*	30
2025-02-17T03:39	-53.4229	-38.7092	43	WCB 2.2N	2	RMT 8	*Muranolepis sp.*	1
2025-02-17T03:39	-53.4356	-38.6878	43	WCB 2.2N	1	RMT 8	*Gymnoscopelus nicholsi*	1
2025-02-17T03:39	-53.4356	-38.6878	43	WCB 2.2N	1	RMT 8	*Gymnoscopelus braueri*	3
2025-02-17T03:39	-53.4356	-38.6878	43	WCB 2.2N	2	RMT 8	*Electrona antarctica*	4
2025-02-17T03:39	-53.4356	-38.6878	43	WCB 2.2N	1	RMT 8	*Muranolepis sp.*	1
2025-02-17T03:39	-53.4356	-38.6878	43	WCB 2.2N	1	RMT 8	*Champsocephalus larva*	1
Total								**151**

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10.8 Macrozooplankton: microplastics, genomics and transcriptomics

Author: Joana Fragão

One of the threats that affect the Southern Ocean ecosystem is pollution, such as the introduction of man-made materials released into marine ecosystem (e.g. microplastics). Microplastics can be easily ingested by aquatic organisms due to their size and have the potential to accumulate and biomagnify along trophic levels. Despite that, they can also release chemical additives (i.e., polybrominated diphenyl ethers (PBDEs), phthalates) with potential hazardous effects for species and ecosystems. Krill, fish and squids were furthermore sampled for study the transfer of microplastics across the Southern Ocean food web, as well as to determine what plastic additives (e.g. PBDEs, MeO-PBDES, phthalates, musk fragances) are present in these organisms and what are the effects they can have on the several tissues of the species (e.g. liver, brain, muscle). Squids were also sampled to investigate their adaptation under a climate change context, for that genomics and transcriptomics analysis will be used when back in Portugal. (Portugal, University of Coimbra & BAS)

EVENT Nº	NET	DATE	SPECIE	SAMPLES'S USE
8		08/02/2025	Squid	Genomics and Transcriptomics
36	2	15/02/2025	Squid	Genomics and Transcriptomics
36	2	15/02/2025	Squid	Genomics and Transcriptomics
40	2	16/02/2025	Squid	Genomics and Transcriptomics

EVENT Nº	NET	DATE	SPECIE	Number	SAMPLES'S USE
36	2	15/02/2025	*Gymnoscopelus fraseri*	5	Microplastics, plastic additives and biomarkers
36	2	15/02/2025	*Gymnoscopelus braueri*	5	Microplastics, plastic additives and biomarkers
36	1	15/02/2025	*Gymnoscopelus braueri*	4	Microplastics, plastic additives and biomarkers
36	1	15/02/2025	*Electrona antarctica*	2	Microplastics, plastic additives and biomarkers
36	1	15/02/2025	*Protomyctophum choriodon*	4	Microplastics, plastic additives and biomarkers

36	1	15/02/2025	*Euphausia superba*	24	Microplastics, plastic additives and biomarkers
36	1	15/02/2025	*Protomyctophum bolini*	1	Microplastics, plastic additives and biomarkers
38	2	16/02/2025	*Protomyctophum choriodon*	4	Microplastics, plastic additives and biomarkers
38	2	16/02/2025	*Euphausia superba*	31	Microplastics, plastic additives and biomarkers
38	1	16/02/2025	*Euphausia superba*	16	Microplastics, plastic additives and biomarkers
40	2	16/02/2025	*Protomyctophum choriodon*	2	Microplastics, plastic additives and biomarkers
40	2	16/02/2025	*Euphausia superba*	20	Microplastics, plastic additives and biomarkers
43	1	17/02/2025	*Electrona antarctica*	8	Microplastics, plastic additives and biomarkers
57	1	19/02/2025	Squid	2	Microplastics, plastic additives and biomarkers
59	1	19/02/2025	Squid	3	Microplastics, plastic additives and biomarkers
60	2	20/02/2025	*Euphausia superba*	85	Microplastics, plastic additives and biomarkers
143	2	09/03/2025	*Euphausia superba*	30	Microplastics, plastic additives and biomarkers

Table 10.8: Summary of macrozooplankton collected for microplastic, plastic additives and biomarkers analyses during SD046 cruise

10.9 Zooplankton trophic ecology

Authors: Kathryn Cook & Daniel Mayor, University of Exeter

Introduction

Zooplankton are the vector through which energy and nutrition are passed from phytoplankton to higher trophic levels, including fish, birds and mammals. Their community activities play an important role in regulating the strength of the biological carbon pump (BCP) by concurrently a) fragmenting large organic particles, b) repackaging small organic particles, c) producing dense and relatively fast-sinking faecal pellets, d) remineralising organic matter, and e) directly transporting matter to depth via vertical migration. Their effects on the BCP can therefore act in both shallow and deeper waters and may occur both actively and passively.

The daily pattern of vertical migration typically includes ascending into surface waters to feed at night and returning to deeper, darker waters during the daytime to avoid visual predation. Grazing on living phytoplankton at the surface provides zooplankton with access to food that is rich in labile substrates and micronutrients, such as omega-3 polyunsaturated fatty acids (PUFAs), which are essential for healthy growth and reproduction. Feeding on detritus at depth may also occur, but this material typically consists of refractory substrates and is largely devoid of nutrition. Fragmentation of detritus may stimulate the production of nutrient compounds by heterotrophic microbes but any nutritional gains must be balanced against the associated energetic losses and the increased risk of detection by their predators.

We have previously hypothesised that migrating zooplankton ingest sufficient material in the surface at night to sustain them at depth during the day, thereby negating the need to feed at depth. However, this hypothesis was derived solely on the basis of zooplankton carbon demands, rather than their requirements for nutrient compounds such as omega-3 PUFAs. Boreal species of copepods of the genus *Calanus* have elevated basal turnover rates of omega-3 PUFAs, relative to other, non-essential fatty acids, suggesting that the supply of these compounds may set an important constraint on daily feeding activities.

We aimed to quantify copepod grazing rates in surface waters, and to collect samples for lipid biomarker analysis and the enzymatic estimation of respiration (Electron Transfer System (ETS) activity) and growth (Aminoacyl-t-RNA synthetases (AARS) activity) rates to better understand the trophic ecology and physiology of mesopelagic zooplankton species.

Methodology

Copepod grazing rates

Experimental animals were collected with the motion-compensated bongo net (100 and 200 µm mesh) using non-filtering cod ends and subsequently sorted using a dissection microscope in controlled temperature laboratory 1 (CT1). Experimental water was collected from the chlorophyll maximum via the CTD and was immediately transferred into HDPE carboys using silicone tubing and stored in CT1 until used. Copepod grazing rates were

examined using particle-removal experiments. In brief, glass incubation bottles were filled with seawater. Experimental animals were carefully introduced into triplicate bottles and incubated alongside triplicate control bottles on a plankton wheel rotating at 1 rpm for 24 hr in CT2. Initial microplankton (100 mL) samples were collected from the same water and preserved with 1% acidified Lugol's iodine.

Oithona spp. were incubated in 200mL bottles, and the experiment was stopped after 24 hours by adding 2mL acidified Lugol's iodine (final concentration 1%) to these bottles without removing the experimental animals. All other copepod species were incubated in 1L bottles. Microplankton (100 mL, preserved with 1% acidified Lugol's iodine) and nutrient samples (15 mL, stored in a fridge until analysis on board) were collected from each of the incubated bottles after 24 hours. The incubated animals were transferred into tin cups for CHN analysis and stored frozen at -80ºC.

Lipid biomarker and enzyme assay samples

Samples were collected with the motion-compensated bongo net (100 and 200 µm mesh), or the depth-discrete Mammoth net (0-1300 m, 300 µm mesh) and MOCNESS (0-1000m, 330 µm mesh) using filtering cod ends and subsequently sorted using a dissection microscope in CT1. Replicates of dominant copepod species were transferred into glass vials for lipid biomarker analyses or plastic Eppendorf tubes for enzyme assay analyses and stored frozen at -80 °C. Replicates were also transferred into tin cups for CHN analysis and stored frozen at -80 °C.

Outcomes

Copepod grazing rates

A total of 19 grazing incubations were carried out during the cruise, using the dominant species in each Bongo net catch (max. 200m) catch. During the Western Core Box (WCB) phase, and the first half of the A23 phase (until A23-44 on 23/02/2025) the dominant copepods were *Calanoides acutus* stages C5, *Rhincalanus gigas* C6F, and *Oithona* spp. (Fig 10.9.1). For the remainder of the cruise, *Calanus* spp. stages C4-C6F, *Metridia* sp. C6F and *Oithona* spp. were the dominant copepod species in the surface waters. Table 10.9.1 gives a full list of incubations.

Fig 10.9.1 Example images of *Calanoides acutus* CV (left), *Rhincalanus gigas* CV (middle) and *Oithona* sp. female (right).

Stn	Expt	Event (animals)	Event (water)	Depth (water)	Species/stage	n/bottle	Lugol's	CHN	Nutrients
P3	GRZ1	11	Underway	Underway	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
P3	GRZ2	30	27	30	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
					Oithona	20	x		
WCB 3.2S	GRZ3	49	46	10	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
					Oithona	20	x		
WCB 3.2N	GRZ4	61	58	35	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
					Oithona	20	x		
A23	GRZ5	68	67	75	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
					Oithona	20	x		
A23-49	GRZ6	75	74	75	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x
					Oithona	20	x		
A23-44	GRZ7	80	79	20	*C. acutus C5*	5	x	x	x
					C. simillimus C5	5	x	x	x
					Oithona	20	x		
A23-33	GRZ8	93	94	75	*C. simillimus C5*	4	x	x	x
					Oithona	20	x		
A23-40	GRZ9	100	101	20	*Metridia C6F*	5	x	x	x
					Oithona	20	x		
BP2_3	GRZ10	106	108	50	*C. propinquus C5*	4	x	x	x
					Metridia C6F	5	x	x	x
					Oithona	20	x		
BP2_7	GRZ11	124	123	20	*Oithona*	20	x		
BP2_8	GRZ12	131	128	15	*R. gigas C6F*	1	x	x	x
					C. propinquus C6F	3	x	x	x
					C. propinquus C5	4	x	x	x
					C. propinquus C4	5	x	x	x
					Oithona	20	x		
BP2_6	GRZ13	150	149	40	*R. gigas C6F*	1	x	x	x
					C. acutus C6F	3	x	x	x
					C. acutus C6F	2	x	x	x
					Oithona	20	x		
M3	GRZ14	165	163	20	*C. simillimus C5*	4	x	x	x
					Metridia C6F	5	x	x	x
					Oithona	20	x		
BP2_4	GRZ15	177	178	50	*C. simillimus C5*	4	x	x	x
					Metridia C6F	5	x	x	x
					Oithona	20	x		
BP2_1	GRZ16	196	194	60	*Oithona*	20	x		
P3	GRZ17	203	204	30	*C. acutus C5*	5	x	x	x
					R. gigas C6F	1	x	x	x

					Oithona	20	x		
A23a shelf	GRZ18	214	213	20	*R. gigas C6F* *C. acutus C5* *Oithona*	1 5 20	x x x	x x	x x
A23a benthic	GRZ19	217	216	20	*Oithona*	20	x		

Table 10.9.1. Zooplankton grazing incubations

Lipid biomarker and ETS samples

A total of 469 lipid samples, 268 enzyme assay samples and 168 CHN samples were collected during the cruise. Most of the samples taken were the lipid storing copepods *Calanoides acutus* and *Rhincalanus gigas*, although samples of the copepods *Calanus simillimus*, *Calanus propinquus*, *Paraeuchaeta* spp., *Metridia* spp. were also taken. During the BIOPOLE phase, many samples were dominated by eggs and larval stages of *Euphausia superba*, so some samples were taken for enzyme and CHN analysis. Table 10.9.2 gives a full list of samples taken.

				Species Stage	*C. acutus* C5			*C. acutus* C6F			*R. gigas* C5			*R. gigas* C6F			Others		
Stn.	**Event**	**Sampler**	**Net**	**Depth**	**ETS**	**Lipids**	**CHN**	**ETS**	**Lipids**	**CHN**	**ETS**	**Lipids**	**CHN**	**ETS**	**Lipids**	**CHN**	**Enz**	**Lipids**	**CHN**
P3	11	Bongo		50-0	x	x	x							x	x	x			
ECB	26	MOCNESS	2	200-175	x									x					
			3	175-150	x									x					
			4	150-125	x									x					
			5	125-100	x									x					
			6	100-75	x									x					
			7	75-50	x									x					
			8	50-25	x									x					
P3	29	MOCNESS	8	250-125	x									x		x			
			9	125-5	x	x	x							x	x	x			
P3	30	Bongo	200	200-0		x	x								x	x			
WCB 3.2 S	49	Bongo	200	75-0	x	x	x							x	x	x			
WCB 3.2N	61	Bongo	200	100-0	x	x	x							x	x	x			
A23	68	Bongo	100	200-0	x	x	x							x	x	x			
A23-49	75	Bongo		200-0	x	x	x							x		x			
A23-44	80	Bongo		200-0	x	x	x										Par C5 CS C5	Par C5	Par C5
A23-40	100	Bongo		200-0													Met C6F		
BP2_3	106	Bongo		200-0										x			ES caly Met C6F Par C5		
BP2_7	122	Mammoth	2	1000-875													ES eggs		
			6	500-375										x					
			7	375-250										x					
			8	250-125										x					
BP2_8	132	Bongo		200-0													Par C6M Par C4		
BP2_8	134	Mammoth	2	1300-1000	x	x		x	x					x	x				
			3	1000-750								x			x				
			4	750-625	x							x			x			RG C4	

			5	625-500	x													
			6	500-375							x			x				
			7	375-250	x						x	x		x				
			9	125-5								x			x			
BP2_8	135	Mammoth	2	1300-1000	x	x		x	x			x			x			
			4	750-625	x	x		x	x			x			x			
			5	500-375	x	x		x	x					x				
			6	500-375		x			x			x			x			
			7	375-250		x						x		x	x			
			9	125-5		x			x			x			x			
BP2_6	148	Mammoth	2	1300-1000	x			x						x				
			3	1000-750	x			x	x					x			Red C6F	
			4	750-625		x		x	x						x			
			5	500-375					x						x			
			6	500-375		x		x	x						x			
			7	375-250	x	x		x	x		x			x	x			
			9	125-5	x			x	x			x		x				
BP2_6	155	Mammoth	6	500-375		x			x									
			7	375-250		x			x									
`			8	250-125		x			x									
			9	125-5					x									
BP2_6	156	Bongo		200-0					x			x			x			Met C6F	
BP2_4	175	Mammoth	2	1300-1000	x	x		x	x						x			
			3	1000-750		x			x						x			PM	
			4	750-625		x			x						x				
			5	625-500	x	x		x	x						x			PM	
			6	500-375	x	x			x					x	x			PM	
			7	375-250					x			x			x			CA C4 PM	
			9	125-0														CA C4	
BP2_4	182	MOCNESS	2	1000-875					x										
			3	875-750		x			x										
			4	750-625		x			x						x				
			5	625-500		x			x						x				

			6	500-375		x			x						x			Met C6F	
			7	375-250		x			x						x			Met C6F	
			8	250-125					x			x			x			Met C6F	
OP2	188	Mammoth	2	1300-1000	x	x		x	x					x	x				
			3	1000-750											x			Red C6M	
			4	750-625	x	x		x			x			x					
			5	625-500	x			x						x					
			6	500-375	x			x			x			x	x				
			7	375-250	x				x					x					
			9	125-5													Met C6F CS C5		
BP2_1	193	Mammoth	2	1300-1000		x			x										
			5	625-500		x			x			x			x				
P3	201	Mammoth	2	2000-1750		x													
			6	1000-750		x													
			7	750-500		x													
			8	500-250		x													
			9	250-5		x													
P3	203	Bongo		200-0	x	x					x	x	x	x	x	x		CS C5 CP C5	CS C5 CP C5
A23a shelf	214	Bongo		175-0	x	x						x		x	x		RG C4	RG C4 CS C5, C6F CP C5	
A23a benthic	217	Bongo		200-0	x	x					x	x		x	x		RG C4	CP C5, C6F CS C5	

Table 20.9.2. Zooplankton biochemistry samples collected. Par = *Paraeuchaeta* spp., CS= *Calanus simillimus*, CP = *Calanus propinquus*, Met = *Metridia* spp., ES = *Euphausia superba*, Red = unidentified large red copepod, RG = *Rhincalanus gigas*, PM = *Primno macropa*, CA = *Calanoides acutus*.

10.10. Zooplankton respiration at atmospheric- and high pressure

Author: Élodie Jacob, Aix-Marseille University; Kathryn Cook and Daniel Mayor, University of Exeter

Introduction

By migrating into deeper ocean layers, zooplankton actively transport carbon ingested at the surface and release it at their migration depth, primarily through respiration. This migration occurs on a daily and/or seasonally basis, with zooplankton either migrating daily or remaining at a specific depth for extended periods. The effect of temperature on zooplankton respiration rates has been extensively investigated, whereas our understanding of how pressure affects their physiological processes remains in its infancy. The majority of values considered for measuring carbon fluxes within the BCP are made at atmospheric pressure and sometimes considered constant along the water column. This can represent a considerable bias in the estimation of carbon flux. *Calanoides acutus* is an abundant overwintering copepod in this area. Its average overwintering depth has been reported as 1000 m but has also been found at 3000 m, corresponding to pressures of 10 and 30 MPa, respectively. Thus, to determine if pressure has an effect on the respiration rate, we sampled *Calanoides acutus* CVs at the surface (0-200 m) as well as at depth and measure their oxygen consumption at atmospheric pressure and under pressure using O_2 Presens sensor spots in sapphire tubes and a Presens sensor dish reader system.

Methodology

Sample collection

At each sampled station, copepods were collected using the BONGO and/or MAMMOTH nets (refer to Table 10.10.3 for event numbers). BONGO nets were employed to assess the effects of pressure on surface copepods, while MAMMOTH nets were used to evaluate the impact of pressure on deep-dwelling copepods. Additional respiration experiments at atmospheric pressure were conducted on additional species where possible (see Table 10.10.3).

Once the BONGO nets were brought on deck, the samples were transferred into buckets and placed in the CT rooms for processing. For the MAMMOTH nets, the catch from a single deep (>500m) net was used. On deck, the cod ends were placed into buckets and immediately covered with black plastic sacks. These buckets were then taken directly to the dark lab for sorting by Jen Freer. *Calanoides acutus* specimens were picked and transferred into pots filled with filtered seawater.

Incubation set-up and post processing

To minimize the exposure of samples to atmospheric pressure, all setup and software preparations must be completed before sampling. Surface seawater (1 L) was filtered (0.2 µm) and placed into a 2 L glass bottle. This water was saturated by shaking and maintained at the in situ temperature, along with the empty 5 mL glass vials, hyperbaric tube, and bottles.

After sampling, *C. acutus* CV specimens were directly picked and rinsed in filtered seawater. However, at some stations, either no Metridia sp. were available or there were not enough to be picked.

Six HP sapphire tubes (Figure 10.10.2) and six glass vials, all equipped with O2 PreSens, are filled with saturated filtered seawater and one copepod each. Controls without copepods consist of three glass vials and one HP tube. Care is taken to avoid bubbles. HP tubes are equipped with their surroundings, and two valves are connected to the stoppers. Hydrostatic pressure is induced in these tubes by adding pressurized seawater from the HP bottles, controlled by a piloted pressure generator (Figure 10.10.3). The glass vials are placed on a 24-channel reader, and the optodes in the tube adapters are connected to the OXY-10 logger. Figure 10.10.4 resumes this protocol.

The pressure chosen is the equivalent of the average overwintering depth, which means 10 MPa. After obtaining consistent data with surface organisms, the pressure is set to 20 MPa.

To replicate in situ conditions as closely as possible, the experiment is set up in a cold temperature room and kept in the dark. For the deep experimentation, the picking and setup are carried out in the dark under red light (Figure 10.10.5).

After incubation, hyperbaric pressure samples are decompressed. Copepods are photographed with a scaled reference, then transferred into CHN capsules and stored at -80°C until analyzing their carbon (C) and nitrogen (N) content.

When the species number sampling allowed it (Table 10.10.4), incubation of 10 individuals in Whirl-park filled with filtered seawater have been conducted for 3 days at atmospheric and under pressure following the protocols described 10.2.

Outcomes

The carbon and nitrogen content of the copepods is determined using a Carbon Nitrogen Elemental Analyzer. This helps account for variations in oxygen consumption due to differences in organism size. Furthermore, the total size and the size of the lipid sac are determined using images. Through individual oxygen consumption over time and the carbon or nitrogen content, a respiration rate is calculated. Thus, individual respiration rates at each station, either at the surface or at depth, will be determined at both atmospheric pressure and under pressure (10 MPa or 20 MPa). This will allow us to determine whether pressure has an effect on the respiration rate of surface and deep copepods (Table 10.10.3).

Table 30.10.3. Respiration experiments. ATM = atmospheric pressure, HP = high pressure.

ID	Event	Net	Date	Pressure (MPa)	Species	Number at ATM	Number at HP
O2.1.S	11	Bongo	10/02/2025	10	*Calanoides acutus CV*	6	7
O2.2.S	26	MOCNESS (NET 5)	13/02/2025	10	*Calanoides acutus CV*	6	1
O2.3.S	30	BONGO	14/02/2025	10	*Calanoides acutus CV*	6	5
O2.3b.S	30	BONGO	15/02/2025	10	*Calanoides acutus CV*	6	6
O2.4.S	49	BONGO	18/02/2025	10	*Calanoides acutus CV*	6	5
	49	BONGO	18/02/2025	NA	*Rhincalanus gigas CVIf*	5	NA
O2.5.S	61	BONGO	20/02/2025	10	*Calanoides acutus CV*	6	6

	61	BONGO	20/02/2025	NA	*Rhincalanus gigas CVIf*	6	NA
	68	BONGO	21/02/2025	NA	*Rhincalanus gigas CVIf*	6	NA
	68	BONGO	21/02/2025	NA	*Calanoides acutus CV*	6	NA
O2.6.S	75	BONGO	22/02/2025	10	*Calanoides acutus CV*	6	6
	75	BONGO	22/02/2025	NA	*Rhincalanus gigas CVIf*	4	NA
O2.7.S	80	BONGO	23/02/2025	10	*Calanoides acutus CV*	6	6
	80	BONGO	23/02/2025	NA	*Paraeuchaeta CV*	6	NA
	80	BONGO	23/02/2025	NA	*Calanus simillimus CV*	6	NA
	93	BONGO	27/02/2025	NA	*Calanus propinquus CVIf*	2	NA
	93	BONGO	27/02/2025	NA	*Paraeuchaeta*	5	NA
	93	BONGO	27/02/2025	NA	*Calanus simillimus CV*	5	NA
	93	BONGO	27/02/2025	NA	*Calanoides acutus CVIf*	4	
	93	BONGO	27/02/2025	NA	*Calanoides acutus CV*	3	
O2.8.S	100	BONGO	01/03/2025	10	*Metridia sp. CVIf*	12	6
	100		01/03/2025	NA	*Paraeuchaeta*	8	NA
O2.9.S	106	BONGO	03/03/2025	20	*Calanoides acutus CV*	6	5
	106	BONGO	03/03/2025	20	*Calanoides acutus CVIf*	3	NA
	106	BONGO	03/03/2025	NA	*Calanus propinquus CVIf*	3	NA
	106	BONGO	03/03/2025	NA	*Paraeuchaeta CV*	2	NA
	106	BONGO	03/03/2025	NA	*Paraeuchaeta CVIf*	2	NA
	106	BONGO	03/03/2025	NA	*Metridia sp. CVIf*	4	NA
	124	BONGO	06/03/2025	NA	*Calanoides acutus CV*	7	NA
	124	BONGO	06/03/2025	NA	*Calanoides acutus CVIf*	3	NA
	124	BONGO	06/03/2025	NA	*Rhincalanus gigas CVIf*	1	NA
	124	BONGO	06/03/2025	NA	*Metridia sp. CVIf*	4	NA
	124	BONGO	06/03/2025	NA	*Calanus sp.*	2	NA
	124	BONGO	06/03/2025	NA	*Paraeuchaeta CIV*	1	NA
	131	BONGO	07/03/2025	NA	*Rhincalanus gigas CIV*	1	NA
	131	BONGO	07/03/2025	NA	*Paraeuchaeta CIII*	2	NA
	131	BONGO	07/03/2025	NA	*Paraeuchaeta CVIm*	3	NA
	131	BONGO	07/03/2025	NA	*Paraeuchaeta CIV*	3	NA
	131	BONGO	07/03/2025	NA	*Rhincalanus gigas CVIf*	1	NA
	131	BONGO	07/03/2025	NA	*C. acutus CV*	3	NA
	131	BONGO	07/03/2025	NA	*C. acutus CIV*	6	NA
	131	BONGO	07/03/2025	NA	*C. acutus CVIf*	2	NA
	131	BONGO	07/03/2025	NA	*Rhincalanus gigas CVIf*	1	NA
O2.10.D	134	MAMMOTH (NET 3)	08/03/2025	10	*Calanoides acutus CV*	6	6
O2.11.D	148	MAMMOTH (NET 5)	10/03/2025	10	*Calanoides acutus CV*	6	6

O2.12.S	165	Bongo	14/03/2025	20	*Metridia sp. CVIf*	12	6
	165	Bongo	14/03/2025	NA	*Calanus simillimus CV*	9	NA
	165	Bongo	14/03/2025	NA	*Calanus simillimus CVIf*	1	NA
O2.13.D	175	MAMMOTH (NET 4)	16/03/2025	10	*Calanoides acutus CV*	6	6
	175	MAMMOTH (NET 4)	16/03/2025	NA	*Calanus simillimus CV*	1	NA
	177	BONGO	16/03/2025	NA	*Metridia CVIf*	4	NA
	177	BONGO	16/03/2025	NA	*Calanus simillimus CV*	5	NA
	177	BONGO	16/03/2025	NA	*Calanus simillimus CVIf*	2	NA
	177	BONGO	16/03/2025	NA	*Calanus simillimus CIV*	3	NA
O2.14.D	188	MAMMOTH (NET 3)	18/03/2025	10	*Calanoides acutus CV*	6	6
	188	MAMMOTH (NET 2)	18/03/2025	10	*Calanoides acutus CV*	4	NA
	188	MAMMOTH (NET 2)	18/03/2025	10	*Calanoides acutus CVIf*	11	NA
O2.15.D	195	MAMMOTH (NET 3)	19/03/2025	10	*Calanoides acutus*	0	1 CV+ 1 F
O2.16.S	203	BONGO	22/03/2025	20	*Calanoides acutus CV*	6	6
	203	BONGO	22/03/2025	NA	*Calanus propinquus CV*	5	NA
	203	BONGO	22/03/2025	NA	*Calanus propinquus CVIf*	1	NA
	203	BONGO	22/03/2025	NA	*Calanus simillimus CVIf*	6	NA
	203	BONGO	22/03/2025	NA	*Calanus simillimus CIV*	3	NA
O2.17.S	214	BONGO	24/03/2025	NA	*Calanoides acutus CV*	6	6
	214	BONGO	24/03/2025	NA	*Calanus propinquus CV*	1	NA
	214	BONGO	24/03/2025	NA	*Calanus propinquus CVIf*	5	NA
	214	BONGO	24/03/2025	NA	*Calanus simillimus CVIf*	3	NA
	214	BONGO	24/03/2025	NA	*Calanus simillimus CV*	3	NA
	214	BONGO	24/03/2025	NA	*Rhincalanus gigas CVIf*	3	NA

Table 10.10.4. Pressure incubation for ETS analyses. ATM = atmospheric pressure, HP = high pressure.

ID	Event	Net	Date of the experimentation	Pressure (MPa)	Species	Number at ATM	Number at HP	Duration
ETS.4.S	49	BONGO	18/02/2025	10	*Calanoides acutus CV*	3*10	3*10	3d
ETS.7.S	80	BONGO	23/02/2025	10	*Calanoides acutus CV*	3*10	3*10	3d
ETS.12.S	165	BONGO	14/03/2025	20	*Metridia sp. Female*	3*10	3*10	3d

ETS.16.S	203	BONGO	22/03/2025	20	*Calanoides acutus CV*	3*10	3*10	3d

Fig 10.10.2 Sapphire tubes.

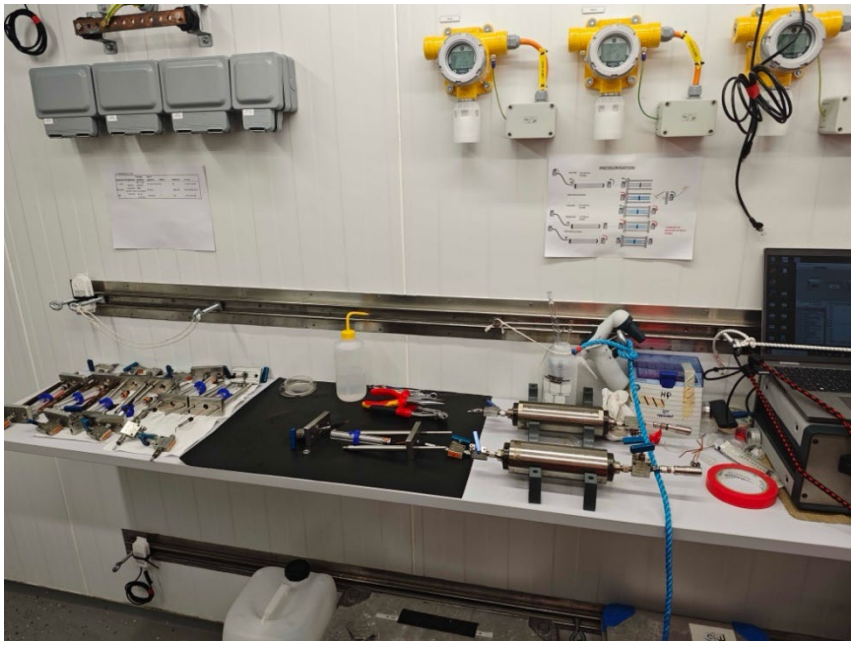

Fig 10.10.3 Set up of the respiration under pressure.

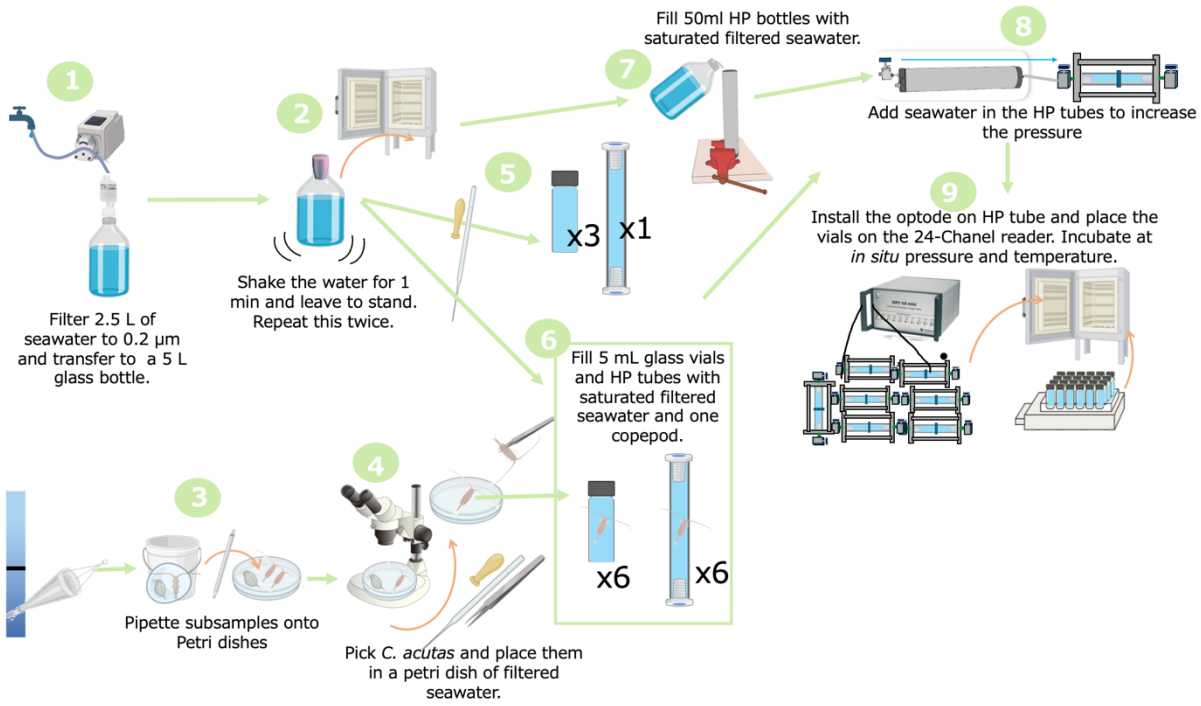

Fig 10.10.4 Schematic protocol of the pressure respiration experiment

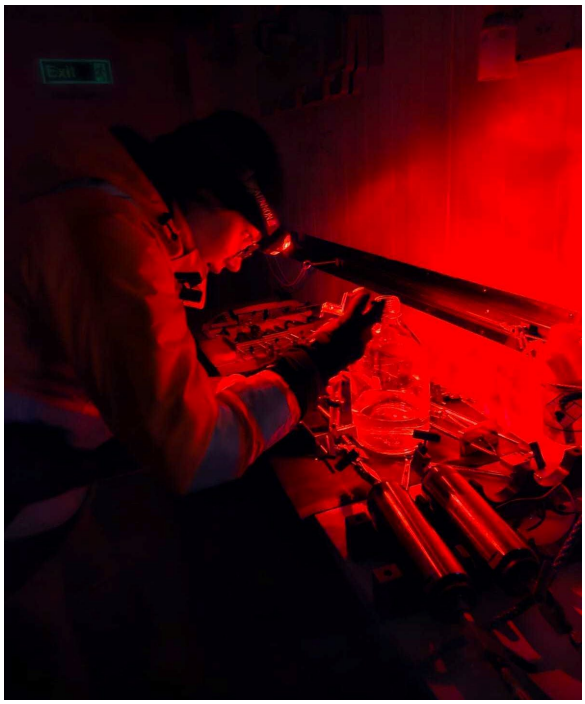

Fig 10.10.5 Set up of the pressure respiration experiments under red light.

10.11. Lipid composition under pressure

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Introduction

The study of the lipid composition of zooplankton, including both structural lipids and carbon-rich reserve lipids, is crucial for a better understanding of the biological carbon pump (BCP) and, in particular, the seasonal lipid pump, which is particularly active in polar regions. Lipids are crucial for the buoyancy and energy reserves of zooplankton, allowing them to maintain their physiological state despite pressure changes during vertical migrations. In this context, copepods of the order Calanoida (Copepoda), such as *Calanoides acutus*, synthesize high-energy wax esters (WE) to survive periods of food scarcity and support reproduction, thereby establishing a close link between lipid storage and the seasonal life cycle (Hagen and Auel, 2001). In *C. acutus*, a seasonal migrant, the fatty acid composition of the WE (notably the presence of polyunsaturated fatty acids - PUFAs) varies depending on the depth at which they are collected, suggesting an influence of pressure on the lipid composition of these organisms (Pond, 2012; Pond et al., 2014). Thus, to determine the pressure effects on the lipid composition of overwintering species, *C. acutus* CV at the surface and at depth are collecting and incubate 3 days at atmospheric pressure or at 10MPa (equivalent pressure of their average depth of overwintering).

Methodology

Sample collection

The sample collection strategy is the same as 10.1. The event use for these incubations are resume in Table 10.11.5.

Incubation set-up and post processing

When possible, water from the CTD (1000m) is filtered (0.2 µm) and placed in a glass bottle. If this is not possible, underway water is used. Triplicates of C. acutus CV (6 individuals) in 250 mL of filtered seawater are incubated at a cool temperature, either under atmospheric pressure or in the pressure conditions equivalent to the average depth of diapause (HP). Six individuals are frozen without undergoing any incubation. However, at some stations, either no C. acutus CV were available, or there were not enough individuals to collect. In such cases, experiments with C. acutus females have been conducted instead. The sealed bottles are made of two plastic plates closed with an aluminum ring, with careful attention to avoid air bubbles. Triplicates under pressure are placed in the main core of a 5L hyperbaric tank filled with distilled water, and hydrostatic pressure is applied using a piloted pressure generator (Fig. 10.11.6). The atmospheric triplicate is incubated in a water-filled basin. All samples are incubated in the dark for 3 days. To replicate in situ conditions as closely as possible, the experiment is set up in a cold temperature room and kept in the dark. For deep-sea experiments, the collection and setup are carried out in the dark under red light. After incubation, the hyperbaric pressure samples are decompressed, and copepods are transferred into pyrolized glass vials and stored at -80°C until lipid analysis is performed. The

nitrogen (N) and phosphorus (P) content is directly analyzed to estimate the excretion rate. The protocol is schematized in Fig 10.11.7.

Outcomes

Lipid analysis involves examining the different fatty acids present in both hydrolyzed phospholipids (phospholipid-derived fatty acids) and storage lipids using gas chromatography–mass spectrometry (GC–MS) in the MIO lab. The non-hydrolyzed phospholipids will be analysed by a collaborator. Comparing lipid analyses under atmospheric pressure and high pressure will allow us to determine if pressure affects the composition of storage lipids and the fatty acids in membrane phospholipids. Additionally, the lipid composition of the incubation can be compared to the initial composition. Finally we will be able to look the effect of the pressure on the surface and deep Calanoides acutus CV as well as the surface Metridia and deep Calanoides acutus female (Table 10.11.5).

Table 10.11.5. Pressure experiments for lipid analyses.

ID	Event	Net	Date	Pressure (MPa)	Species	Number T0	Number at ATM	Number at HP	Duration
L.1.S	11	Bongo	10/02/2025	10	*Calanoides acutus CV*	6	1*6	1*6	1d
L.3.S.D	29	MOCNESS (NET 2)	14/02/2025	10	*Calanoides acutus CV*	6	3*6	3*6	3d
L.4.S	49	BONGO	18/02/2025	10	*Calanoides acutus CV*	6	3*6	3*6	3d
L.5.S	61	BONGO	20/02/2025	10	*Calanoides acutus CV*	6	3*6	3*6	3d
L.6.S	75	BONGO	22/02/2025	10	*Calanoides acutus CV*	6	1*6	1*6	3d
L.7.S	80	BONGO	23/02/2025	10	*Calanoides acutus CV*	6	3*6	3*6	3d
L.10.D	134	MAMMOTH (NET 3)	08/03/2025	10	*Calanoides acutus CV*	6	3*6	3*6	3d
L.11.D	148	MAMMOTH (NET 5)	10/03/2025	10	*Calanoides acutus Female*	6	2*6	2*6	3d
L.13.D	175	MAMMOTH (NET 4)	16/03/2025	10	*Calanoides acutus CV*	6	2*6	2*6	3d
L.13.D	175	MAMMOTH (NET 4)	16/03/2025	10	*Calanoides acutus Female*	6	1*6	1*6	3d
L.14.D	188	MAMMOTH (NET 3)	18/03/2025	10	*Calanoides acutus CV*	0	1*6	1*6	3d
L.14.D	188	MAMMOTH (NET 3)	18/03/2025	10	*Calanoides acutus Female*	0	2*6	2*6	3d
L.16.S	202	BONGO	22/03/2025	20	*Calanoides acutus CV*	21	3*6	3*6	3d

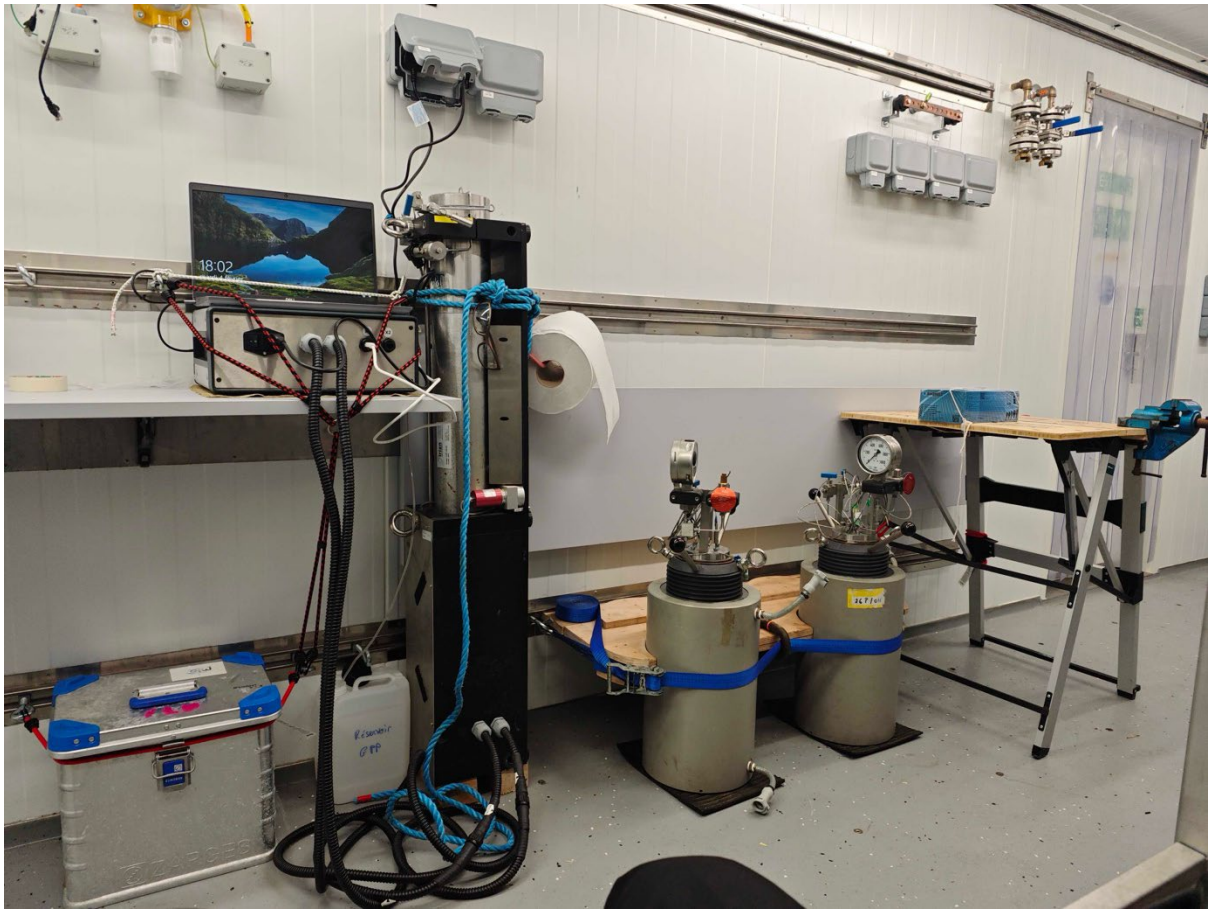

Fig 10.11.6 Pressure generator (left) and the two pressure tanks (right) used for the lipids and ETS pressure incubations.

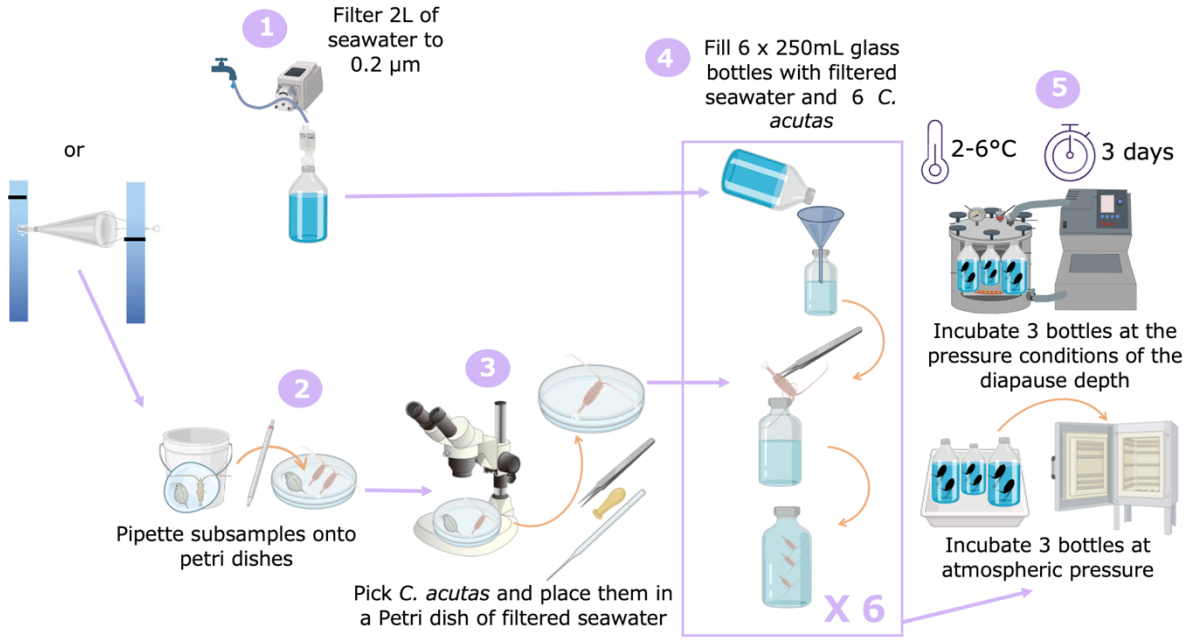

Fig 10.11.7 Schematic protocol of the pressure lipids experiment

11. Marine Mammals Survey

Authors: Manuela Bassoi (Fieldwork coordinator), Hannah Cubaynes, Elena Josso, Hayley McLennan

Project Coordinator: Dr Jen Jackson

Introduction

The Scotia Arc (spanning the Scotia Sea in the South Atlantic) was at the epicentre of modern whaling in the Southern Hemisphere during the early 20th century. During the summer, this is an area of importance for multiple baleen and toothed whale species who use it as a seasonal feeding habitat, with at least eight species sighted and caught there: humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*), Antarctic minke whale (*Balaenoptera bonaerensis*), dwarf minke whale (*Balaenoptera acutorostrata*), sei whale (*Balaenoptera borealis*), southern right whale (*Eubalaena australis*) and sperm whale (*Physeter macrocephalus*). Since whaling ended, few sightings' surveys have been conducted to estimate the density and distribution patterns of these recovering populations, and most only cover parts of this area (e.g. Branch 2011; Williams *et al.,* 2014; Viquerat & Herr 2017).

In 2019, UK and Norwegian vessels worked in collaboration to conduct a cetacean survey across the Scotia Arc, including parts of South Georgia and South Sandwich Islands, generating the first estimates of abundance of humpback and fin whales from the Scotia Arc since whaling ended (Baines et al., 2021; Biuw et al., 2024), as well as an analysis of the spatial covariation between humpback whales and krill (Baines et al. 2022), and estimates of the total regional consumption of krill by both species.

Six years on, the SDA will be crossing extensive areas of the Scotia Arc, providing a second opportunity for a dedicated team to collect cetacean sightings and monitor the distribution and relative abundance of cetaceans in the Scotia Arc (Annex CS1). In parallel, this survey will also endeavour to collect quantitative measures of fur seal density using a protocol derived from recent winter surveys of krill predators at South Georgia (Annex CS2).

Therefore, the main objective of this project during the cruise was to conduct surveys in the Western Core Box (WCB) area and throughout the Scotia Arc, including regions of South Georgia, South Sandwich and the Orkney Islands, using both cetacean and fur seal protocols.

Methods

SURVEY PROCEDURE

The surveys followed the transect line and distance sampling methodologies (Buckland et al., 2015), see Annex CS1 for the cetacean protocol and Annex CS2 for the fur seal protocol. The visual monitoring (ON EFFORT mode) took place whilst the vessel was sailing (at a speed of 8 to 14 knots), in daylight, with a wind speed of up to 27 knots, a sea state of up to Beaufort 6

and moderate visibility (at least 2 nm). In poor sea and/or weather conditions, we conducted the survey (OFF EFFORT mode) to monitor if conditions improved sufficiently to start or resume the ON EFFORT survey, and in the expectation that some animals might come close, as many areas during the cruise have little information and data on marine mammal distribution and occurrence.

During the cruise, two observers would be on watch simultaneously (port and starboard) and a data recorder assisted with data recording and species identification. Watch periods were during daylight hours, from about 05.30 to 18.45, and changed during the cruise with sunrise and sunset.

Depending on the number of people available, the rotation of the survey team was different. If the team consisted of three people, the rotation took place every 20 minutes, with the observer on port side replacing the observer on starboard side and the data recorder replacing the observer on port side, and so on. This rotation allowed the observer to watch the sea for no more than 40 minutes. However, there were no rest periods, and when we had many sightings over many hours (e.g. during the WCB survey), it was very tiring for the team (Figure 1). This was required during the WCB phase of the cruise due to a concurrent seabird survey being carried out by one observer for this period (Chapter 15).

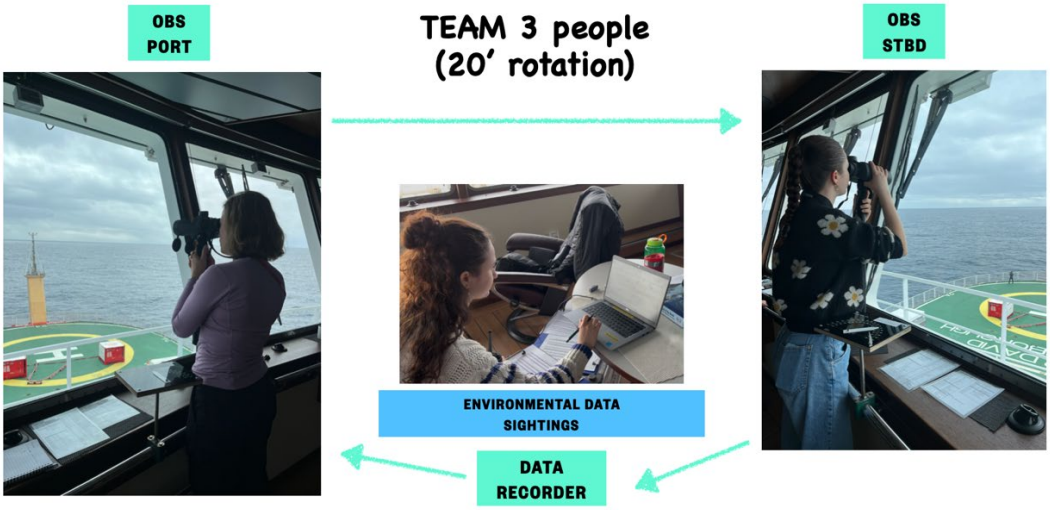

Figure 11.1. Survey procedure with three persons.

When the team consisted of four people, which is the ideal minimum, the rotation was performed every 30 minutes, with the resting position replacing the observer on port side, and the data recorder replacing the observer on starboard side, who went on rest. This rotation allowed a maximum observation time of 30 minutes with a break every hour and a half, which is very important in areas with high animal density (Figure 11.2).

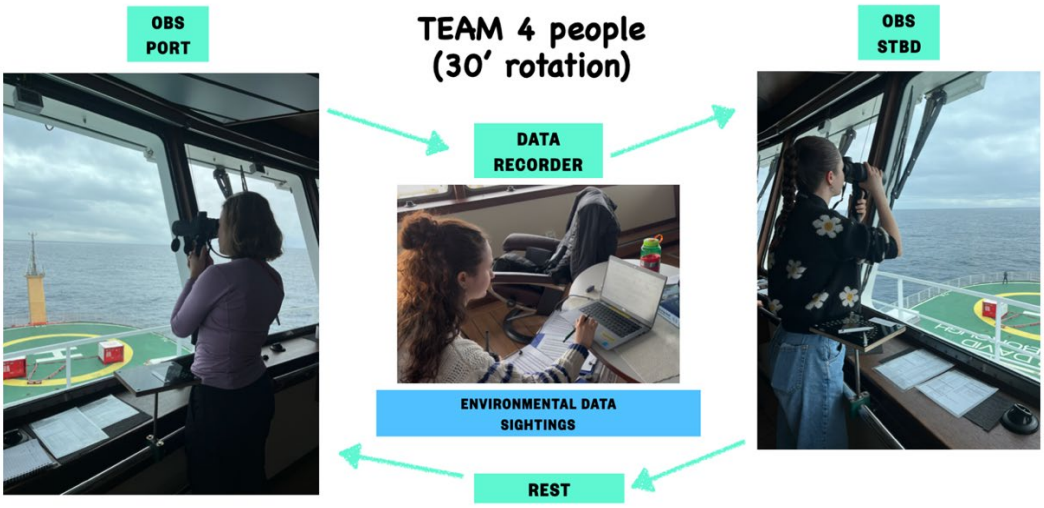

Figure 11.2. Survey procedure with four persons.

Positions: Observers and Data Recorder (DR)

The observers searched with the naked eyes and binoculars, scanning their search area as follows: the observer on port side searched the area from 90º port to about 10º starboard, and the observer on starboard side searched the area from 90º starboard to about 10º port (Figure 11.4). This ensured that the trackline is covered by both observers. All cetaceans and fur seals were recorded.

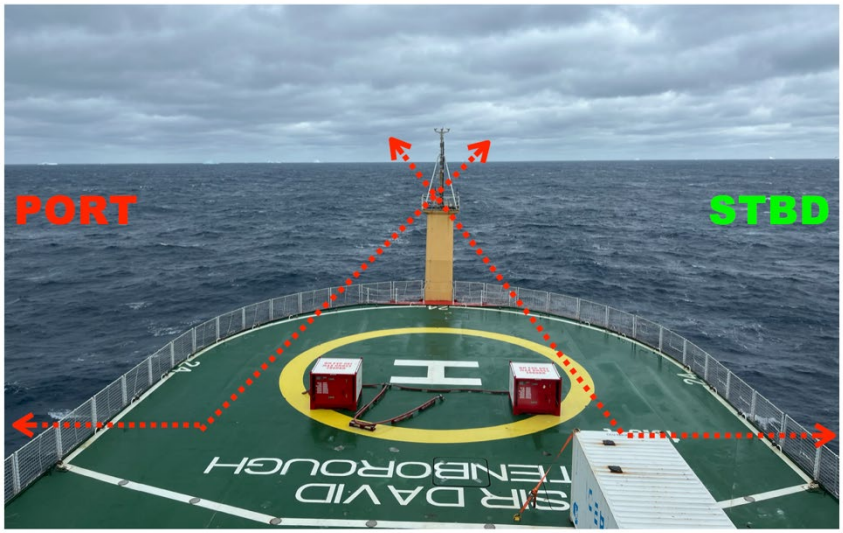

Figure 11.4. Port and starboard observers and their searching area.

The main responsibility of the observer team was to obtain accurate information on the horizontal angle, reticle, cue, method (eye or binoculars), species identification, and number of individuals. It is important to obtain estimates of the angle and distance to the original sighting position, to minimise bias arising from responsive movement of the animals to the ship. Therefore, each observer had 7x50 binoculars with reticles, and the angles from the trackline to the sighting were obtained from pointers on the mounted angle boards (0° indicating directly ahead of the vessel, Figure 11.5), to estimate the radial distance to the sightings.

Figure 11.5. Angle board mounted on the bridge front window and printed effort and sighting codes.

In the back of the bridge, next to the DP desk, we placed all our material stored in a box: binoculars and monopods, VHF radios, sighting and effort paper forms and pencils, and laptop. On the table, the laptop was logged into the ship's WIFI to access the SDA Event Log. In the event log, there were two forms: 'marine mammal observations: effort', and 'marine mammal observations: sightings'. The DR worked in this area at the back of the bridge (Figure 11.6) and communication between the observers and the DR was via VHF radios (from the SDA).

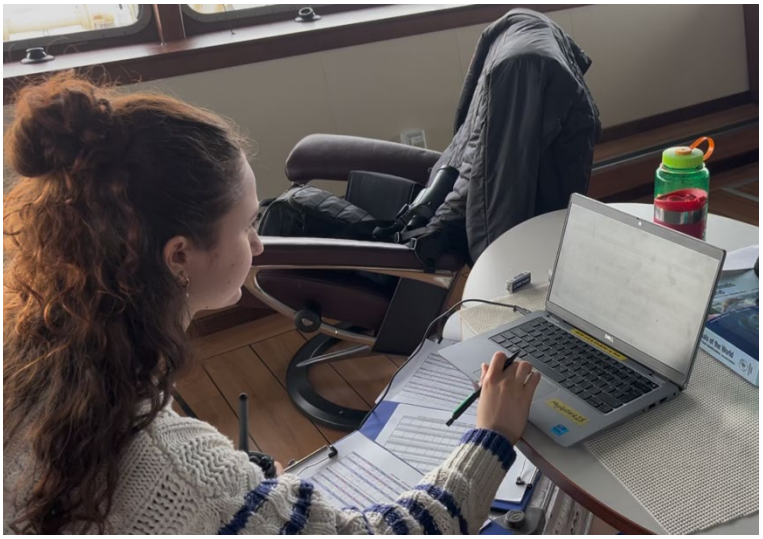

Figure 11.6. Data recorder working at the back of the bridge.

The DR was responsible for accurately recording the effort and weather data in the Event Logger (and on paper forms, see Annexes CS3 and CS5) at the beginning and end of each transect, as well as every time the team changed position (every 20 or 30 minutes). However, any change in the type of search effort or environmental conditions that might affect the detection of animals was also recorded (changing conditions).

When an observer had a sighting, they reported the angle, reticles, clue and method of sighting to the DR as quickly as possible. The DR immediately opened a new event in the sighting form, which contained the fields to be filled in, just as in the paper form (see Annexes CS4 and

11.6). When one observer made a detection, the other observer continued to search in their usual way.

The paper form was therefore very important in surveys with many sightings, where there is no time to fill in the Event Log, so that the most important information about the sightings (time UTC, reticles, angles, cue and method) can be recorded quickly and then entered into the Event Log. At the end of each day the paper form sightings were checked against the data in the Event Log.

Daily actions after the survey included: checking effort and sighting paper forms with the Event Log; checking for discrepancies in the Event Log and correcting typos; backing up the Event Log to two external hard drives; downloading and backing up all photographic images of sightings.

DATA STORAGE

SDA's Event Log system (https://eventlog.sda.bas.ac.uk): (1) Marine Mammals Observations – effort and (2) Marine Mammals Observations – sightings.

Parameters included in BAS Event Log on SDA for effort and environmental monitoring:

Time (UTC)*; transect_no; latitude*; longitude*; effort; transect_type; weather; Beaufort; swell; visibility; sightability; glare; ice; ice_type; SS_temperature(C)*; depth_EA640*; obs_port; obs_stbd; DR_1; DR_2; obsXdr; wind_direction (true)*; wind_speed (true)*; Speed over Ground(knots)*; Course over Ground (degrees)*; wave_height_m*; Comment.

Parameters included in BAS Event Log on SDA for sighting information:

Time (UTC)*; sighting_no; angle; reticles; method; cue; est_dist; latitude*; longitude*; sp_code; N_min; N_max; N_best; N_groups; calves; swim_direction; behaviour; behaviour_FS; transect_no; effort; obs; duplicate?; dupl_ID; photo; camera; photo_no; Course over Ground (degrees)*; Comment.

* Variables filled automatically by the Event Log.

See "Annex CS1" tables for menu of codes for environmental and sighting variables. All the codes that have the value zero (0) must be filled in the Event Log as double zeros (00), because the system automatically reset the variable to a blank field when it is just one zero.

DATA CHECKING AND CALCULATION OF EFFORT AND SIGHTINGS PARAMETERS

There is an R SCRIPT (SDA046_live_sightings.R) for the data generated by the Event Log (effort and sighting forms downloaded as CSV) with all the scripts to check the data, examine the variables, calculate the effort distances and times, calculate the radial and perpendicular distances of the sightings, calculate cetaceans' positions; generate maps, produce effort and sighting tables.

Outcomes

WESTERN CORE BOX (WCB)

The Western Core Box (WCB) survey has been running since 1996 and it is a unique time series of data on the distribution and abundance of macrozooplankton and micronekton around South Georgia (POETS-WCB - British Antarctic Survey - Project). The area is an 80 x100 km on/off shelf survey box on the north-western shelf of South Georgia. Data collection typically comprises eight active acoustic survey transects and eight stations at which CTD casts and stratified RMT8 nets are conducted, as well as target fishing of Antarctic krill swarms. Higher predator surveys have previously been conducted concurrently with the WCB acoustic transects, most recently in 2019, to study predator-prey interactions and baleen whale recovery (Baines et al., 2021).

With the SD046 cruise, approximately 300 nautical miles and 30 hours of data collection (ON Effort mode) were conducted during the WCB phase (Table 11.1). During the effort, we followed both protocols for cetaceans (distance sampling methodology, Annex CS1) and fur seals (methodology proposed by Russell Leaper, Annex CS2), and **178** sightings of seven cetacean and one fur seal species were recorded (Table 11.2 and Figures 11.7 to 11.9).

Table 11.1. Marine Mammal Survey transects (ON effort) in the WCB.

	date	transect	time_hours	distance_nm
1	2025-02-15	WCB 1.1 A	2.45	22.45
2	2025-02-15	WCB 1.1 B	0.09	0.92
3	2025-02-15	WCB 1.1 C	1.71	16.81
4	2025-02-15	WCB 1.2	4.34	42.94
5	2025-02-16	WCB 2.1 B	1.26	12.48
6	2025-02-16	WCB 2.2	4.03	39.76
7	2025-02-17	WCB 3.1	4.36	43.62
8	2025-02-17	WCB 3.2 A	1.30	12.59
9	2025-02-17	WCB 3.2 B	2.50	24.29
10	2025-02-18	WCB 4.1	4.28	43.17
11	2025-02-18	WCB 4.2	4.11	40.92

On the second day of the WCB survey, the weather deteriorated and there were only a few hours with good visibility and sightings, as can be seen on the third and second transect lines. Nevertheless, we stopped using the fur seal protocol at the end of the first day, as the number of sightings was very high, distracting from the cetacean survey, which was the priority. However, after some adjustments and in consultation with the project coordinator, we resumed the fur seal effort on the third day (Figure 11.9).

Table 11.2. Marine Mammal species sightings during the WCB survey.

	Species	WCB Sightings
1	Blue whale	1
2	Cruciger dolphin	5
3	Fin whale	12
4	Fur Seal	112
5	Humpback whale	29
6	Killer whale A	1
7	Like Antarctic Blue whale	1
8	Like Blue whale	1
9	Like Fin whale	6
10	Like Humpback whale	3
11	Like Right whale	1
12	Like Sei whale	2
13	Right whale	3
14	Unid large baleen	1

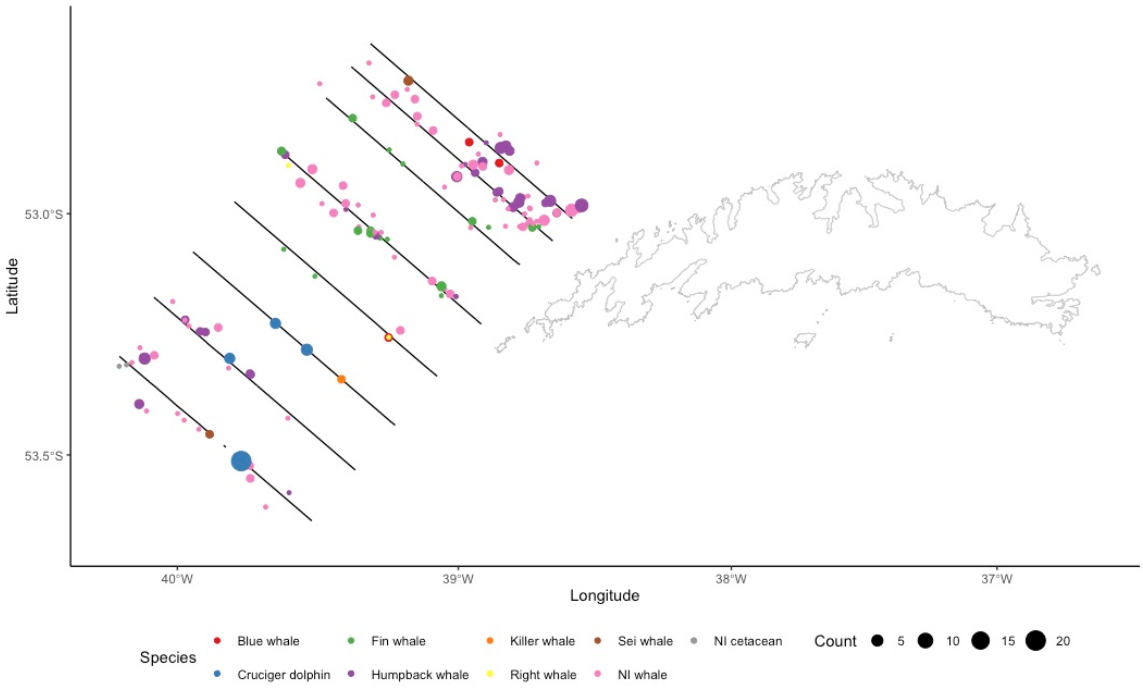

Figure 11.7. All cetacean species sightings during the WCB survey.

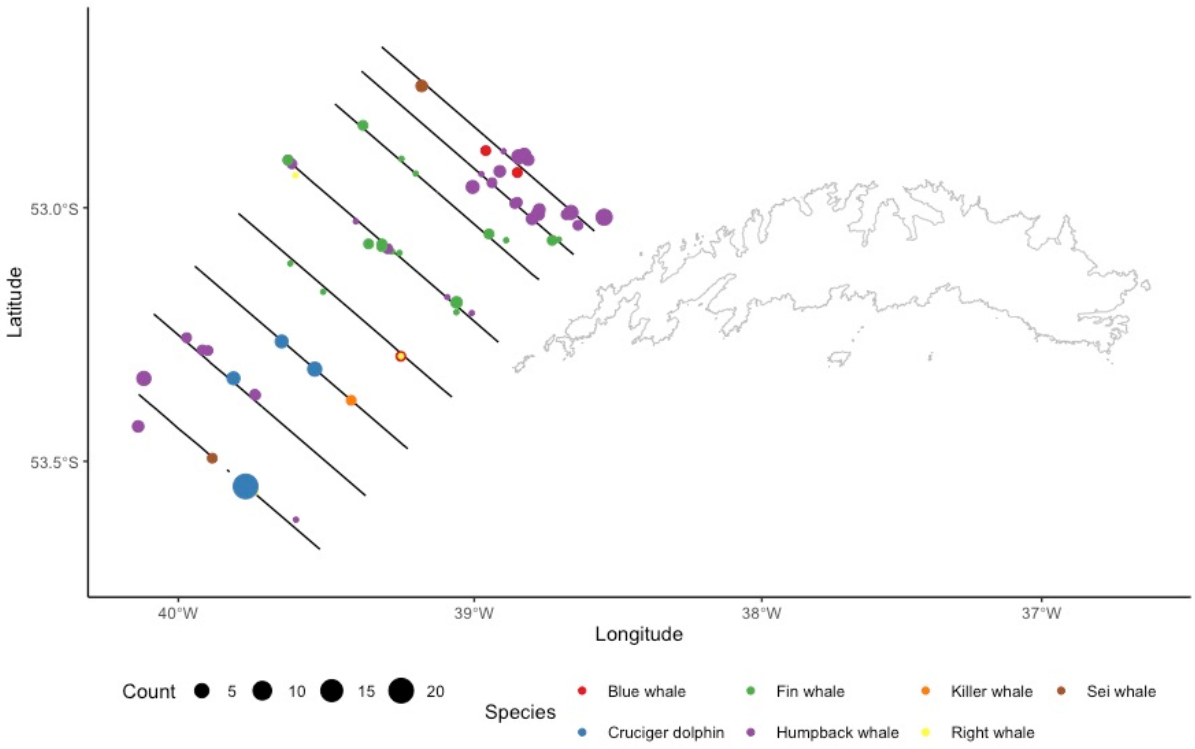

Figure 11.8. Main cetacean species sightings during the WCB survey.

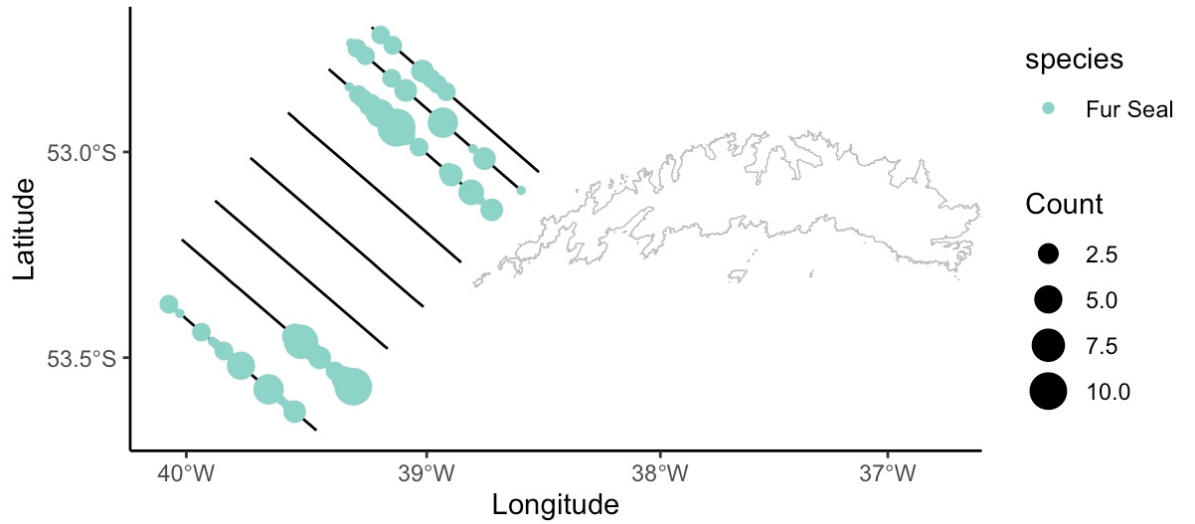

Figure 11.9. Fur seal sightings during the WCB survey.

VISUAL TRANSECTS (PLATFORM OF OPPORTUNITY)

Throughout SD046's cruise, the marine mammal team conducted onboard surveys while the vessel was in transit (at a minimum of 8 knots). If the weather and sea conditions were good (at least moderate visibility, swell < 4m and Beaufort <6) this was considered ON effort mode (see Figure 11.10 for the frequency of transects below and above some of the parameters). If the conditions were not below these parameters, the survey was conducted in OFF effort mode. It was decided to continue surveying by one observer when conditions were not good to monitor weather and sea conditions for improvements and resume ON effort mode. The team surveyed during the SDA046 cruise a total of 1,076.9 nm and 84.5 hours (ON effort), and 399.4 nm and 49.5 hours on OFF effort mode. Table 11.3 shows the survey effort for each transect line with nautical miles and hours (ON and OFF mode).

The most sighted species was the fur seal, and for the baleen whale species was humpback whale followed by fin, sei and Southern right whale (Figure 11.11). Cruciger dolphin (also called hourglass dolphin) was the most frequent odontocete, followed by killer whale.

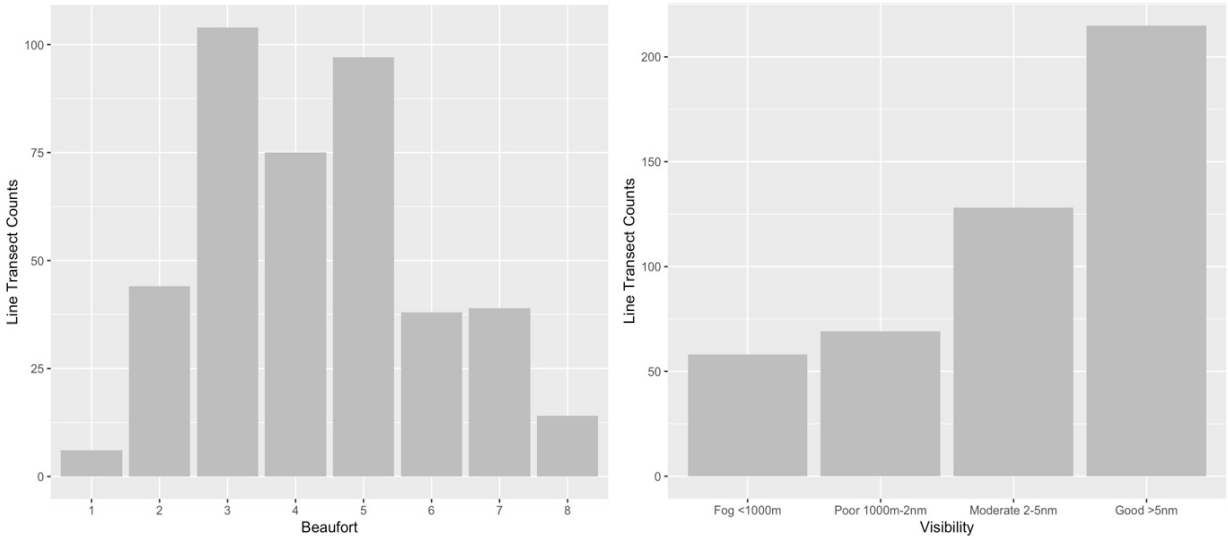

Figure 11.10. Beaufort sea state and visibility categories frequency during all the line transects.

Table 11.3. Transect lines effort ON (left) and OFF (right).

	date	transect	time_hours	distance_nm
1	2025-02-07	T01	1.14	14.69
2	2025-02-07	T02	1.01	13.38
3	2025-02-08	T04	3.32	46.95
4	2025-02-09	T06	4.24	60.19
5	2025-02-09	T07	2.58	35.21
6	2025-02-10	T08	3.11	30.24
7	2025-02-13	T11	0.77	7.32
8	2025-02-20	T17	1.59	14.97
9	2025-02-21	T18	5.29	51.58
10	2025-02-21	T19	1.40	13.54
11	2025-02-21	T20	0.31	3.04
12	2025-02-21	T21	0.81	7.98
13	2025-02-22	T23	1.87	25.75
14	2025-02-22	T24	0.96	12.96
15	2025-02-22	T25	2.45	35.27
16	2025-02-23	T27	0.53	7.71
17	2025-02-23	T29	5.32	76.44
18	2025-02-25	T30	0.60	8.49
19	2025-02-25	T32	1.40	20.06
20	2025-02-25	T33	1.02	14.74
21	2025-02-26	T35	2.06	29.66
22	2025-02-26	T36	0.39	5.71
23	2025-02-26	T37	2.71	37.15
24	2025-02-27	T38	1.10	15.02
25	2025-02-28	T39	2.36	31.67
26	2025-02-28	T40	1.37	18.84
27	2025-03-01	T41	3.94	49.77
28	2025-03-01	T42	5.68	70.84
29	2025-03-03	T43	0.18	1.85
30	2025-03-03	T44	0.13	1.20
31	2025-03-06	T45	1.55	17.23
32	2025-03-06	T46	5.49	64.72
33	2025-03-09	T49	4.58	65.53
34	2025-03-11	T52	2.07	29.25
35	2025-03-15	T53	2.74	37.90
36	2025-03-17	T56	0.62	7.99
37	2025-03-22	T59	2.27	30.07
38	2025-03-23	T60	1.92	26.83
39	2025-03-23	T61	0.29	2.67
40	2025-03-24	T64	3.38	32.51

	date	transect	time_hours	distance_nm
1	2025-02-07	PW03	1.29	5.54
2	2025-02-08	PW05	1.06	5.75
3	2025-02-10	PW09	0.68	0.13
4	2025-02-11	T10	1.24	5.06
5	2025-02-14	T12	1.03	12.99
6	2025-02-14	T13	4.02	48.15
7	2025-02-14	PW14	1.00	0.00
8	2025-02-16	WCB 2.1 A	3.01	29.90
9	2025-02-18	PW15	1.22	11.18
10	2025-02-19	PW16	1.28	12.16
11	2025-02-22	T22	1.03	14.15
12	2025-02-22	PW26	1.04	4.55
13	2025-02-23	T28	6.67	85.56
14	2025-02-25	T31	0.50	5.71
15	2025-02-25	T34	2.16	29.13
16	2025-03-07	PW47	1.22	0.20
17	2025-03-08	PW48	2.86	0.04
18	2025-03-09	PW50	1.24	0.21
19	2025-03-10	PW50	1.05	13.52
20	2025-03-10	PW51	1.10	0.96
21	2025-03-15	PW54	1.38	0.00
22	2025-03-17	PW55	1.14	14.68
23	2025-03-21	T57	8.58	73.29
24	2025-03-22	PW58	1.43	1.94
25	2025-03-23	T62	1.94	19.28
26	2025-03-23	T63	0.38	5.30

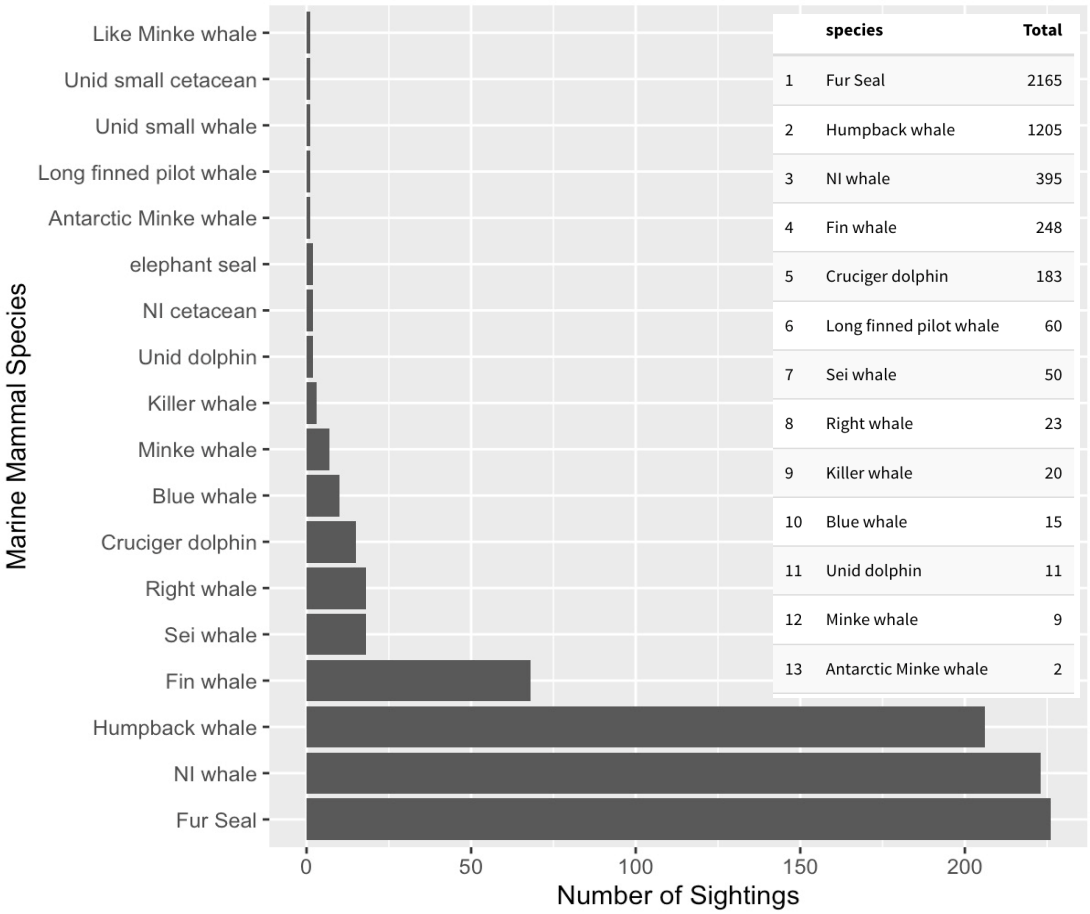

Figure 11.11. Bar chart with the number of sightings for each species (according to our species code categories, see Appendix 11.6), the and the table with the total number of individuals (N).

There is little information on the distribution, abundance and density of many marine mammal species in some of the areas travelled to on the SD046 cruise (e.g. Southwest Sandwich Islands). Although the sea and weather conditions were not ideal in many transects, mainly due to heavy fog, we still had many days with good visibility, which produced some interesting findings.

There were some regions with a high concentration of cetacean species (see Figures 11.12 to 11.14), such as the slope region off the south-eastern of South Georgia. In this region (Figure 11.12, about 36° west longitude), we sighted an enormous number of humpback whales and fur seals feeding and interacting, estimated to be about 500 whales and at least 1,000 fur seals. During this event, the echo sounder (EK80) recorded a huge biomass of krill, which shows the importance of recording the density of whales and krill at the same time. Another area with a high number of whales (50 sightings in 2 hours of survey) was the south-east Orkney Islands (see Figure 11.14), along the slope region. Further concentrations occurred in the western and south-western South Sandwich Islands (Figure 11.13). There are certainly more areas with a high frequency of sightings, but due to poor visibility caused by dense fog or sailing at night, we were unable to determine this.

Another interesting result was when we sailed in the eastern area of the A23 Iceberg. We stayed in this area for almost 2 days with moderate visibility and good sea conditions and only

had two sightings. Unfortunately, visibility was very poor when sailing in the western area of the A23.

Fur seals sightings were very frequent around South Georgia, decreasing south of 55º S latitude, and with only two sightings south of 60º S (Figure 11.15).

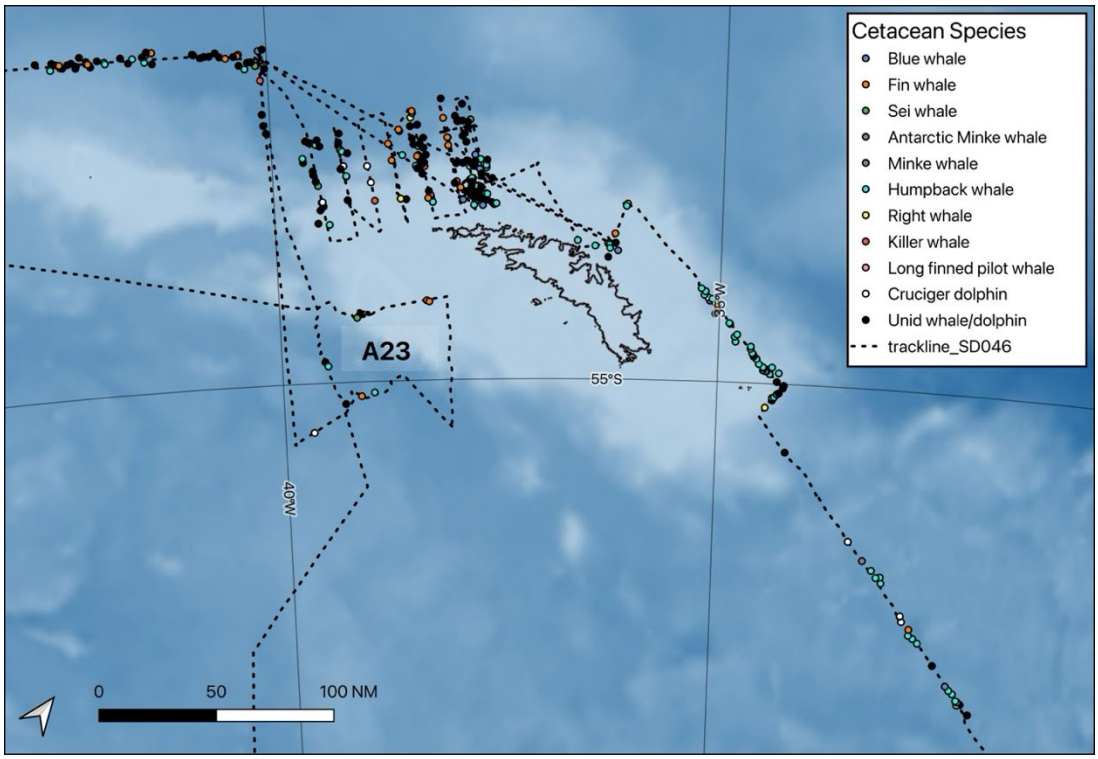

Figure 11.12. Map of the cetacean sightings around South Georgia islands with the SDA route.

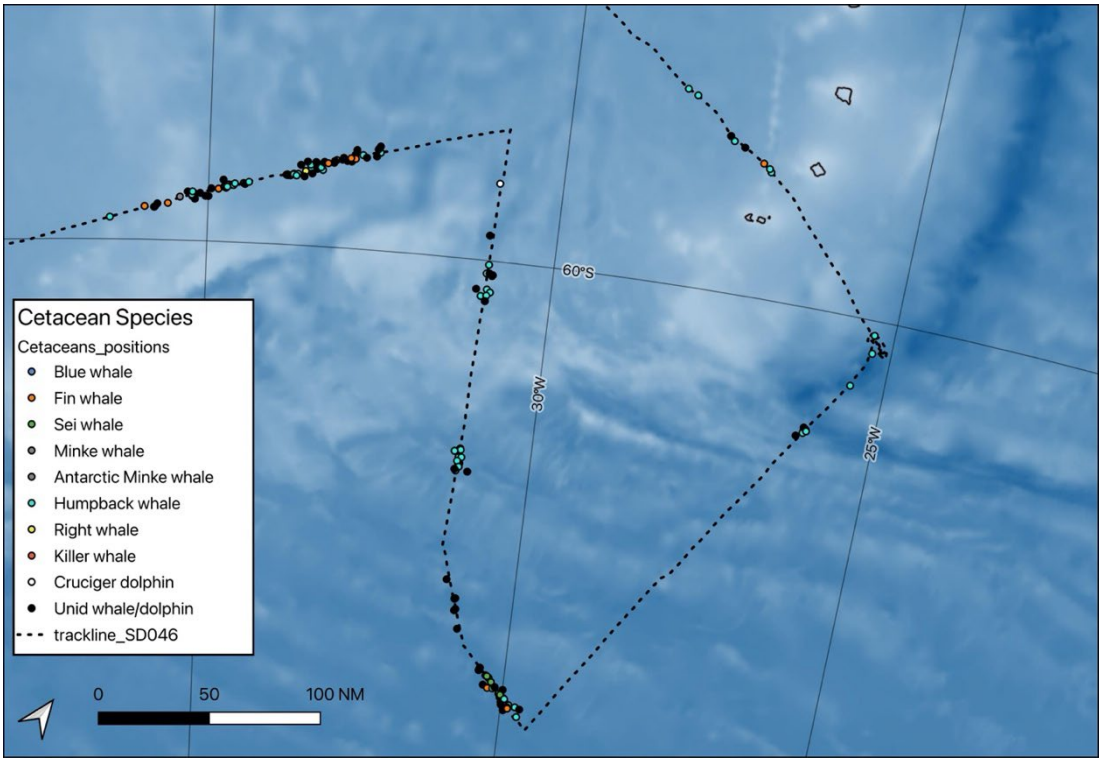

Figure 11.13. Map of the cetacean sightings around South Sandwich Islands with the SDA route.

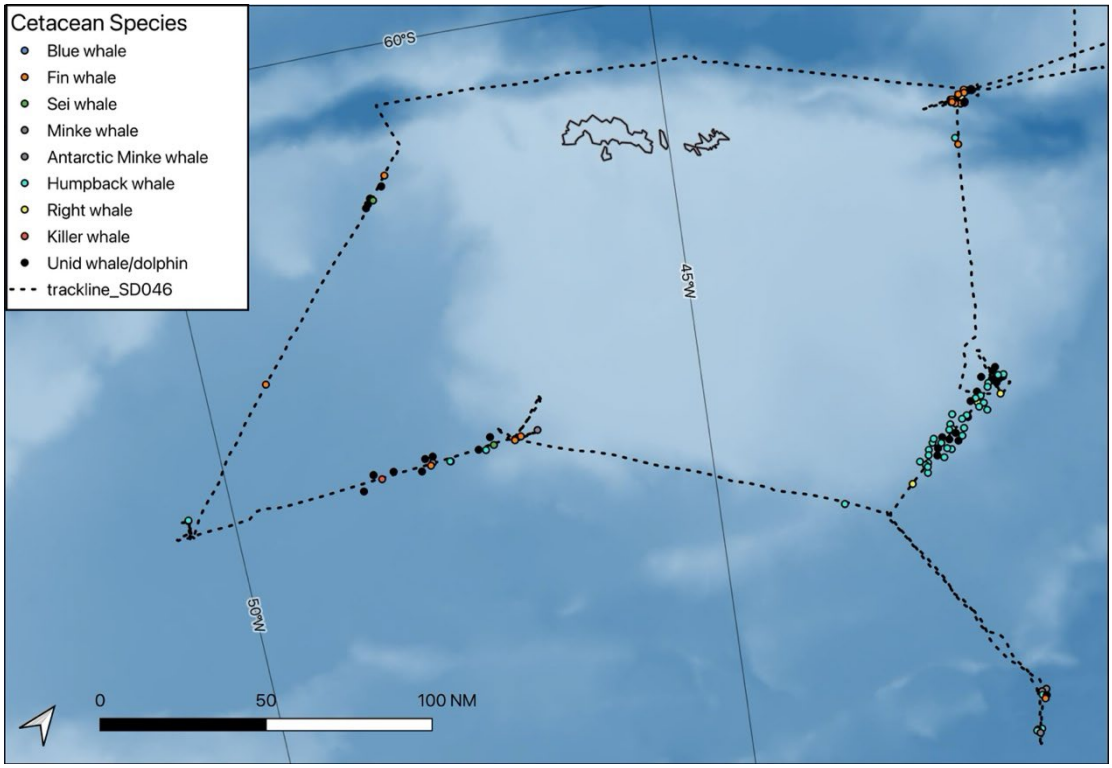

Figure 11.14. Map of the cetacean sightings around Orkney islands with the SDA route.

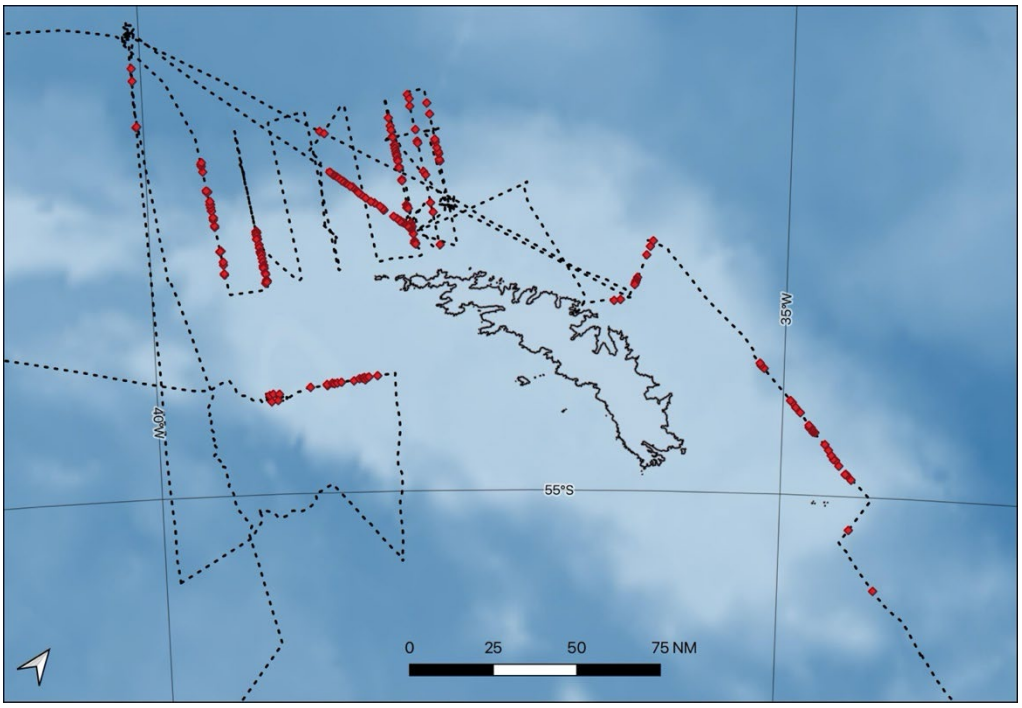

Figure 11.15. Map of the fur seal sightings with the SDA route (only two sightings occurred under the 60º latitude).

Recommendations

This cruise was a pilot study for the standard protocols of marine mammal line transect surveys on board the SDA. The Event Log was created, tested and changed during the first days of the cruise, as were the variables and codes for the effort and sightings data. Our platform was located on the bridge (23.1 metres eye level) for the entire cruise. However, the bridge is not recommended for the methodology because of the following problems:

(1) There are too many visual obstructions such as the windows because the glass is often not clean, and it is difficult to focus the binoculars. In addition, the windows are divided, as shown in Figure 16, creating a shadow area. We asked four people to use the angle board to measure how many degrees you could not see from each side, and the average was 19° for the port side and 17° for the starboard side. So, these angles of obstruction need to be considered when analysing the data.
(2) The bridge is a place where the deck officers work, people visit the bridge, etc., which distracts the observers.
(3) On the other hand, the team must talk on the radio about the weather and the sightings and this also disturbs the deck officers on their watch.

Figure 11.16. The window on the bridge where the observers stand for the surveys. The red arrow indicates the visual shadow for the observers (about 17° for the starboard side and 19° for the port side).

We therefore strongly recommend moving the platform (data collection) to the observation deck on later voyages, but outside rather than inside. Ideally, two observation boxes (port and starboard) should be installed on each side of the outside front area (Figure 11.17).

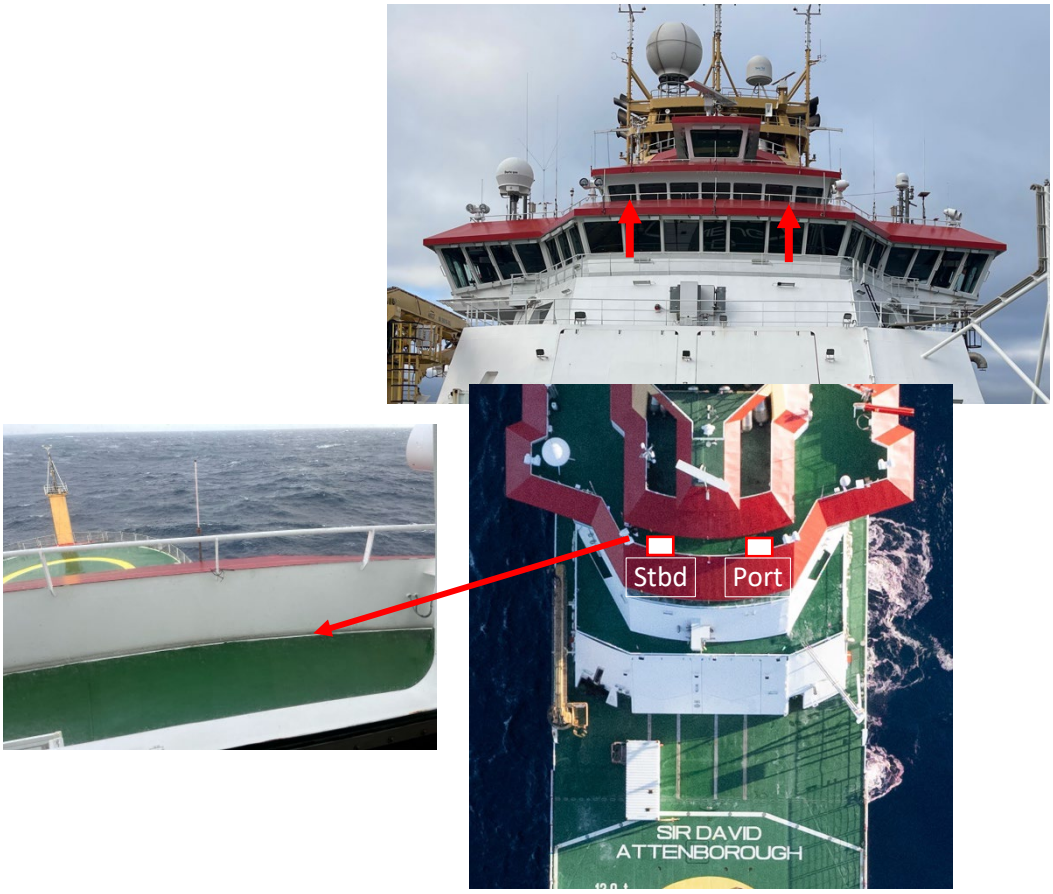

Figure 11.17. The observation deck with the proposed positions for the observation boxes (starboard and port side).

The boxes can be made of aluminium or fibreglass and are removable. This means that they can be stored in the ship and only placed on the observation deck during the surveys. In this way, they last longer and do not detract from the ship's external appearance. Figure 11.18 shows examples of observation boxes. The data recorder can work inside the observation deck (Figure 11.19) with a view of the observers and can quickly move outside if necessary (for photos and assistance with ID). In addition, all study material can be stored on the observation deck. To summarise, the observation deck with the boxes outside and all the facilities inside makes this location ideal for future visual platforms.

Another important recommendation is the minimum number of 4 people in the marine mammal team. This is because on many days with long working hours and in areas with high animal densities, one person is needed in the “resting position" to help with sightings. In addition, the maximum time an observer can properly scan the sea is 30 minutes - which allows observers to switch between the resting position and the data recorder position to give their eyes a rest. It is also important that the marine mammal team members are dedicated to the project and do not work as volunteers from other science teams.

Cetacean and fur seals protocols have different range distances to survey, with the first observer searching more distant areas with binoculars and the second searching an area of no more than 1000 metres from the vessel. This means that observers will neglect one or the other protocol when scanning. It is therefore recommended that one or two other people to collect data on the fur seals independently of the cetacean observers. The data recorder can record both sightings, but the observers must be independent.

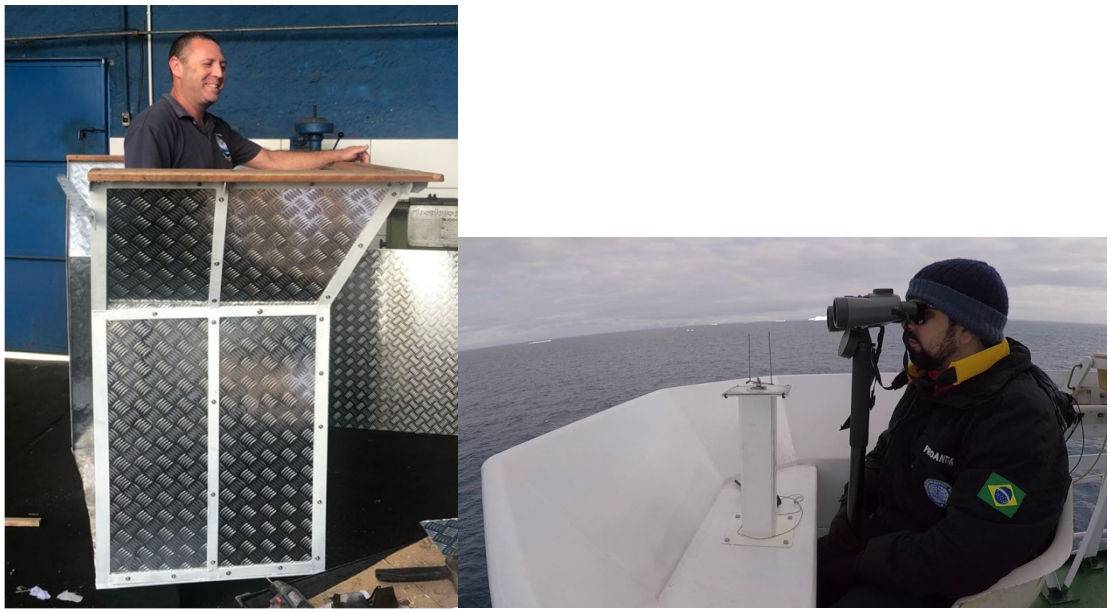

Figure 11.18. Examples of observation boxes (aluminium at left and fibre at right).

Figure 11.19. Observation deck internal area.

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12. Benthic Biology

12.1 Agassiz Trawl

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Introduction

Within BIOPOLE, the work package 2 focuses on how biological processes alter carbon: nutrient ratios in polar environments, including focus on parametrising biological processes of the lipid pump. Research questions to be addressed are 1) Do benthic animals increase the efficiency of the lipid pump by consuming overwintering zooplankton, especially calanoid copepods, at depth?, and 2) How can we represent the stoichiometric consequences of the polar lipid pump in a biogeochemical model?. To collect selected benthic fauna feeding on pelagic calanoid copepods as well as diapausing calanoid copepods, AGT deployments were planned for around 500 m and 1500 m water depth at the BIOPOLE superstations and at 3500 m at the BIOPOLE Mooring site.

A double-sampler epibenthic sledge after Brandt & Barthel (1995) was used to collect macrobenthic epifauna in its epi-sampler, while the supra-sampler collected epifauna capable of swimming, demersal zooplankton as well as zooplankton species known from the upper water column, which could include diapausing calanoid copepods.

A deployment at each collection depth of the AGT was planned after WCB phase of SD046 and at each of the BIOPOLE superstations. No deployments were planned along A23 transect and in the South Sandwich Trench.

Aims of the AGT deployments were 1) to collect macrobenthic fauna for lipid and stable isotope analyses, and 2) to assess the macrofaunal diversity.

Methodology

Agassiz Trawl (AGT)

Our Agassiz trawl used a mesh size of 1 cm and had a mouth width of 2 m. At each station, where previous data was unavailable, the seabed topography was examined prior to trawl deployment using multibeam sonar. The AGT was used to sample animals approximately 1 cm and larger in length, which comprise the larger macro- and megafauna, but did capture some smaller animals as well.

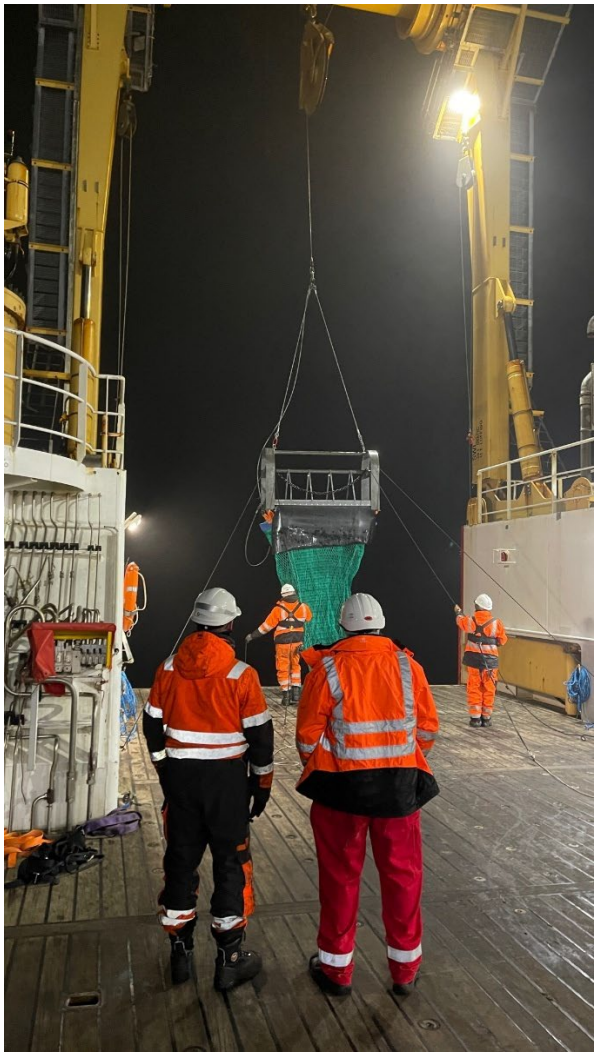

Figure 12.1.1. Deployment of AGT

The AGT was trawled for 10 min on the seabed on each of the 11 events it was deployed (Figure 12.1.1, Appendix 1). The trawl at event 129 (3600 m BIOPOLE mooring station) was a failed trawl due to the inner net inverting.

Table 12.1.1. Details of the successful AGT deployments sampled on SD046

Event Number	Date	Start Lat	End Lat	Start Long	End Long	Min Depth	Max Depth
SD046_016	11/02/2025	-53.5736	-53.5751	-37.0491	-37.0544	555.04	561.48
SD046_065	20/02/2025	-53.8404	-53.8404	-36.0604	-36.0679	704.45	735.08
SD046_102	02/03/2025	-60.6683	-60.6697	-42.264	-42.2746	1393.68	1426.11
SD046_116	04/03/2025	-60.68	-60.6781	-42.4738	-42.467	554.23	554.23
SD046_126	06/03/2025	-60.5423	-60.5439	-47.6707	-47.6808	1618.5	1704.16
SD046_144	09/03/2025	-61.9819	-61.9821	-46.7898	-46.8005	1562.15	1562.15
SD046_153	10/03/2025	-61.83	-61.8267	-46.6705	-46.6763	610.09	611.86
SD046_170	15/03/2025	-62.0016	-62.006	-41.9932	-41.9998	1470.25	1476.3
SD046_180	16/03/2025	-61.8659	-61.8661	-42.1526	-42.1615	597.78	605.59
SD046_200	19/03/2025	-60.5436	-60.5396	-40.9625	-40.9658	580	580

The AGT was deployed following SDA's SEA-SD-DEP-EQUIP-08 issue status 1.0.

Sample processing

Samples were cleaned on deck to remove mud before transfer to the wet lab. Samples were photographed as total catch and hand-sorted into groups varying from Phylum to species level collections. The wet-mass (biomass) of the different taxa was assessed by using calibrated scales (with accuracy and resolution of 0.001 kg). Animals were either preserved in 96% ethanol, RNA later, or frozen at –20°C or –80°C. Whole animals (for smaller organisms) or tissue samples (for larger organisms) were frozen at -80°C in 2 ml cryovials for future diet analysis (lipids and stable isotopes).

All specimens were catalogued for the BAS benthic sample database and a large proportion of them were documented photographically using a set of cameras and macro lenses up to 5x real size (for specimens down to 0.5 mm), or using a camera attached to a stereomicroscope for the smallest specimens (see section 12.2 for detail of photographic setup).

Examples of macrobenthic specimen specimens from the AGT. Photo credits to Lydia A. Schmidt and Gonzalo Giribet.

Outcomes

11 AGT deployments were made during the expedition SD046 (Fig. 12.2.3, Table 12.2.1.), of which two were on the shelf of South Georgia during the WCB phase of the expedition and the others were during the BIOPOLE phase

12.2 Camera-Epibenthic Sledge

Authors: Katrin Linse, Isabelle Cooper, Lisa Friberg, Gonzalo Giribet, Huw J. Griffiths, Matt Hood, Elena Josso, Lydia A. Schmidt, J. Leonard Verheyen, Petra Ten Hoopen

Introduction

Within BIOPOLE, the work package 2 focuses on how biological processes alter carbon: nutrient ratios in polar environments, including focus on parametrising biological processes of the lipid pump. Research questions to be addressed are 1) Do benthic animals increase the efficiency of the lipid pump by consuming overwintering zooplankton, especially calanoid copepods, at depth?, and 2) How can we represent the stoichiometric consequences of the polar lipid pump in a biogeochemical model?. To collect selected benthic fauna feeding on pelagic calanoid copepods as well as diapausing calanoid copepods, C_EBS deployments were planned for around 500 m and 1500 m water depth at the BIOPOLE superstations.

A double-sampler epibenthic sledge after Brandt & Barthel (1995) was used to collect macrobenthic epifauna in its epi-sampler, while the supra-sampler collected epifauna capable of swimming, demersal zooplankton as well as zooplankton species known from the upper water column, which could include diapausing calanoid copepods.

A deployment at each collection depth of the C-EBS was planned prior to and after WCB phase of SD046 and at each of the BIOPOLE superstations. No C-EBS deployments were planned along the C-EBS transect and in the South Sandwich Trench.

Aims of the EBS deployments were 1) to collect macrobenthic fauna for lipid and stable isotope analyses, 2) to assess the macrofaunal diversity, and 3) to record the presence of upper pelagic calanoid copepods, especially of *Calanoides acutus*, in near seafloor water depth.

Methodology

Camera-epibenthic sledge (C-EBS)

Epibenthic sledges (EBS) with a bottom shovel to open the sampler box doors on the seafloor only are proven sampling devices to collect macrofaunal organisms on and above the seafloor (Brandt & Barthel 1995, Kaiser & Brenke 2016). During the BIOPOLE II 2 (SD046) expedition, one types of EBS were deployed, and a double, supra- and epi-sampler EBS *sensu* Brenke (2005), named TATI (Figure 12.2.1). The EBS were equipped with a bracket to hold a Posidonia USBL transponder on deployment. The EBS was equipped with one of SDA's USBL transponders on its first deployment, but following receiving issues with SDA's poles, USBL transponders were not fitted for further deployments.

The C-EBS was equipped with a SubC Rayfin Benthic camera, two DeepSea nano SeaLite lights and two lasers. The camera and the lights had their power connected minutes before deployment start, with a successful power connect being indicated by switched on lights. The

lasers were using a customs-made pressure switch for switch on at water depth for safety reasons. As the pressure switch developed a fault, the power pack of the lasers was removed after 3 deployments.

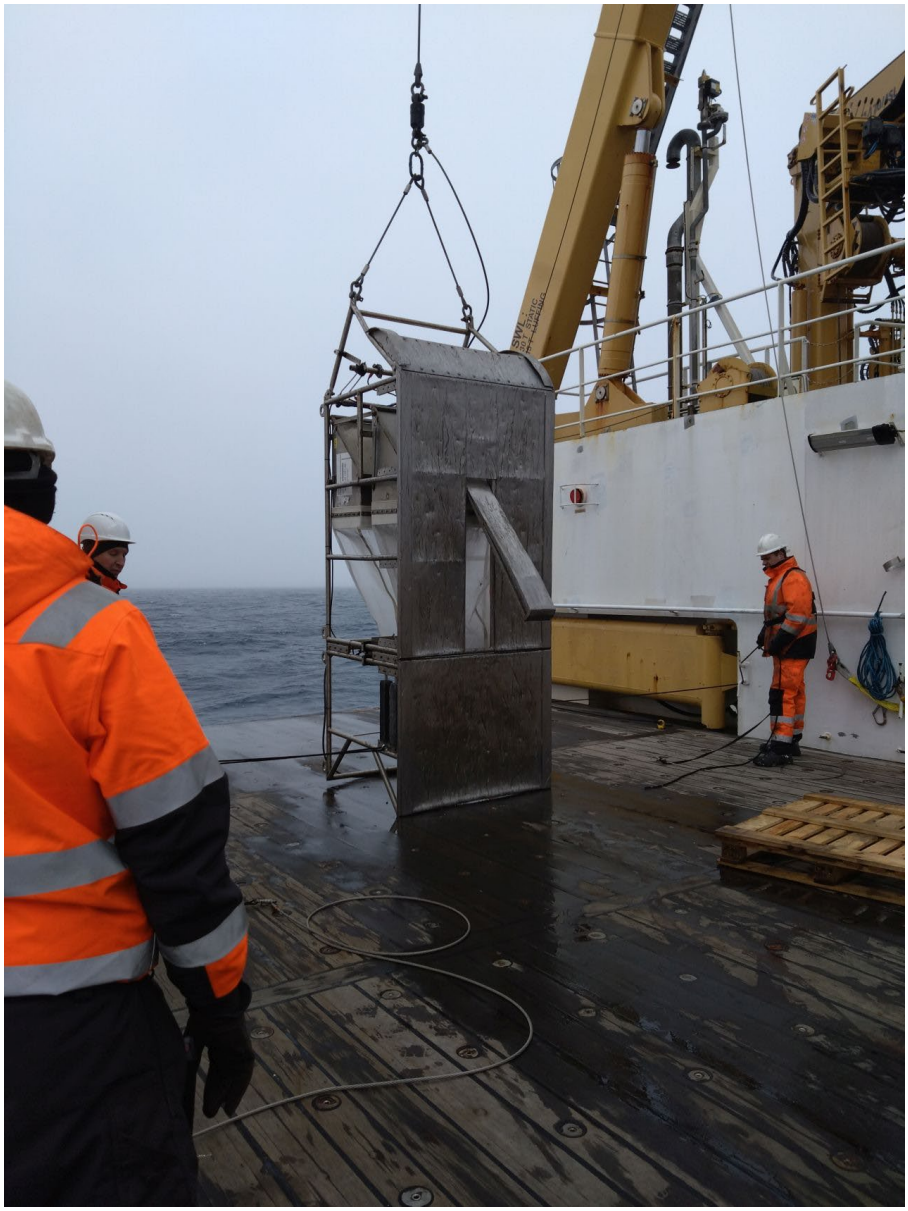

Figure 12.2.1. Deployment of C-EBS TATI

A single C-EBS was deployed at those stations were substrate allowed and drop stones were not prevalent. As trawled gear never hits the same spot when repeating a station (Brattegard and Fosså, 1991), pseudo-replicate samples were not taken during this expedition. The C-EBS was trawled for 10 min on the seabed on each of the nine events it was deployed (Figure 12.2.5, Annex EL).

The C-EBS was deployed following SDA's SEA-SD-DEP-EQUIP-08 issue status 1.0, which was subsequently updated (see Recommendations below).

1. SDA holding on DP on start position.

2. Lower cable with 0.3 m/s to 200 m water depth, increase SDA to 0.3 kn, then increase winch speed to 0.5 m/s until about 80 m above seafloor.

3. Winch speed reduced to 0.3 m/s for landing in seafloor.

4. SDA moving forward on DP with 0.3 kn over ground, while veering cable with 0.3 m/s until 1.5-times cable length to water depth (< 1000 m water depth) or 500–1000 m cable length over water depth (> 1000 m water depth).

5. SDA moving at 1 kn for 10 min.

6. SDA stop, holding stationary position on DP for recovery.

7. Heave cable with 0.3 m/s until EBS leaves seafloor and hangs in the water column at about 50 m above seafloor.

8. Then raise heaving speed to 0.7 m/s until deck.

9. On deck the EBS will be secured in an upright position to removal of samples.

Landing of the EBS on ground and lift off ground were monitored by the vessels tension meter Grafana system (Fig. 12.2.2.) and deployment events like in water, on bottom, start trawl, end trawl, off bottom and on deck recorded in SDA's event log system (see Section 6 Data Systems).

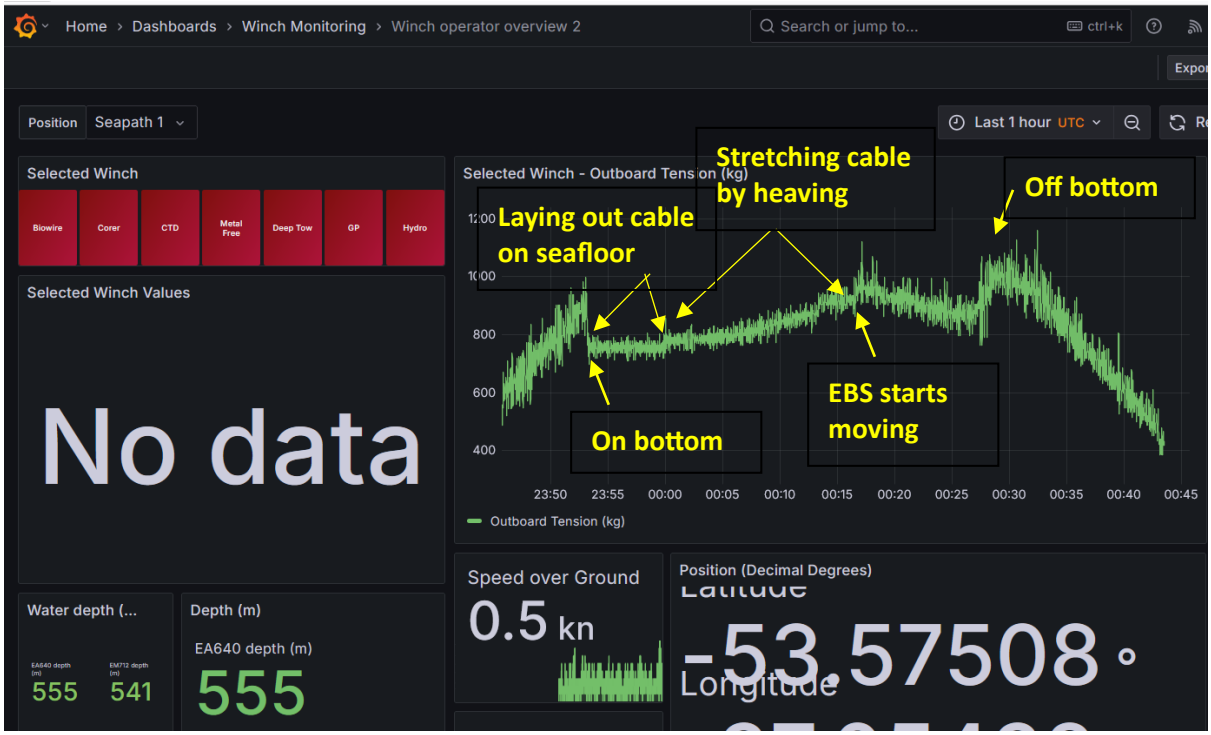

Figure 12.2.2. Tension meter history on SDA's Grafana.

The EBS trawl lengths were calculated using the following formula:

$s = v1 \times t1 + v2 \times t2 + v3 \times t3$

s = trawl length, t1 = vessel trawl time (min), t2 = vessel haul (min), t3 = winch haul time (min), v1 = vessel trawl speed (m/s), v1 = vessel haul speed (m/s), v1 = winch haul speed (m/s).

In total, nine C-EBS were deployed across two study areas. The C-EBS deployments in 500 m to 3420 m depth had calculated trawling distances of between 579 m and 1029 m. Video data were downloaded from the memory drives and uploaded to SDE's leg: drive. Footage was available from six deployments.

Sample processing

On deck, while the C-EBS was secured in upright position, the supra- and epi-nets were washed down into the cod ends using cold seawater from the uncontaminated seawater supply. The cod ends were then transferred into buckets with seawater. If sample (e.g. sediment) was seen above in the nets above the cod ends, a tray was placed underneath the cod ends prior to removal to collect the sample.

The supra cod end was directly transferred into the cold room CT1 (+4 °C) for the zooplankton team to assess the sample for calanoid copepods. On return to the wet lab, the supra sample was treated like the epi (see below).

The epi sample was transferred into the wet lab and if the sample was clean, meaning mud free, transferred into sorting trays and organisms visible to the eye were removed. Bulk subsamples in small trays were taken for live sorting of small microspecies under a Meiji stereomicroscope. If > 2 specimens were found of the same morphotype, one was fixed in 96% non-denatured ethanol for morphological and genetic identifications, while one or more were frozen at -80°C for lipid and stable isotope studies. Selected specimens were preserved in RNA later to enable additional transcriptome and genome studies. Other selected specimens of unique or taxonomically interesting groups were preserved in 96% ethanol for subsequent work, including taxonomic, genetic and ecological (i.e., metabarcoding of gut content to investigate host/prey interactions) study. Remaining bulk samples were sieved with water from the uncontaminated seawater tap over a 300 µm mesh and fixed in chilled (-20°C) 96% ethanol.

When available, muddy cod end samples and net overstands were sieved on deck at the sieving table with filtered, uncontaminated seawater over stacked 1000 µm and 300 µm sieves. Organisms visible to the eye were removed and fixed in 96% ethanol and the remaining bulk sample was also fixed in 96% ethanol.

All ethanol samples were stored initially in the -20°C science freezer room. Bulk samples were checked in about 3-hourly intervals for the first 12 hours and gently rolled to enable ethanol fixation and to avoid freezing.

All these specimens were catalogued for the BAS benthic sample database and a large proportion of them were documented photographically using a set of cameras and macro lenses up to 5x real size (for specimens down to 0.5 mm), or using a camera attached to a stereomicroscope for the smallest specimens.

Selected supra and epi bulk samples were sorted to higher taxonomic levels (phylum, class or order) under a Meiji and a Motic stereomicroscope and counted. Due to sampling at the end of the expedition and short time availability, sorting of all C-EBS bulk samples to major taxonomic levels could not be performed on board. Some selected taxonomic groups were sorted to species for some EBS samples (Mollusca).

Macrobenthic specimen imaging

Larger macrofaunal photography

Standard macrophotography uses macro lenses than can provide up to 1x magnification (35mm for a full sensor camera, equivalent to traditional 35mm film). These macro lenses are ideal for specimens that are between a few mm in length/diameter and several cm). We photographed specimens with a dark background in dedicated small aquaria and accessory lights (either an incandescent lamp or flashes) using a Nikon D7500 camera with a AF MICRO NIKKOR 60mm macro lens or a Canon EOS R5, RF100mm F2.8 L Macro IS USM, with a Canon Speedlite Transmitter ST-E2, and three remote Speedlite 270EX II flashes. Images were processed to remove backgrounds and crop as necessary using dedicated software (Lightroom, Photoshop, etc.).

Smaller macrofaunal photography

For specimens 5mm in length or smaller, we used a Canon EOS R5 or a Canon EOS 5D MIV, with a MP-E65mm F2.8 1–5x Macro Photo, and Canon Speedlite Transmitter ST-E2, Speedlite 270EX II x3. The MP-E65mm F2.8 1–5x Macro Photo has a minimum size of 1x (not allowing photograph of larger specimens) but the advantage of allowing photography of 5x real size, therefore becoming the lens of choice for animals a few millimeters in length/diameter.

Figure 12.2.3. Setup for photographing mm-to-cm-sized specimens.

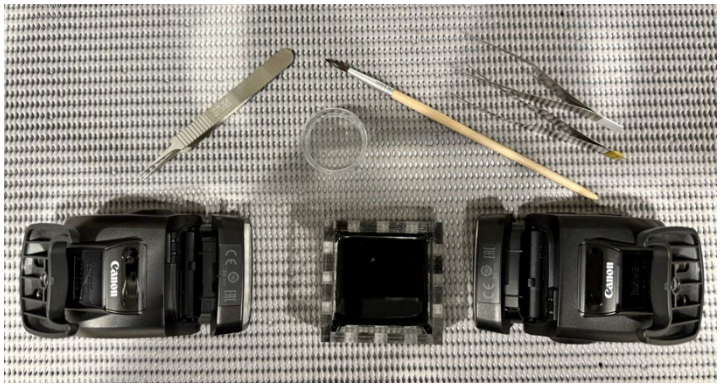

Figure 12.2.4. Example of small aquarium setup for photographing mm-sized specimens.

Additionally, during sorting of bulk samples, sediment type examples and selected macrofaunal specimens were photographed with an AmScope MU1803 USB camera attached to the trinocular Meiji stereomicroscope.

As few selected specimens from C-EBS deployment #017 were mounted on 11.5 mm Hitachi SEM stubs on carbon stickers and imaged with a Hitachi TM4000Plus tabletop SEM in the dark room.

Outcomes

Nine C-EBS deployments were made during the expedition SD046 (Fig. 12.2.5, Table 12.2.1.), of which two were on the shelf of South Georgia during the WCB phase of the expedition, with one was apported during deployment due to a caught steading line and repeat C-EBS deployment cancelled because of incoming weather, and the others were during the BIOPOLE phase.

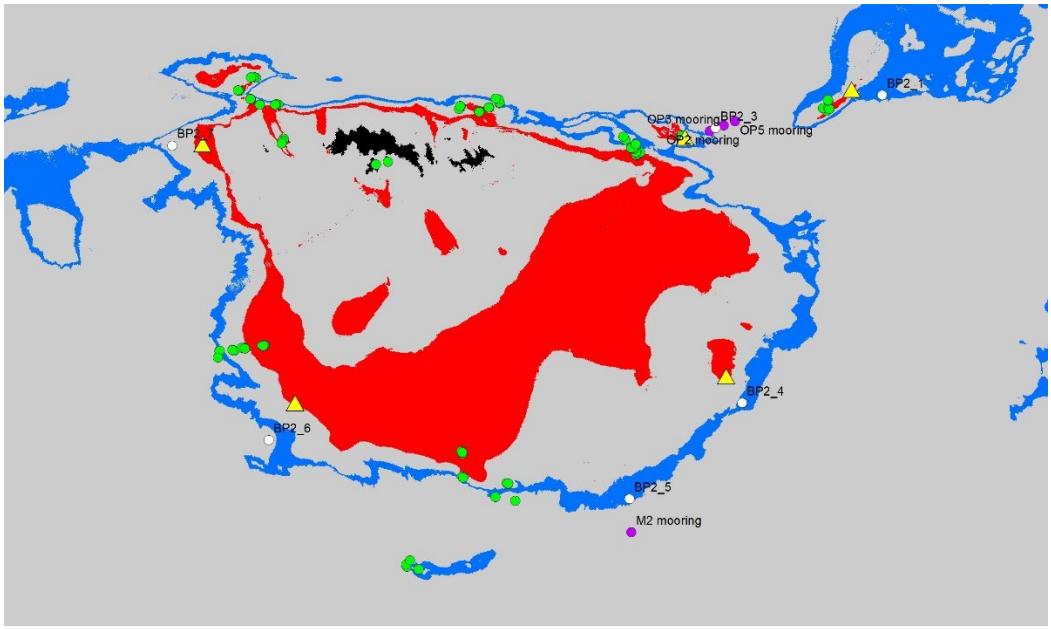

Fig. 12.2.5. Map of C-EBS stations in BIOPOLE phase of SD046

C-EBS deployments and trawling distance

Event number	Superstation	Water depths (m)	Trawling distance (m)	Camera	Number of bulk vials	Number of benthos vials
#017	WCB	550	579	No	2	49
#109	BP2_3_1500	1500	1029	Yes	2	64
#117	BP2_3_500	500	489	Yes	2	80
#130	BP2_8_3400	3420	957	Yes	4	84
#145	BP2_6_1500	1500	795	Failed	4	123
#154	BP2_6_600	600	633	Failed	3	79
#173	BP2_4_1500	1505	849	Yes	3	69
#181	BP2_4_500	600	633	Yes	4	
#199	BP2_1_500	580	615	Yes	4	

Table 12.2.1. Successful C-EBS deployments: event number, superstation, water depths, trawling distance, camera deployment, and numbers of bulk and benthos vials

In-situ seafloor habitats

The SubC Rayfin Benthic camera was attached to the C-EBS on eight deployments and during six deployments collected in-situ images from the sampled shelf and slope habitats (Fig. 12.2.6).

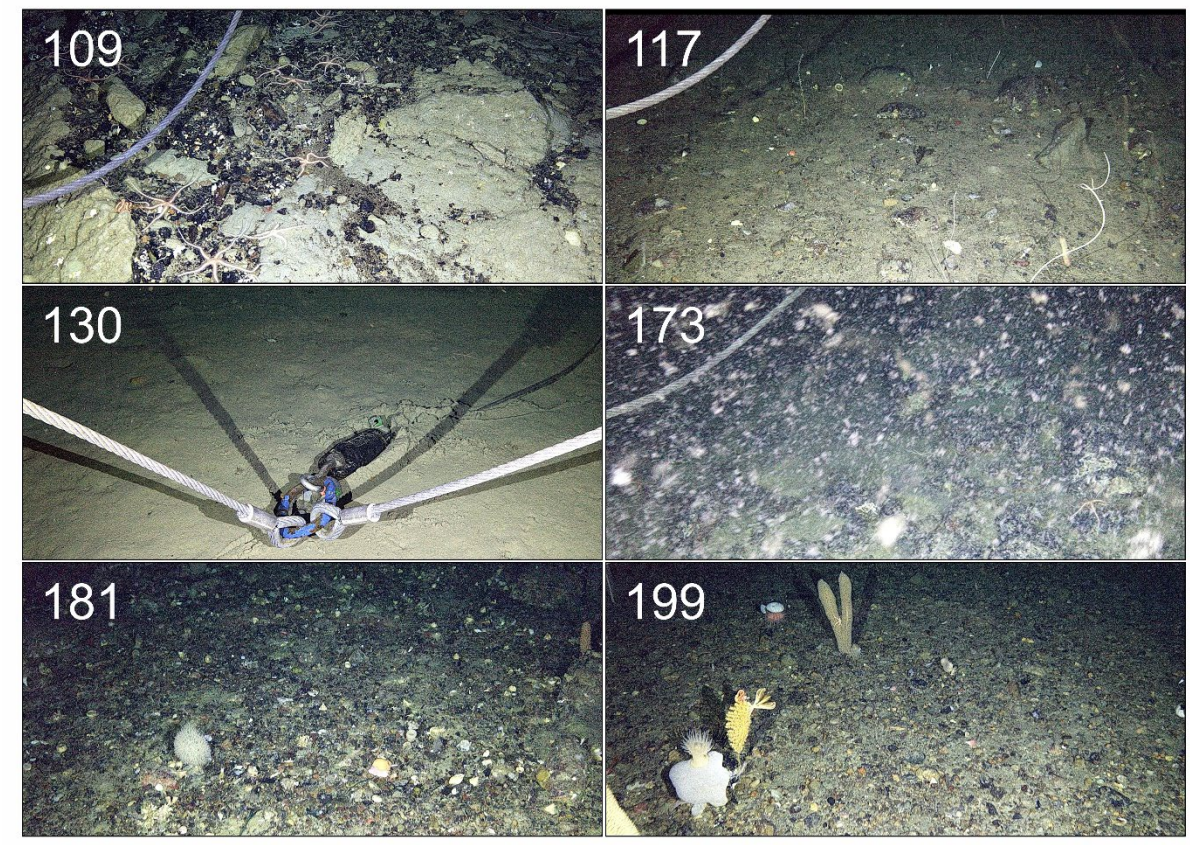

Fig. 12.2.6. In-situ habitat types for the C-EBS deployments

Macrobenthic samples

The nine C-EBS deployments yielded a total of 28 bulk and 548 benthos vials (Table 12.2.1.). 159 vials contained benthic fauna were fixed in 96% ethanol and 389 cryovials contained individual specimens for lipid and stable isotope analyses (Table 12.2.2., Appendix A)

	#017	**#109**	**#117**	**#130**	**#145**	**#154**
Annelida	6	2	8	15	30	3
Crustacea	12	8	31	15	33	15
Cnidaria	–	3	1	–	–	1
Echinodermata	11	8	4	8	6	5
Mollusca	–	–	14	6	10	3
Nermertini	–	–	2	–	2	–
Porifera	–	3	–	–	–	1
Chaetognatha	–	1	3	–	–	1
Bryozoa	–	–	–	–	1	–
Chordata	–	–	–	–	–	1
Total	29	25	63	44	82	30
	#173	**#181**	**#199**			
Annelida	3	1	2			
Crustacea	16	23	17			
Cnidaria	1	1	5			
Echinodermata	7	4	13			
Mollusca	–	1	10			
Nermertini	4	–	–			
Porifera	1	1	1			
Chaetognatha	–	1	3			
Bryozoa	–	–	–			
Chordata	–	–	1			
Total	32	32	52			

Table 12.2.2. Individual benthic specimens fixed in cryovials at -80°C per C-EBS station for lipid and stable isotope analysis.

Across all EBS combined, we froze at -80°C a total of 70 individuals of Annelida, 170 of Crustacea, 12 of Cnidaria, 66 of Echinodermata, 44 of Mollusca, 8 of Nemertini, 7 of Porifera, 9 of Chaetognatha, 1 of Bryozoan, and 2 of Chordata.

Selected individual benthic specimens were photographed, especially if a representative of the morphospecies was frozen for lipid analyses (Figure 12.2.7).

Figure. 12.2.7. Live photos of selected macrobenthic species collected by the C-EBS

	Event no	#017	#109	#117	#130	#145	#154	#173	#181	#191
	Depth (m)	550	1500	500	3400	1500	600	1500	585	500
	Trawl distance (m)	579	1029	489	957	795	633	849	633	615
Phylum	Class/order	S&E	S&E	S&E	S, sv E	S&E	S, sv E	S, sv E	S only	live
Annelida	Polychaeta	604	26	176	50	295	88	87	9	
	Echiura	4	0	0	0	1	0	0		
	Sipunculida	6	0	0	0	12	27	0		
	Oligochaeta	0	0	1	0	0	0	0		
Crustacea	Isopoda	522	51	339	14	142	42	35	2	
	Copepoda harp.	5	4	5	1	9	0	0		
	Copepoda cala.	78	8	6	5	106	40	0	3	
	Amphipoda	609	114	717	16	136	66	120	19	
	Cumacea	479	3	39	5	83	44	18		
	Decapoda	0	0	13	0	9	2	0		
	Leptostraca	0	0	6	1	0	0	0		
	Euphausiacea	0	0	0	0	8	6	1		
	Mysidacea	90	0	22	24	0	16	0		
	Ostracoda	268	11	85	0	92	6	23	8	
	Tanaidacea	7	4	18	5	61	2	4		
	mixed taxa	12	0	0	0	0	0	0		
Chelicerata	Pycnogonida	0	55	21	0	8	2	0		
Nematoda		10	2	1	1	37	0	1		
Mollusca	Bivalvia	217	2	25	11	76	42	21	1	
	Gastropoda	541	16	56	1	106	38	21	6	
	Scaphopoda	0	0	0	0	35	5	7		
	Polyplacophora	0	0	0	0	2	0	0		
	Solenocastres	4	6	12	1	20	7	3	5	
	Caudofoveata	0	1	0	0	1	1	0		
	Monoplacophora	0	0	0	0	14	0	0		
	Cephalopoda	0	0	0	0	0	0	0		1
Priapula	Priapulida	0	0	0	0	0	0	8		
Echinodermata	Asteroidea	0	2	7	3	1	3	0		
	Echinoidea	9	2	0	0	1	3	1		
	Holothuroidea	178	4	11	3	22	7	8	2	
	Ophiuroidea	221	100	31	3	115	8	101	5	
	Crinoidea	0	0	0	0	3	0	0		
Chaetognatha		3	0	7	0	4	1	1		
Cnidaria		0	0	0	0	0	0	0		
	Hydrozoa	3	38	1	0	0	0	0	1	
	Anthozoa	0	0	4	0	0	1	2		
	Coronata	0	0	0	0	0	0	0		
		0	0	0	0	0	0	0		
Bryozoa		0	4	11	0	11	38	0		
Brachiopoda		0	0	0	0	2	0	0		
Kinorhyncha		0	0	0	0	0	0	0		
Nemertini		7	2	7	0	12	5	10		
Hirudinea		0	0	0	0	1	4	0	1	
Enteropneust		0	0	0	0	9	0	0		
Platyhelminthes		5	0	0	0	0	0	0		
Porifera		6	81	2	0	2	6	1		
Ascidiacea		0	0	0	0	0	2	0		
Indet		4	11	10	0	2	0	0		
Total		3892	547	1633	144*	1438	512*	473*	62**	1***

Table 12.2.3. Specimen numbers of higher level macrobenthic taxa per C-EBS collection sorted on board of RRS Sir David Attenborough. *bulk Epi sample not sorted, **no Epi sample sorted, ***no Supra or Epi sample sorted.

Recommendations

EBS/C-EBS SEA-SD-DEP-EQUIP review

The C-EBS was initially deployed following SDA's SEA-SD-DEP-EQUIP-08 issue status 1.0, with the Science Bosun commenting on turning of the C-EBS on the cable when lifted off deck. This led to review and update of SEA-SD-DEP-EQUIP-08, which is currently with Joe Hooper for acceptance. Katrin Linse noticed the different way the block is attached to the A-frame on SDA compared to other vessels, which regularly deploy EBS without having the issue of a turning EBS (Fig. 12.2.7.).

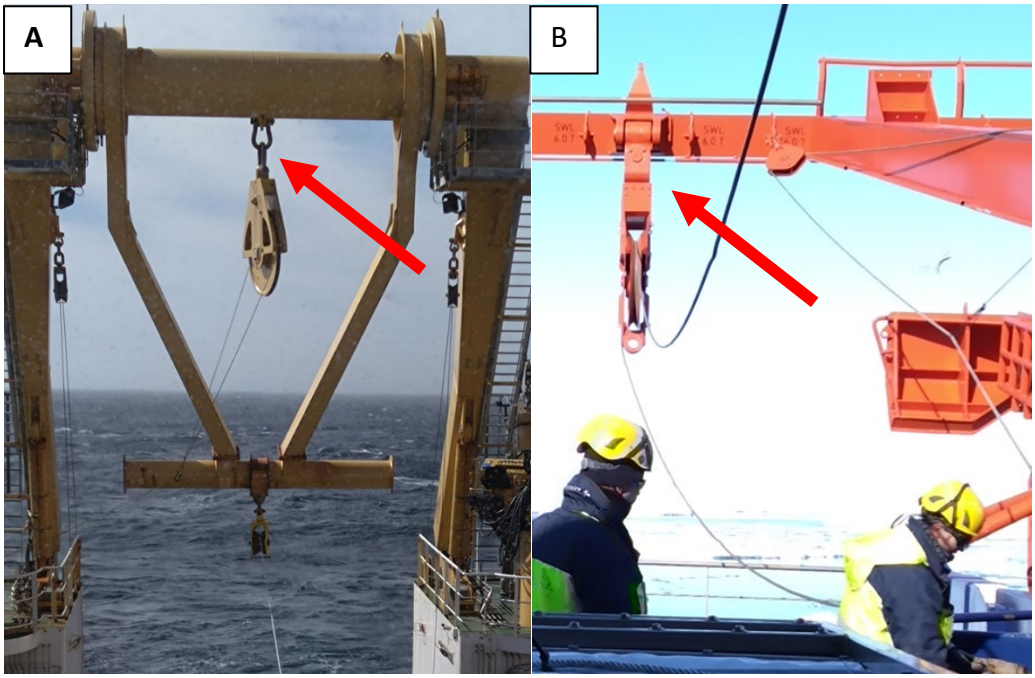

Fig. 12.2.7. Differences in block attachment to A-frame. A) RRS Sir David Attenborough. B) RV Polarstern.

EBS adjustable spring implementation

The C-EBS during deployment #130 lost a spring on the supra-sampler. Katrin Linse's recommendation is to replace the four springs with adjustable tension springs (Fig. 12.2.8).

Fig. 12.2.8. Adjustable tension springs on DZMB EBS BERTA.

C-EBS laser system

Review pressure switch for C-EBS lasers, the previous C-EBS camera system had a timer for switch on which worked reliable. To avoid the lasers to be on when the EBS is arriving on deck, a timer for switch off should be included.

USBL SOP for benthic towed gear

The C-EBS was equipped with a SDA USBL transponder on its first deployment for logging and recording its positions, which did not deliver saved data. SDA's USBL transponder system used on trawled benthic gear and its recording should be tested to have SOP for USBL use on benthic trawled/towed gear.

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Appendix A: Cryoboxes 1–9 containing all EBS and AGT cryovials.

	1	2	3	4	5	6	7	8	9	10
A	1	2	3	5	6	13	12	14	47A	47B
B	48A	48B	49A	50	51	52	56	57	58	59
C	60	62	68	69	70	71	72	73	75	76
D	77	65	66	67	79	80	81	92	93	94
E	95A	95B	95C	102	103	104	110	109	107	112
F	108	111	127	128	129	130	137	138	141	143
G	145	144	149	150	151	152	153	154	155	156
H	157	160	161	162	163	165	166	168	167	171
I	179	181	182	183	185	186	195	232A	236A	233A
J	229A	235A	243A	127A	233C	244A	234A	224	226	239

Fig. 12.2.9: Cryobox 1.

	1	2	3	4	5	6	7	8	9	10
A	239B	225	222	234	221	234C	228A	235A	246A	245A
B	237A	233B	220	247	223	240A	256A	262	241	263
C	261	257	248A	254A	282	269	275	288	267	292
D	295	285	280	278	297	279	273	266	271	281
E	284	277	283	272	300	301	276	270	268	274
F	289	287	298	291	290	341	337	338	339	334
G	335	342	296	308	311	309	310	312	313	314
H	315	316	317	318	319	321	322	331	323	324
I	325	330	332	333	336	340	326	97A	97B	97C
J	359	360	361	353	352A	363	364	365	369	367A

Fig. 12.2.10: Cryobox 2.

	1	2	3	4	5	6	7	8	9	10
A	366A	366B	366C	370A	354	372	371	373A	373B	373C
B	376	377	368A	378	380	381	382	379	383	390
C	392	391	388A	384	396A	396C	400B	396B	400A	412
D	402	405	404	406	401	436	449	450	441A	448
E	426	424	444	446	445	422	415	420	427	433
F	421	437A	440	439	438A	425	431	432	414	443A
G	460	470	457	456	455	484	471	472	469	476
H	480	479	477	485	481	488	487	489	503	517
I	511	514	529	509	534	530	528	540	524	532
J	516	520	542	539	510	541	518	522	519	533

Fig. 12.2.11: Cryobox 3.

	1	2	3	4	5	6	7	8	9	10
A	394	395	895A	895B	895C	960	1039A	1039B	1039C	
B										
C										
D										
E										
F										
G										
H										
I										
J										

Fig. 12.2.12: Cryobox 4 containing cites corals.

	1	2	3	4	5	6	7	8	9	10
A	506	507	508	505A	523	531	546	549	550	551
B	552	572	569	566	553	573	554	548C	563	559
C	571	555	564	548A	565	567	560	562	561	548B
D	584	575	583	574	576A	577	588	589	587	590
E	591	625	626	627	628	629	630	631	632	633
F	634	635	636	637	638	639	640	641	597	620
G	611	596	612	602	609	599	617	607	624	593
H	603	619	616	615	613	595	608	621	618	622
I	642	643	700C	700B	700A	684	697	698	692	715
J	713	701	685	690	699	716	689	702	712	696

Fig. 12.2.13: Cryobox 5.

	1	2	3	4	5	6	7	8	9	10
A	694	708	714	719	710	681	711	683	703	706
B	691	721B	721A	721C	723	727	751	687C	686A	695A
C	724	733	729	732	687B	687D	746	734	730	743
D	742	744	741	739	738	740	731	754	753	748
E	752	747	755	758	763	762	764	768	765	771
F	777	776	775	651	647	653	646	655	648	649
G	781	782	787	848	841B	841C	846C	839	838	841A
H	830	846A	846B	840	852A	852B	829	821	853	854
I	836	827	828	826	823	837	855	844	859A	860
J	857	858A	850	824	845	825	862	849	866	864

Fig. 12.2.14: Cryobox 6.

	1	2	3	4	5	6	7	8	9	10
A	863	859B	851	865	868	867	903	898	885	892
B	880	881	884	882	878	902	890	889	900	899
C	879	888	887	901	895	877	904	984	999	985
D	1001	1010	1006	1005	981	988	989	982	979	987
E	1004	1002	986	983	998	961	964	980	962	967
F	969	970	1030	1028	1029	966	1015	1017	991	963
G	965	990	1027	974	1026	1032	1024	968	978	975
H	972	1025	973	1016	1022	1023	1034	1036	1035	1037
I	1038	1040	1042	1049A	1049B	1049C	917	796	945	919
J	918	916	794	798	914	912	915	1064	1058	1063

Fig. 12.2.15: Cryobox 7.

	1	2	3	4	5	6	7	8	9	10
A	1065	1066	1062	1056	1055	1072	1071	1061	1070	1059
B	1060	1067	1068	1074	1075	1076	1077	1083	1091	1089
C	1086	1088	1080	1081	1082	1113	1113A	1114	1116	1149
D	1147	1148	1139	1137	1144	1146	1127	1129	1130	1131
E	1142	1125	1164	1133	1153	1152	1132	1124	1126	1141
F	1143	1128	1140	1161	1151	1150	1145	1157	1159	1158
G	1160	1135	1134	1162	1163	1120	1138A	1136	1154	1123
H	1119	1167	1166	1172	1174	1175	1168	1169	1170	1173
I	1177	1201	1202	1204	1199	1195	1200	1198	1188	1197
J	1208	1205	1196	1203	1210	1207C	1207B	1209	1214	1207A

Fig. 12.2.16: Cryobox 8.

	1	2	3	4	5	6	7	8	9	10
A	1217	1218	1219	1220	1229	1228	1230	1235		
B										
C										
D										
E										
F										
G										
H										
I										
J										

Fig. 12.2.17: Cryobox 9.

13. CASS Projects – Predator-krill interactions

Author: Hayley McLennan

Overview

Predator presence is suggested to be a key driver of the shape and packing concentration of Antarctic krill swarms. We proposed this project to measure the three-dimensional shape of krill swarms using a novel fisheries acoustic instrument on the hull of the RRS SDA, the Simrad ME70, alongside net samples and predator observations. This will enable investigation of krill swarm characteristics relative to predation pressure and krill demographics in the Scotia Sea.

The ME70 was activated for 79 hours and 42 minutes over the cruise, 11 hours and 20 minutes of testing; 22 hours and 25 minutes in the Western Core Box; and 45 hours and 57 minutes at BIOPOLE 2 stations. 13 zooplankton nets (8 RMT8 trawls, 5 Mammoth nets) were carried out while the ME70 was active which will provide data to validate interpretation of acoustic backscattering intensity.

A marine mammal survey was carried out while the vessel was in transit during daylight hours and favourable weather conditions throughout the cruise. For full details of this see Chapter 13. During the Western Core Box transects a seabird survey was also conducted following European Seabirds At Sea (ESAS) methods, which will be discussed within this chapter. The most abundant seabirds were prions (435 in-transect sightings of 934 individuals, which were not identified to species level) and white-chinned petrels (164 in-transect sightings of 175 individuals). Within the 300 m strip transect there were 33 sightings of penguins (105 individuals), 185 sightings of fur seals (467 individuals), and 17 sightings of cetaceans (41 individuals) by the seabird observer during the Western Core Box survey.

13.1 ME70 survey

Introduction

Active acoustics are one of the major methods of surveying Antarctic krill; however, krill may be under-sampled by traditional single beam echosounders (SBEs) as these sample a vertical slice through the water column and fail to detect swarms off the survey track. This may lead to spatial mismatch in studies that aim to link krill abundance and distribution with surveys of krill predators. Multibeam echosounders (MBEs) sample a swathe of the water column to either side of the survey track, recording swarms that may be missed by SBEs. Furthermore, SBEs may not provide accurate estimates of aggregation parameters as they record a slice through swarms, which are often irregularly shaped. MBEs enable reconstruction of the 3D structure of swarms and the calculation of volume and surface area. Using an MBE, Cox et al. (2010) found Antarctic krill swarms in the southern Shetland Islands had a consistent surface area to volume ratio of 3.3 m^{-1} despite variation in size, indicating strong selection for this ratio, perhaps as a trade-off between reducing predation

risk and accessing oxygen (Brierley and Cox, 2010). However, there are limited MBE data on Antarctic krill collected to date.

The Western Core Box survey uses scientific echosounding and RMT8 trawls to gather data on the abundance and distribution of krill near South Georgia, and has been running since 1996. We supplemented the 2025 Western Core Box survey with night-time MBE observations of krill swarms, using the new fisheries MBE capability of the RRS SDA - the Simrad ME70 – fitted to its hull. MBE data was collected concurrently with 6 of the RMT8 macrozooplankton/micronekton trawls that are part of the WCB survey. Surveying the same swarms using MBE acoustic- and net-sampling will enable exploration of the relationship between the demographics of swarms and their physical structure and diel behaviour. Swarm characteristics will be investigated relative to environmental and temporal variables. MBE observations of Antarctic krill in the WCB will also be compared to previous surveys to determine whether the consistent surface area to volume ratio observed by Cox et al. in the Southern Shetland Islands in 2006 was also found off South Georgia in 2025.

Methods

The ME70 transducers are mounted on a pole that can be lowered from the hull of the SDA, however this restricts the vessel's speed. The vessel has to travel at <6 knots to deploy the pole and <11 knots when the pole is deployed, but ideally <8 knots for surveying. Due to this restriction and the requirement to integrate the ME70 with the other bioacoustics when active (i.e. the EK80), it was not possible to operate the ME70 during the standard daytime transects of the Western Core Box. However, on completion of the transects at ~16:00 each day, the ME70 or the deep-water bathymetric swath (EM124) were activated provided that a successful pre-watch had been conducted (i.e. a trained MMO had been observing for at least an hour and no marine mammals were seen within 500 m of the sound source for 20 minutes prior to the activation). If the ME70 was the first multibeam instrument to be activated, a 20 minute ramp up was conducted comprising 10 minutes at half power (-12 dB) followed by 10 minutes at quarter power (-6 dB) before moving to maximum power for surveying. If the ME70 was deployed and activated immediately after the EM124 had already been active, a ramp up was not conducted.

On the 7th, 8th and 14th of February the ME70 was turned on to test its operation and define a beam mode to be used for the Western Core Box survey and any further data collection later in the cruise. Martin Cox (Australian Antarctic Division/AAD) provided guidance based on his experience operating the ME70 on an AAD vessel previously. The beam mode was used was named SD046WCB and was set up according to the specifications in Table 1. The recording and display depth were set to 200 m. Background noise increased notably beyond this depth. The ME70 could not be calibrated due to time constraints at the calibration site and the difficulties of calibrating multibeam echosounders in general. Since the calibrated EK80 was active simultaneously with the ME70 it will be possible to scale backscatter from the ME70 using the EK80 data (e.g. Cox et al., 2010).

K-Sync was used to synchronise pings from the different acoustic instruments. When the ME70 was active, the EK80 and ME70 were set to ping alternately every 2 seconds (i.e. each instrument every 4 seconds). The ADCP (OS150) pinged every two seconds in concert with both instruments.

Table 13.1.1: Beam mode settings used for the ME70

Tab	Setting	Set to	Rationale
Frequency band	Upper frequency	119 kHz	Essentially covered 70-120 kHz range but allowed reference beams to be set to 70 and 120 kHz exactly (the software can automatically change the frequencies of the reference beams if they overlap with the fan beam frequencies).
Frequency band	Lower frequency	71 kHz	
Frequency band	Freq/beam spacing	Linear	Left as default
Frequency band	Freq/beam distribution	Inverse V	As used by Martin Cox/AAD. Options are V (lowest frequency in the middle of the fan) or inverse V (highest frequency in the middle of the fan). V maximises range in the middle of the fan while inverse V maximises angular discrimination in the middle of the fan. Since we only recorded to 200 m this made sense.
Frequency band	Pulse duration	1562 µs	Adjusted automatically by other settings.
Frequency band	Pulse type	CW	Left as default
Frequency band	# of beams in group	4	Left as default
Reference beams	A - Frequency	70 kHz	Reference beams set to be equivalent to downward facing 70 and 120 kHz SBEs.
Reference beams	B – Frequency	120 kHz	
Reference beams	A & B – beam width	7 degrees	
Reference beams	A & B – steering angle	0 degrees	
Fan of beams	# of beams in fan	23	As used by Martin Cox/AAD. Options range from 3 to 45 so 23 seems like a reasonable intermediate.
Fan of beams	Athwart beam opening angle	3.7 degrees	Leaving these at the default of 4 degrees caused a warning – *"Too wide beams spacing in fan will cause repeated main lobes. Steering of outer beams have been limited."* This warning appeared to prevent the use of optimized beam spacing and use linear beam spacing instead, which resulted in a much narrower swath. Reducing the beam opening angles slightly to 3.7 enabled the use of optimized beam spacing.
Fan of beams	Along beam opening angle	3.7 degrees	
Fan of beams	Athwart centre of fan	0.0	Left as default
Fan of beams	Along centre of fan	0.0	Left as default
Fan of beams	Beam spacing alt.	Optimized	Using optimized beam spacing created the widest swath.
Fan of beams	Beam spacing linear	4.0	Left as default (not used as beam spacing alt. set to optimized)
Fan of beams	Beam spacing optimized	-3.0	Left as default

Outcomes

There were 79 hours and 42 minutes of ME70 data collection over the SD046 cruise comprising 11 hours 20 minutes of testing, 22 hours 25 minutes of survey effort during the Western Core Box phase (Figure 1), and 45 hours 57 minutes of operation during the BIOPOLE phase. In the Western Core Box 6 RMT8 trawls (3 stratified and 3 target) were conducted with the ME70 active. In the BIOPOLE phase 5 Mammoth nets and 2 RMT8 trawls were conducted with the ME70 active (Table 2).

Table 13.1.2: Dates and times of ME70 operation and details of nets used during ME70 operation.

Start	Max power	Stop	Nets [event number]
16:15:23 07/02/2025	16:36:00 07/02/2025	23:42:24 07/02/2025	N/A
16:17:27 08/02/2025	16:37:44 08/02/2025	21:40:53 08/02/2025	1 x RMT8 (test2) [007]
16:09:48 14/02/2025	16:30:45 14/02/2025	19:19:22 14/02/2025	N/A
20:10:57 15/02/2025	20:10:57 15/02/2025	05:55:42 16/02/2025	2 x RMT8 stratified (1.2Nst, 1.2Sst) [036; 038]
20:02:22 16/02/2025	20:02:22 16/02/2025	01:26:22 17/02/2025	1 x RMT8 stratified (2.2Sst) [040] 1 x RMT8 target (2.2)_ [042]
23:44:25 18/02/2025	23:44:25 18/02/2025	00:47:37 19/02/2025	N/A
03:05:03 19/02/2025	03:05:03 19/02/2025	04:27:08 19/02/2025	1 x RMT8 target (4.2) [053]
22:42:17 19/02/2025	22:42:17 19/02/2025	04:08:57 20/02/2025	1 x RMT8 target (ECB) [060]
17:55:56 07/03/2025	18:16:03 07/03/2025	08:26:12 08/03/2025	2 x Mammoth [135; 140]
20:22:40 08/03/2025	20:44:29 08/03/2025	04:41:39 09/03/2025	1 x RMT8 (BP2_8) [143]
19:15:42 09/03/2025	19:40:01 09/03/2025	03:28:16 10/03/2025	N/A
20:25:11 10/03/2025	20:45:58 10/03/2025	02:10:19 11/03/2025	1 x Mammoth [155]
20:39:36 15/03/2025	20:39:36 15/03/2025	06:24:15 16/03/2025	2 x Mammoth [174; 175]
17:51:15 16/03/2025	17:51:15 16/03/2025	03:09:34 17/03/2025	1 x RMT8 target (BP2_4, net failed but enough krill for length frequency distribution) [184]

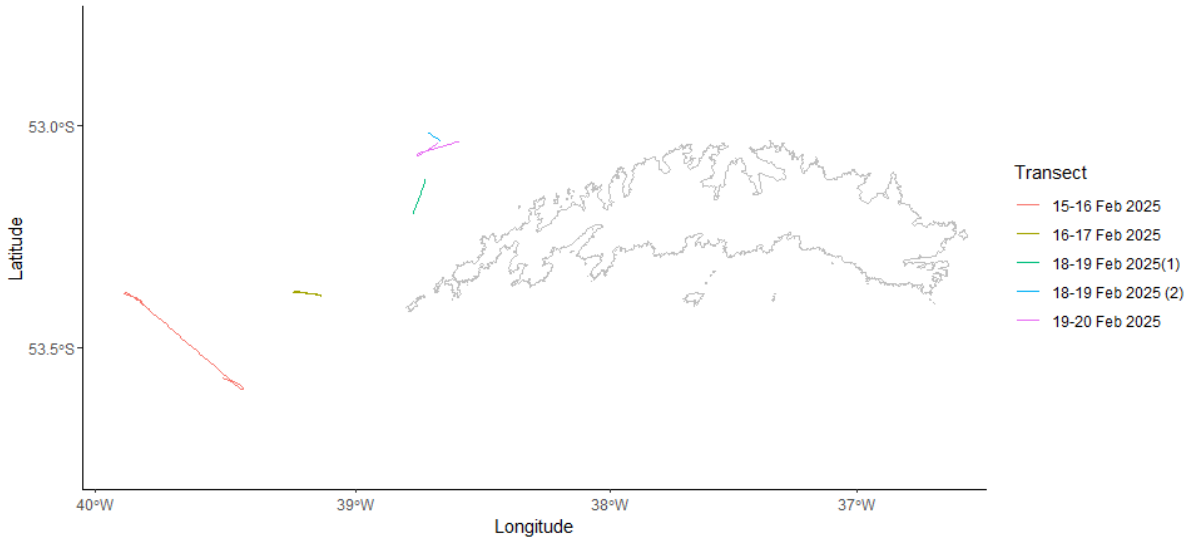


Figure 13.1.1: Locations of ME70 transects in the Western Core Box.

Recommendations

Under JNCC guidelines, multibeam echosounders require a pre-watch/pre-shooting search prior to activation. This should last 60 minutes (30 in waters < 200 m deep) and the mitigation zone (500 m around the sound source) must have been clear of marine mammals for 20 minutes before the sound source is activated. A pre-watch cannot be conducted in darkness or visibility < 500 m. As a result, activing the ME70 requires advance planning especially if it is desirable to have the instrument active in hours of darkness. Since there was a continuous marine mammal survey throughout the Western Core Box transects, one method used to address this was to activate the EM124 bathymetric swath at the end of the transect, assuming all mitigation conditions were met. It was then possible to switch from the EM124 to the ME70 when the vessel was in a position to lower the pole.

On 17th February a pre-watch was not conducted and the EM124 was not activated due to adverse weather conditions. Later the weather had improved and deployment of the ME70 would have been possible, but it was past sunset and not possible to conduct a pre-watch. Therefore, the ME70 was not activated. In future due to the changeable weather conditions it is advised to take the required steps to maintain the possibility of activing the ME70 during the night.

On the 8th February the ME70 failed to start pinging when activated. The cause of this was unclear and restarting the program with factory settings resolved the issue. However, this resets where the output files from the program are saved, so the files were not saved to the D drive (which is then automatically backed up to the legwork drive). If it is required to open the program with factory settings, ensure the output folder is changed before starting to record data.

On 18th February the ME70 was activated at 23:44 in a higher sea state than previous and with the vessel travelling beam-on to the swell. This caused vibrations through the vessel and shocks to the pole that resulted in noise spikes in the data. It was decided the best course of action was to retract the pole and reactivate the EM124 to transit faster to the RMT8 fishing station, and to deploy the ME70 again when the vessel was moving slower

and into wind. This appeared to resolve the data quality issues and spared stress on the pole during transit.

13.2 Higher predators survey

Methods

Cetaceans were surveyed using a distance sampling methodology as described in Chapter 13. For the duration of the Western Core Box transects, a seabird survey was also conducted following adapted ESAS methods by Hayley McLennan with support from Hugh Venables. The ESAS survey method records all marine mammals and birds in contact with the water in a 300 m strip transect to one side of the vessel, and assigned to a distance band based on distance from the vessel track (Figure 13.1.1). Flying birds are recorded in a snapshot every 300 m along the vessel track to a distance of 300 m ahead of the observer and 300 m perpendicular to the trackline (Figure 13.2.2). These observations are considered 'in transect'. Birds and mammals further than 300 m from the vessel track line or recorded outside of the snapshots are considered 'out of transect'.

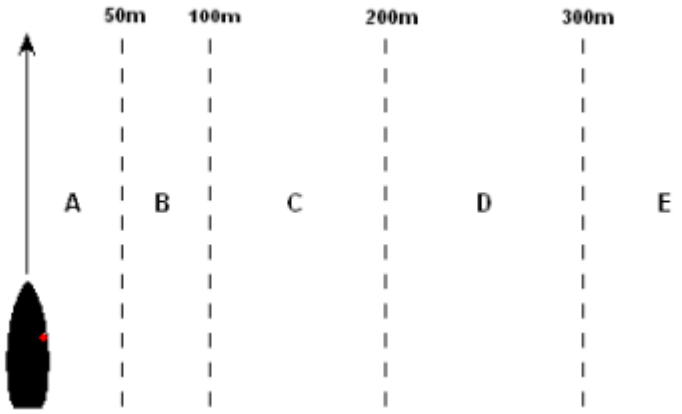


Figure 13.2.2: The 300m wide transect is divided into four bands (A, B, C and D) anything outside the transect is assigned to band E.

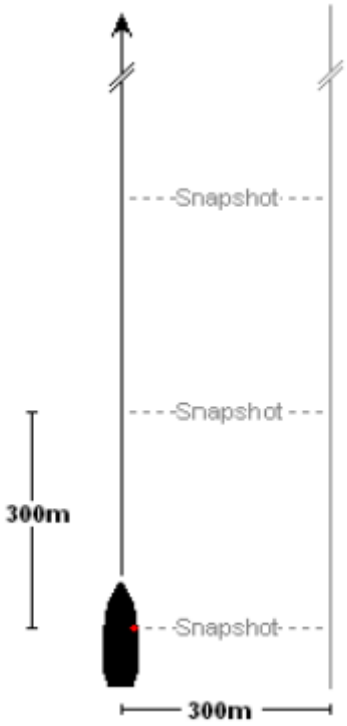


Figure 13.2.3: Snapshots are taken every 300m along the transect, timing is determined by the ship's speed. Any flying birds within the transect at the time of the snapshot are recorded as 'in transect'. Birds passing through the transect between snapshots are recorded as 'out of transect'. Any birds or marine mammals recorded in Band E are also 'out of transect'.

Distances were measured using a range finder (Rangefinder formula | JNCC Resource Hub). An app designed using CyberTracker software was used on a Samsung 10-inch tablet for data collection (Figure 13.2.3). An interval timer app was used with predetermined settings to alarm at 300 m intervals for speeds of 8, 9 and 10 knots. After failure of the RapidCast on the first day of the Western Core Box (which required the vessel to slow to 8 knots for deployment), the vessel travelled at a continuous 10 knots for the remainder of the survey. Therefore, snapshots were taken every 1 minute.

Often seabirds associate with the vessel and will follow the ship and fly in circles around it. This can make it challenging to avoid double-counting of the same individuals. Seabirds obviously associating with the vessel are omitted from the survey, which in some cases may lead to underestimation of vessel-associating species.

Figure 13.2.4: Flowchart of screens in the CyberTracker bird survey app. Sightings could be saved from either the 'Behaviour' or 'Flight direction' page. On saving a GPS location was obtained for the sighting.

Outcomes

There were 1908 sightings of flying seabirds, 23 sightings of seabirds (other than penguins) in contact with the water, 33 sightings of penguins, 185 sightings of fur seals and 17 sightings of cetaceans (by the bird observer). 980 of the seabird sightings were recorded during snapshots and 238 of the sightings in contact with the water were within the 300 m strip transect, resulting in 1218 in-transect sightings (Figure 13.2.4, Figure 13.2.5, Figure 13.2.6).

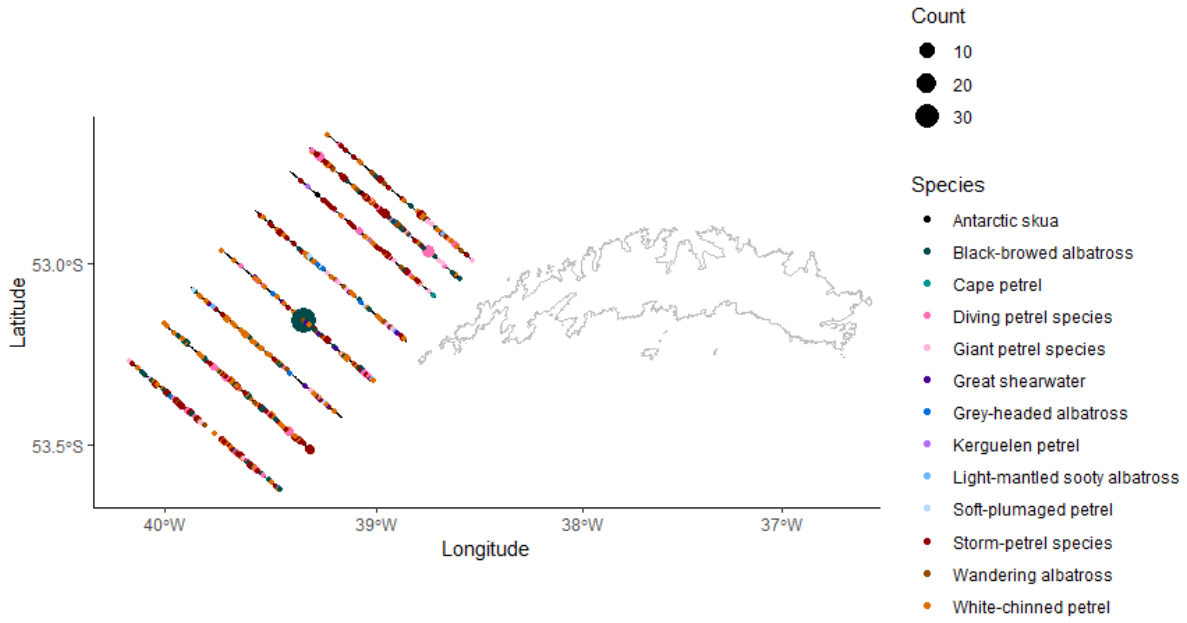


Figure 13.2.5: Flying birds in snapshot along the Western Core Box transects (excluding prions).

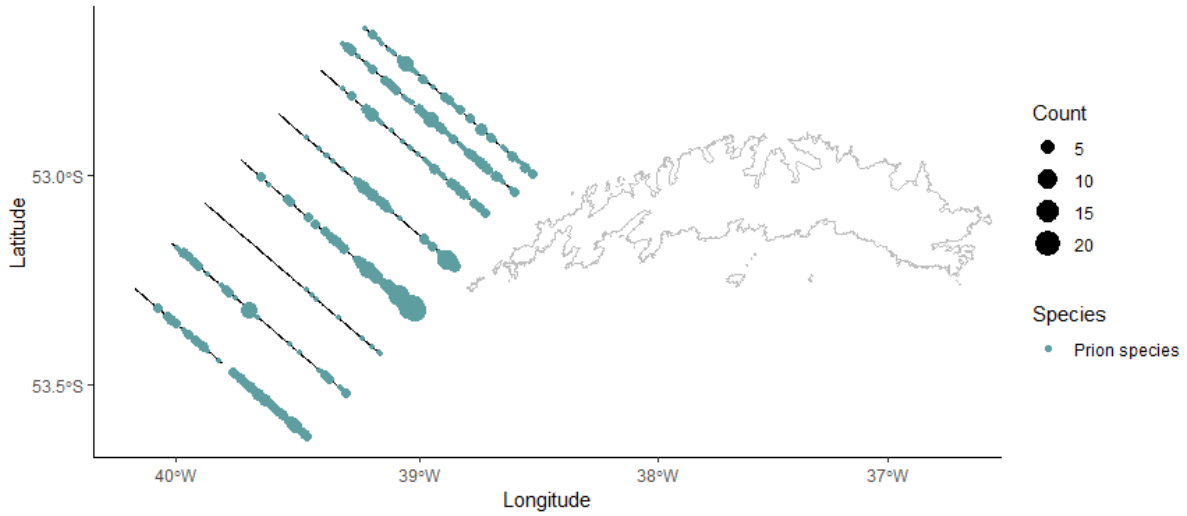


Figure 13.2.6: Prions in snapshot along the Western Core Box transects.

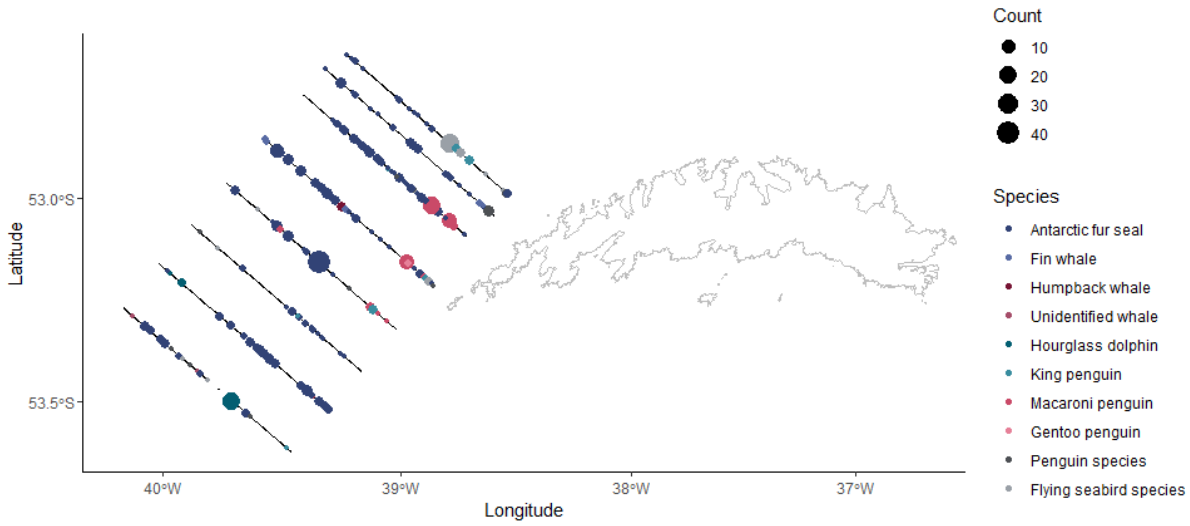


Figure 13.2.7: Sightings of animals in contact with the sea (mammals, penguins, and flying birds on the water) along the Western Core Box transects.

Recommendations

For a single observer working alone, recording all sightings (in and out of transect) is possible for some stretches of transect but often not feasible due to the high density of seabirds. The ESAS methodology allows for switching from all sightings to in-transect sightings only, which is likely a more realistic approach for South Georgia summer bird surveys. On 16th February a very high abundance of prions were seen when approaching South Georgia on the 2.2 transect and the decision was made to only record flying prions during the snapshots and not out of transect prions, which was followed for the rest of the survey. In future this option, or only recording in-transect sightings for all species, may be decided upon from the beginning, or out-of-transect sightings may be recorded only for species of specific interest. Having a scribe to work with a bird observer would also improve the survey method, but is unlikely to be practicable with vessel personnel constraints.

Similarly, with a team focussed on cetacean sightings working simultaneously, although whales and dolphins seen during the survey were recorded, the bird observer did not spend time scanning far ahead of the ship to detect cetaceans as this would have been redundant duplication of effort and detracted from the seabird data. Antarctic fur seals were also recorded but it should be noted that within the distances in which seabirds were being surveyed many fur seals would have been responding to the vessel, so these data may not be valuable for behavioural studies. As the marine mammal observation team were also recording environmental conditions every half hour or when conditions changed, a separate weather log was not kept for the seabird survey. However, it should be noted that the seabird survey (in particular 300 m snapshots of flying seabirds) is not as limited by visibility as the marine mammal survey and so data should be useable from lower visibility/higher sea states.

Collecting data digitally reduces data entry time and time spent scribing, but has some constraints. Notes were taken on paper during the day of anything that needed to be corrected at the end of the day. The app recorded a GPS location for every sighting but at times there was a lag obtaining a GPS position. Setting up the tablet by the bridge windows at least 10 minutes prior to the start of surveying to obtain a GPS fix helped with this issue. If the GPS was taking too long to find a fix after recording a sighting the app had an option to

skip GPS. When this happened the GPS position was interpolated from the previous and next sighting – sightings were frequent enough that there was minimal change in position between records. Another option would be to use the time of sightings to obtain a GPS position from the vessel's event log.

The app design worked fairly well and the ease of designing a custom app using CyberTracker is an advantage, but it would be good to have a more specialised interface. For example, an app with the ability to 'learn' regularly input species and provide shortcuts to enter these would speed up data entry. If there were not another team recording environmental conditions on the bridge a method for monitoring these would also have to be included.

References

Cox MJ, Warren JD, Demer DA, Cutter GR, Brierley AS (2010) Three-dimensional observations of swarms of Antarctic krill (Euphausia superba) made using a multi-beam echosounder. Deep Sea Research Part II: Topical Studies in Oceanography. 58: 7-8. https://doi.org/10.1016/j.dsr2.2009.10.003.

14. Laboratory spaces

14.1 Experimental aquarium container

Authors: Katrin Linse, Eloise Littley, Samantha Kentwell (not on board)

Introduction

The Experimental Aquarium Container (EAC) is a new asset for the RRS Sir David Attenborough that was purchased as an associated project but had its polar water trial outstanding to SD046. The initial trial on the SDA was done by Samantha Kentwell in September 2024 on the leg Harwich to Madeira with assistance by Deck engineer Hans Braten, engineers and ABs. Her report (below) formed the valuable manual to operate the container. During SD046 we had the advantage that Deck engineer Hans Braten and Shawn Swanney were on board, assisting with the running and trouble shooting.

Experimental Aquarium Container

By Samantha Kentwell

General Container setup

Figure 14.1.1- Cabinet position

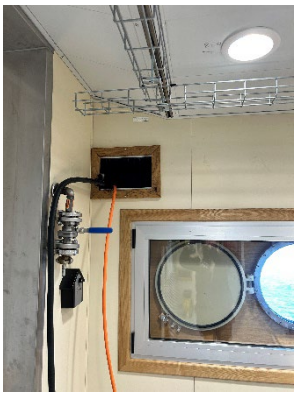


Figure 14.1.2- higher channel

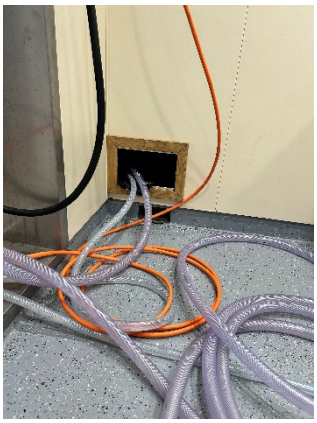


Figure 14.1.3 – lower channel

Deckhands and engineers will move the container into position (coming out from wet lab, parallel to port side of ship- figure 14.1.1). *Always await instruction from deck crew/ engineers prior to entering aquarium, they will confirm it is safe to enter*.

Once in place, 4 pin plug will be connected to give power to the entire container through the higher channer in the lab wall (figure 14.1.2) Open door slowly as the door may be obstructed from within the wet lab, ensure care when entering as pipes may have been stored in the first room.

Ensure all pumps, tanks, lids, fittings are correctly fitted and in container. If not contact aquarium manager. All pumps should be switched off at wall, if not turn these off before turning on transformer.

Figure 14.1.4—Reservoir tank

Figure 14.1.5- Sump tank plugs

Air handling unit system setup

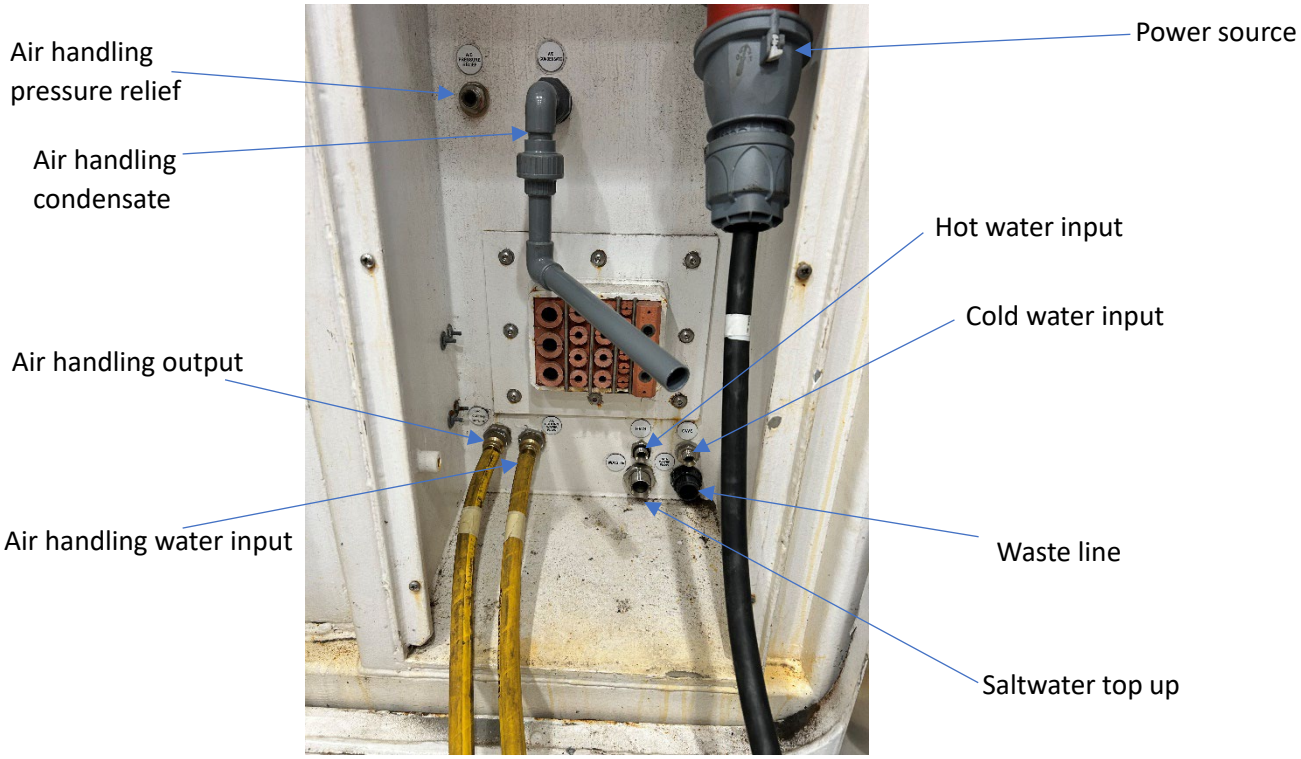


Figure 14.1.6- Control ports

The Experimental aquarium air handling unit can be run on either fresh or saltwater. Check with Simon (Deck engineer) to see if freshwater pump is running. Saltwater (uncontaminated sea water UCSW) can only be run while at sea (it will bring in sediment if not deep enough).

Freshwater setup – can be used in port

Deck engineers will assist with fitting water flow in/ out of air handling unit. Run hose from fresh/ saltwater input to the air handling water input (shown in figure 14.1.6) and run another from air handling water output to either the freshwater cooling outlet (will

Figure 14.1.7 – Air Handling unit electrical

Figure 14.1.8- Air handling unit control

be next to the input on deck) or to the scupert (if using saltwater). Run these hoses through the small channels at the base of the deck (figure 14.1.3), the channels higher up are only for dry electrics (the power source should be run through this already).

Once system is hooked up to the water system, turn on the air conditioning, to do this turn the large handle to the on position (lights on control panel should be lit up now if power is running through) and turn on the green start button. Let run for a few minutes watching for any faults. If the system trips, the most likely cause is too low flow- speak to deck engineers to remedy this, it may mean you have to turn the flow higher or change to a different (saltwater/ freshwater) chilling system. To see what the system is set at, you must open the electrical cabinet – *NEVER DO THIS ALONE, ALWAYS HAVE A DECK/ ENGINEER TO ASSIST OR PROVIDE A SECOND SET OF EYES.* Once open, you can also change the setting for the air conditioning unit via the control panel, recommended temperature is -5. Let the system cool down over a number of hours prior to entering again. Ensure the door to the aquarium is firmly closed- you may have to slam the door to ensure it locks.

Tank setup

Figure 14.1.9- Tank setup

The system set-up consists of 24 100L tanks (12 either side), one sump tank and a reservoir tank. The sump tank (right side of container) connects to all 24 tanks via right and left side ABYZZ pumps found in the middle chamber of the sump, there is also a biofilter pump in this middle chamber, it feeds the last chamber of the sump to move the biofilter media around. The reservoir tank has one pump that feeds the sump tank, this tank holds the saltwater fill hose- chilled saltwater is plumbed into this reservoir tank and once temperature is confirmed, it can be pumped into the sump tank. Both the sump and reservoir tank have seneye sensors.

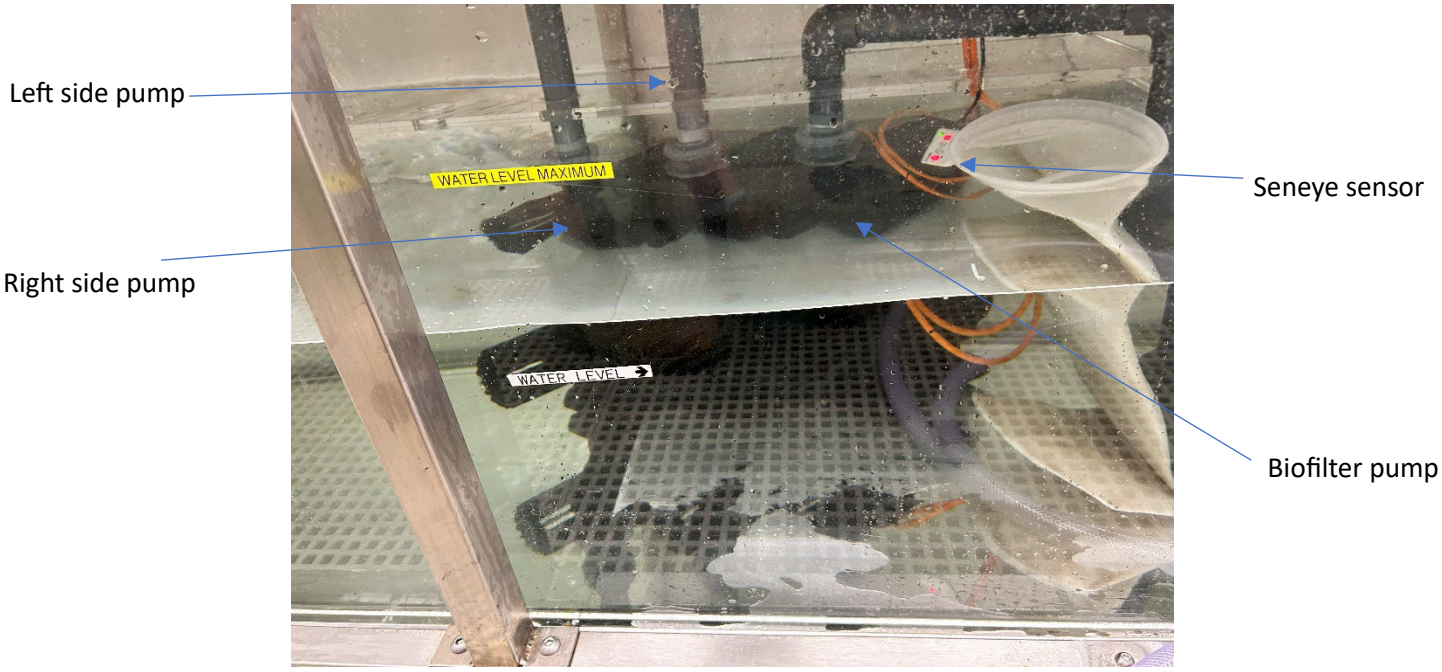


Figure 14.1.10 – System sump tank

Once chiller system is up and running, the tanks can be filled. This water should be run through the chiller prior to entering the container, the air handling unit is unable to efficiently chill the water. Run the Uncontaminated Sea Water (UCSW) through the chiller system into an IBC, this can then be pumped into the Aquarium via the seawater top up at the front of the container (figure 14.1.4).

Figure 14.1.11 – Tank top up valves

Figure 14.1.12 – Valve running from right to left tanks

Before filling any of the tanks, ensure all valves to each individual tank is closed as well as the line of pipe running from the right tanks to the left tanks (this isn't needed if both pumps are running correctly).

The inlet into the systems sits in the reservoir tank, once this is filled you can turn the SW feed pump on and fill the main sump. Keep the saltwater top up on while filling the main sump otherwise the reservoir pump **will** run dry.

Once sump is filled, ¾ open 2 individual tanks, one on each side of room (figure 14.1.3) and turn on the right and left side sump pumps. Allow these tanks to fill and once draining back into the sump, continue this cycle until all tanks are filled. *Be aware to not opening the valves fully as the drain won't be able to keep up and the individual tank will overflow*. Keep an eye on the sump/ reservoir tank and turn on/ off as needed.

Once tanks are filled, check balance on all inlet valves, ensure sump is at correct level (figure 14.1.10) and keep reservoir tank topped up in case of emergencies/ waterchanges.

Seneye slides

Seneye slides must be changed once every 30 days, there is one sensor in each of the reservoir and sump tanks. To access data or change the slides, you have to access the seneye dashboard for the experimental container (find this through your emails of the dashboard or save as a bookmark).

Ensure the seneye slides are always in the water and check daily that no abnormal lights are flashing.

Changing seneye slides

To change the slide, take sensor out of water, remove backing of the sensor and dispose of the old sensor. Open the new seneye slide pack and either take a photo of or keep the pack as the code is used to activate the new slide. *When opening pack, take care not to touch the sensor section of the slide itself, hold the slide by the edges*. Place the new slide on the groves where the old slide was (match up cut out corner on slide and grooves) and close the backing. Access your seneye dashboard, click dashboard again and click on the slide activation panel. Input the slide code into the text box and click activate, this should now be activated and reading accordingly. *If any trouble with this process contact aquarium manager*.

Methodology

Experimental Aquarium Set-up

The EAC was set up following the protocol with the following exceptions:

1) The biofilter media were not used for this trial and therefore the biofilter pump not started.
2) The air handling unit was set to -2.0ºC, compared to -5.0ºC during the Harwich-Madeira leg, given the colder ambient sea temperatures by the deck engineers.
3) No IBCs were used.

Once international waters were reached, the aquaria were filled with uncontaminated seawater via a tap in the wet lap.

Experimental Aquarium Running

While the aquarium was running, the air temperature inside the aquarium compartment was daily monitored with T-loggers present in the EAC's cabinet.

As this was a "fit-for-purpose" trial, no marine specimens were inserted in the tanks and the aquarium was solely pumping uncontaminated seawater around.

Experimental Aquarium Close-down

At the end of the expedition, the seawater was removed as far down as possible using hoses of different sizes, a suction pump provided by Deck engineer Hans Braten and gravity. The remaining water was scooped and sponged out by hand.

Outcomes

Experimental Aquarium Container performance

The cooling unit of the EAC was switch on 6th February and on 7th February the reservoir tank was filled and left to acclimatise. On 8th February, the sump tank and top row of aquarium were filled and the reservoir tank restocked. The cooling unit was switch off for a short time until the seawater flow from the reservoir tank to the circulation system was established as the valve near the container ceiling had frozen and was not turn able.

On 8th and 9th February T-loggers placed at different front, back, top and bottom locations in the aquarium compartment measured 0.4ºC to -3.7ºC.

At 22:00 on 9th February, a temperature increase to 8ºC was noted, which was first thought to be a de-frosting cycle but at 7:20 on 10th February the temperatures had risen to 11.8ºC. The cooling system had stopped and was restarted but did not cool. The reason was that for the P3 mooring recovery the uncontaminated seawater supply was stopped, which provides the cooling water for the EAC cooer unit. A decision by Katrin Linse and deck engineers was taken to keep the EAC's cooling system switched off until the WCB moorings were recovered, but to leave the water pumps running. On 13th February the inner EAC temperature reached 17.7ºC, which lead to the decision to strap the container doors open to cool the system via ambient air temperature, which cooled it to 8.3ºC.

On 10:00 15th February the cooling system was switched on again and until 3rd March performed well with air temperatures ranging from -7.7ºC (near to cold air inlet during cooling period) to 0.9ºC at the lower container end.

On 3rd of March temperature increase to 8ºC was noted, caused by an accidental push-in of the emergency stop button, while the fire alarm system was checked by the ETO.

On 4th March the system developed a common fault after the uncontaminated sea water supply was clogged.

On 15th March the system developed a common fault after the uncontaminated sea water supply was stopped for mooring recovery.

On 15th March the system developed a common fault after the uncontaminated sea water supply was stopped for ice.

On 20th March the system was stopped as during the P3 redeployment the uncontaminated seawater supply would be stopped and this would cause a common fault.

The aquaria were kept running until 26th March to monitor the temperature increased of the outer and inner aquarium room. A positive surprise was the relatively slow temperature increase in the inner room after 7ºC were reached.

Overall, the EAC performed well on this expedition.

Recommendations

1) Replace the lost 3-step safety stepladder for safe access to the top tanks for checks and water changes and aquaria cleaning.
2) Place the EAC supply boxes in the wet lab when the EAC is in use and not stored somewhere in the science hold.
3) Purchase siphon and/or bilge pumps for pump out of aquaria at end of expeditions
4) Purchase a set of waterproof loggers for tests when Seneye system not in ue
5) When in PDH Bar Hill for re-fit, exchange two aquaria in lower row at the front with the two oval aquaria for pelagic zoo-and mesoplankton
6) Purchase mesh crate to hold the different tube size rolls
7) When in PDH Bar Hill, correct light switch system, so inner red light cannot be overridden.
8) **When SDA is in Oskov/DK refit, communicate with Hans Braten regarding changing the cooling fluid in the cooler unit so that the EAC can run on SDA's cooling water system.**
9) **After refit and cooling water change, test EAC cooling system running on SDA's cooling water during post refit sea trials. No water in aquaria required.**
10) **On return to Harwich, transfer EAC to PDH Bar Hill for EAC re-fit by AME and Electronics.**

14.2 Scanning electron microscope

Authors: Katrin Linse, Eloise Littley, Petra Ten Hoopen

Introduction

In the planning phase of the RRS Sir David Attenborough, under the umbrella of the “associated projects”, innovations to UK’s new polar research vessel were discussed and the purchase of a tabletop scanning electron microscope (SEM) was approved. A SEM is a type of electron microscope that scans a sample surface with a focused beam of electrons and can achieve high resolutions with several thousand times magnification. The use of SEMs, mostly environmental SEMs with low vacuum observation modes, on research vessels is not established and most reports come from geological survey vessels in the low latitude waters of the Pacific and Indian oceans. In 2016, a Hitachi TM3000 was used on RV Polarstern in the Arctic Fram Strait, showing the possibility of operating environmental SEMs on Polar research vessels. BAS purchased a Hitachi TM4000Plus for the RRS Sir David Attenborough, which had been used for the first time in Greenland’s fjords in summer 2024.

A SEM on board will enable scientists to assess their biological and geological samples for microfeatures, integrity and identifications, and with this potentially shortening up time between collection and publication.

The aim during SD046 was to test the TM4000Plus in the Southern Ocean and to establish boundary conditions for its use.

Methodology

Hitachi TM4000Plus

The TM4000 Series features innovation and cutting-edge technologies which redefine the capabilities of a tabletop microscope. This new generation of the long-standing Hitachi tabletop microscopes (TM) integrates ease of use, optimized imaging, and high-image quality, while maintaining the compact design of the well-established Hitachi TM Series products. The TM4000Plus has two levels of accelerating voltage, 5 kV and 15kV, enabling the use of environmental samples which do not require gold or similar sputter coating. The magnification goes from 15x to 30000x in 40 preset steps. The full Hitachi Instruction manual is available as pdf on the SEM desktop (Figure 14.2.1.)

Figure 14.2.1. Hitachi TM4000Plus SEM in the dark room of RRS Sir David Attenborough

Sample preparation

Marine invertebrate samples, collected by C-EBS and fixed in 96% ethanol, were selected for SEM work. Individual specimens were cleaned with fine painting brushes and shaken in cryovials containing soapy water, given the lack of a small ultrasonic bath. Cleaned samples were places into fresh ethanol and transferred using fine feather-weight forceps to the 15 mm diameter SEM stubs, 6 mm high, with a M4 thread and covered by a 12 mm Leit Adhesive Carbon Tab (agarscientific .com). The sample on the stub was the air dried prior to use in the SEM.

TM4000Plus activation

The activation of the TM4000Plus followed the V 1.1 Scanning Electron Microscope use on board the RSS Sir David Attenborough - For trained and authorised users ONLY, given Katrin Linse is the trainer for users in BAS, Cambridge for use of the TM3000 in CB and TM4000Plus on SDA. In Recommendations (below) a more pictured guide for the transit bolt removal than the V 1.1 is given. Otherwise, the guidance for SEM use in board was followed (see below).

SDA Laboratories

Scanning Electron Microscope use on board the RSS Sir David Attenborough

For trained and authorised users ONLY

The Scanning Electron Microscope (SEM) is a delicate and highly technical piece of equipment. It is easily damaged by sudden movement and user error. Please keep log of use and report any issues to the Lab Manager on board.

This procedure is in addition to the SOP quick start manual provided with the instrument and covers shipboard protocol. For issues or assistance during use please call the Laboratory Manager on duty.

SEM USER NOTES, SEE BELOW FOR BRIDGE NOTES

Conditions for use:

- User has been signed off for use by BAS Cambridge SEM Group
- User has induction with SDA Lab Manager, induction signed
- In use signage is in place on Dark Lab Door
- **Calm** weather conditions for duration of capture
- Ship notified that SEM will be in use for a defined duration, confirmed that planned movements suitable
- Samples are suitable for capture, dry, clean free of dust, if ethanol used that this has evaporated off
- Correct stub sizes are supplied by user

Quick stop in the event of sudden change of conditions such as weather/ship movement change:

- Bridge will call
- If poor weather, heavy thruster use, or movement is less than 5 minutes out
- Stop image capture
- Leave under vacuum
- Turn off and isolate at switch
- Remove side panels and secure stage and column

If you have more time, apply normal shut down sequence and secure stage and column

Liaise with the bridge when/if conditions improve to restart instrument

Procedure to start work:

Also see TM4000 quick start sheet and manual

1. Sign on door to be placed as IN USE
2. At the start of work call the bridge and let them know the SEM work will commence, phone number for SEM Lab is 2368

3. Give estimate of time of use, ask them to call if conditions are going to change
4. Fill out Log book for instrument
5. Unlash the instrument and remove side panels
6. Gloves on
7. Unbolt the STAGE and COLUMN
8. Replace side panels, re-secure SEM to bench
9. Read checklist for instrument, follow steps
10. When unbolted and checklist ticked, turn on instrument and computer
11. Vacuum will kick in and will go under vacuum
12. Wait until under vacuum BEFORE starting programme
13. Open programme, ensure connection
14. Release to air, prepare sample stub
15. Put stage under vacuum and begin capture
16. **NOTE**: Leave programme open when moving between loading samples so the programme knows what the microscope is doing

Shut down:

1. See manufacturer quick notes on shut down
2. Stop capture
3. Put chamber under AIR
4. Remove sample
5. Put chamber under vacuum
6. Close programme
7. Once under vacuum shut down instrument (switch on side)
8. Turn off at plug
9. Remove side panels
10. Secure stage and column with bolts
11. Replace side panels and re-secure SEM to bench
12. Call bridge to let them know work with the SEM is complete
13. Complete Logbook
14. Tidy work station, secure items in Lab
15. Switch sign on door to SEM off

Notes:

- SDA Laboratories does not provide consumables, user to supply
- Before mounting ensure samples are not salty, are fully dry, are free of dust, see sample preparation notes
- Only approved user may operate
- Only approved sample types may be used
- (If working with samples generated and dried on the cruise you can use gentle paper fanning to ensure everything is stuck to stub, do this before putting each stub in the chamber)
- If any errors or issues occur during operation please let Lab Manager know immediately

Filing of images:

- SEM Computer is not connected to the Legwork Drive, this is in development. Transfer images by USB add to Legwork drive
- Log sheet if needed for paper copy

- Lab Manager will create a new folder for your cruise e.g. SD041 KangGlac
- Each stub to get its own folder, e.g. M4C, within that folder each image can be named to identify the following: **CRUISE ID_STUB ID_POSITION ID,** or other naming convention as agreed with PSO/Data manager

Bridge notes on the use of the SDA Labs Scanning Electron Microscope

Dark Lab, SDA Laboratories

The Scanning Electron Microscope (SEM) is a delicate high precision piece of equipment that operates under vacuum. It can be easily damaged by sudden movement and user error. It sits under the SDA Lab Management Team's equipment remit and approved users will be named for each cruise when in use.

The SEM has very delicate moving parts, the stage and column of the SEM must be aligned correctly to operate, if they become misaligned the microscope may cease to work and could be an expensive repair.

Because of how delicate and easy it is to damage at sea there are some conditions for use for the user listed above to consider before requesting use.

As unexpected movements can cause damage to the instrument the user is asked to call the bridge to notify that the instrument is in use. This is so the bridge can let them know if the conditions are worsening or if the ship will start move around more than usual when moving off station etc.

Note: Heavy forward bow thruster movement will interfere with the image, if a lot of forward bow thruster movement will be used during the time requested it would be best to advise to delay use of the SEM for another time

SEM Lab phone number is 2368

See user procedure notes for their steps in process above

Bridge info:

- User calls to say that SEM will be in use, give estimation of time, this can be several hours
- Make a note that SEM is in use on the bridge so that bridge is aware if there is a chance of bridge team
- If conditions change during SEM use, the bridge will call the SEM Lab to let them know. The user can then secure the column and stage to protect the instrument from damage. In an emergency, this can be completed in 5 minutes.
- Change in condition can include:
    - Moving through heavy ice
    - Heavy use of forward bow thruster
    - Going beam on in heavy weather
    - Weather worsening
- If no weather notice is issued the user will call the bridge to notify that the SEM work is complete

Last updated 11/02/2025, prepared by Aisling Smith

Environmental parameters

With no environmental boundary conditions are given, other than calm weather during use, initially wave height and later also roll, pitch and heave information were provided by data manager Petra Ten Hoopen for the times of the SEM use. Calm weathers were interpreted as the vessel barely moving and average wave height of 1.5 to 1.6 being shown on the data screen.

Outcomes

TM4000Plus use

The TM4000Plus was used 3 times during SD046, twice on 26th and once on 27th February in the southern South Sandwich Trench area. Sea conditions were calmest seen during SD046, with vessel's thrusters on low use during deep-sea CTD deployments. To our knowledge, this was the first time a SEM has been used on board of a research vessel in the Southern Ocean.

Start of the SEM use was delayed as the telephone in the Dark room was not working, so no direct phone communication with the bridge was possible. The phone had been turned off completely and was turned on by ETO, has this had been forgotten on boarding in Punta Arenas. On 26th February, wave heights ranges from 1.19 to 1.49 m, roll degree from -0.6 to 0.79, pitch degree from -1.19 to 0.12 and heave (mm) from -570 to 600. On 27th February, wave heights ranges from 1.53 to 1.74 m, roll degree from -1.15 to 1.57, pitch degree from -1.54 to 0.52 and heave (mm) from -670 to 690. On the 27th February, movement of the object under x5000 magnification was observed, cracks and break in the observed cumacean occurred (Figure 14.2.2.) and SEM observations were immediately stopped, and transit bolts inserted. Following this, the maximum wave height for SEM use was set by Katrin Linse for below 1.5 m, which did not occur during the following weeks of the expedition.

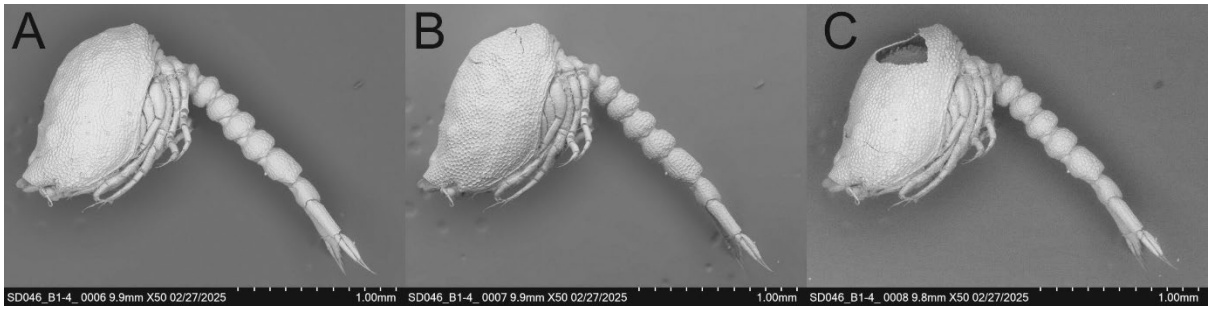


Figure 14.2.2. SEM images of South Georgia cumacean. A) Initial image, carapace intact. B) Carapace with crack appearing. C) Coming back from magnification to x5000 hole in carapace was observed.

To improve sample preparation and specimen stage handling, Deck engineer Hans Braten manufactured stands for specimen stubs and a holder for the specimen stage (Figure 14.2.3).

Figure 14.2.3. Manufactured stands for specimen stubs and a holder for the specimen stage

Specimens analysed

To test the SEM under Southern Ocean conditions, selected macrobenthic invertebrates, e.g. bivalves, gastropods, cumaceans, ophiuroids, from EBS #017 were mounted on 15 mm stubs (user provided) and imaged under varying magnifications and acceleration voltages (Figure 14.2.4).

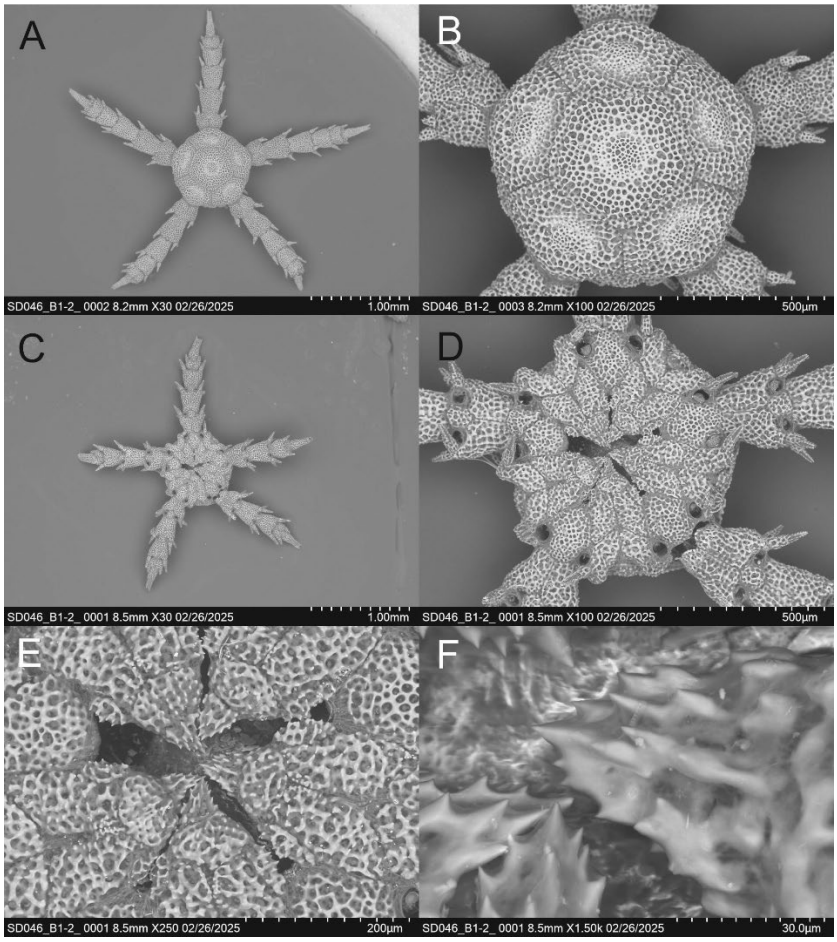


Figure 14.2.4. SEM images of South Georgia ophiuroid *Ophiocten* sp. under different magnifications. A) Dorsal view x30 magnification. B) Dorsal view onto central disc x100 magnification. C) Ventral view x30 magnification. D) Ventral view onto mouth x100 magnification. E) Ventral view onto mouth teeth x250 magnification. F) Ventral view onto mouth teeth x1500 magnification.

Recommendations

In Katrin Linse's opinion, the TM4000Plus successfully passed its vessel acceptance test and Southern Ocean expedition worthiness during SD046 and should be routinely made available to scientific and, if possible, SDA engineer users on RRS Sir David Attenborough. The TM4000Plus requires a detailed and pictured user guide, showing the steps who to remove and reinsert the transit bolts as well as guidance for potential error messages that can occur during use.

Katrin Linse's recommendations are:

1) Installation of a SDA display monitor on the wall behind the SEM monitor so that SEM users can constantly monitoring wave height, pitch, roll and heave in a Grafana display mode during use and stop use when any of these parameters pass the boundary. The recommended boundary for wave height is below 1.5 m, which boundaries for pitch, roll and heave need to be determined but should be low the values reached on 27th February.

2) Move the pump from the shelf underneath the worktop onto the far end corner of the work top. Running the cable from there in front of the draw to the beck of the SEM is not ideal and opening the draw to get to consumables while pumping action occurred caused an error. This error only required a shut down and start up of the SEM but should be avoided. The pump might need to be placed onto a motion-buffering mat and then secured on the worktop (Figure 16.2.5).

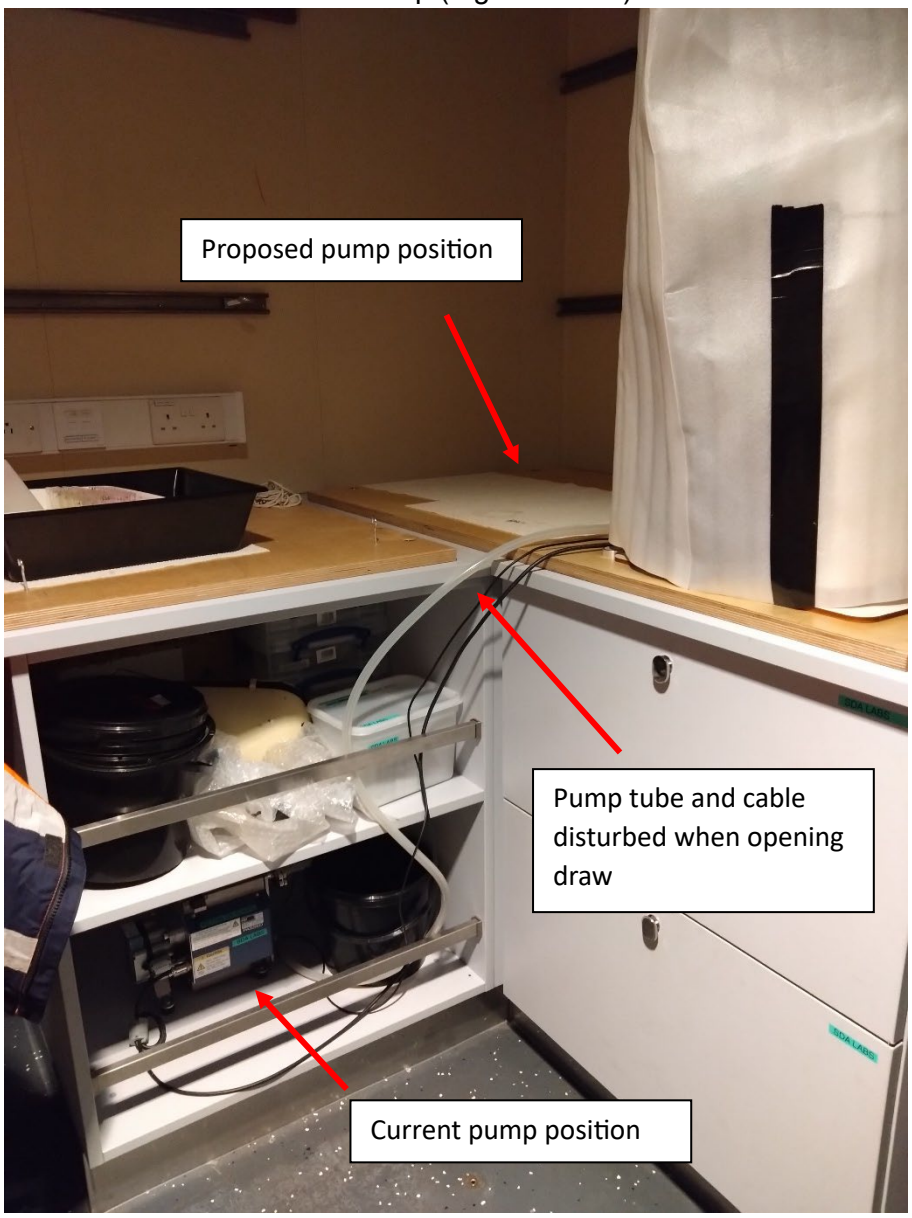


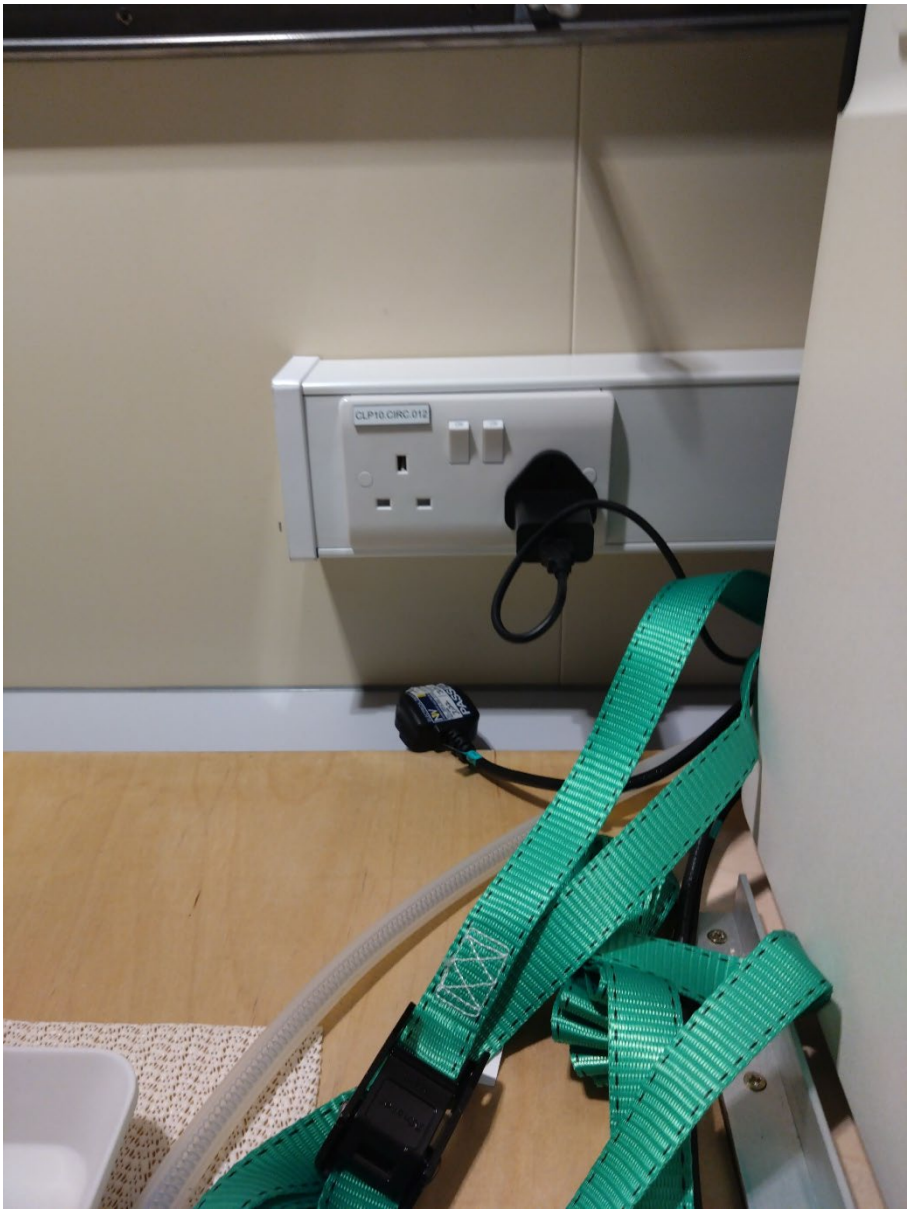
Figure 14.2.5. Current position of the pump and recommended new positions

3) After changing pump position, the two big draws under the SEM should be used to store the SEM consumables. They then would not be in an open shelf but a closed draw.
4) Katrin Linse replaced the blue plastic buckle lashing straps with two metal buckle lashing straps that each can hold 150kN (Figure 14.2.6.).

Figure 14.2.6. New, metal buckle straps for TM4000Plus

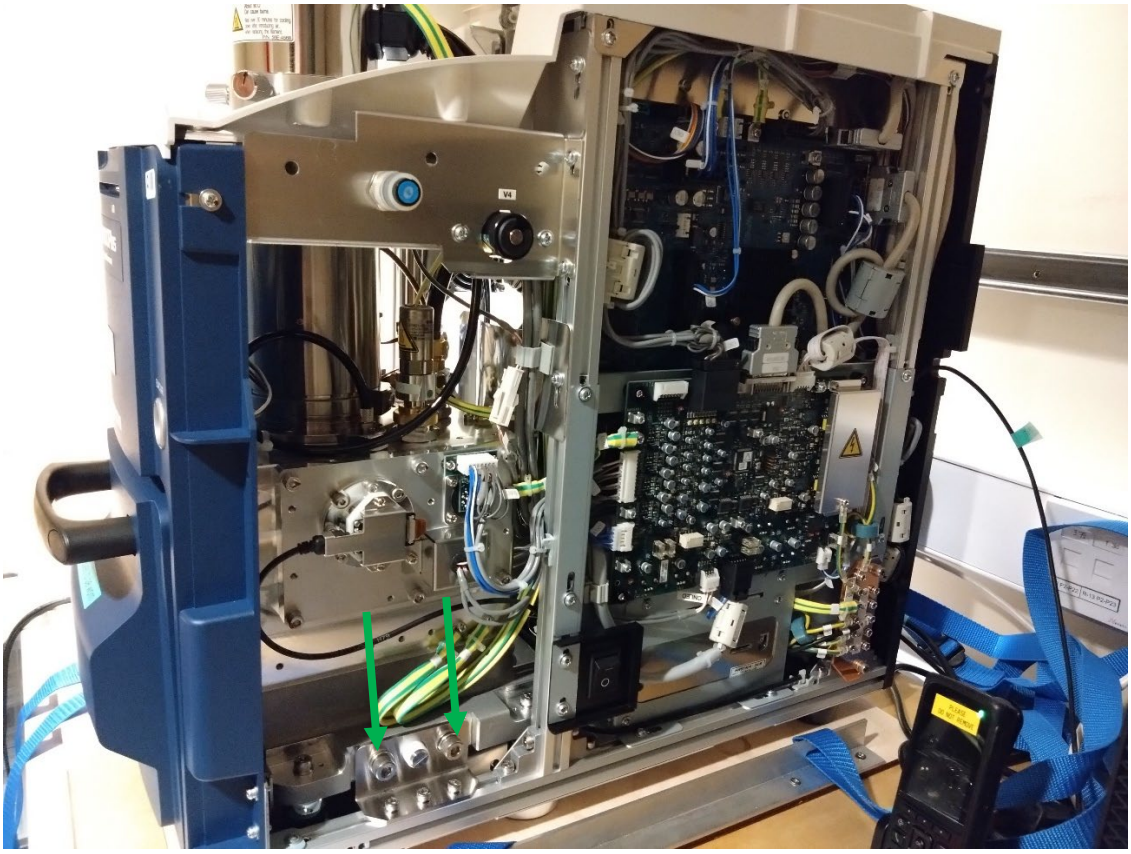
5) Purchase an SEM specific Allen key set for the M4 and M6 transit bolt removal and insertion.
6) Katrin Linse recommends purchasing a small ultrasonic cleaning bath to clean specimens/objects of dirt before mounting onto stubs. These are available for around £30 as jewellery or dental cleaners.
7) In the SEM user book inset columns for total use time per use (important for assessment of filament use time and age) and environmental parameter conditions (min and max as taken from Grafana displays).
8) Katrin Linse's recommendations what would be important in a pictured user guide for transit bolt removal, SEM use and transit bold insertion.

a. Before starting to remove SEM side panels, make sure power cord is disconnected.



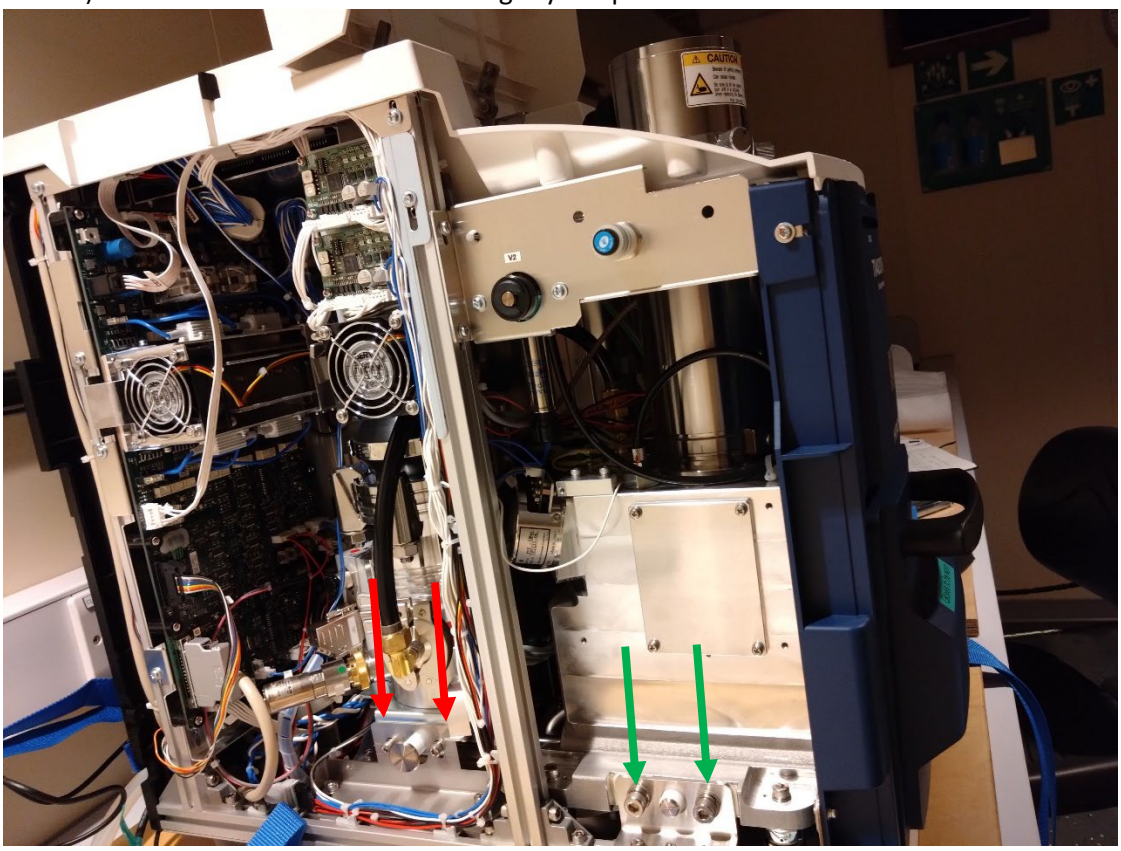
b. Remove lashing straps by losing and placing being and in front of SEM.

c. Remove right hand side panel first and remove M6 bolts (green arrows).

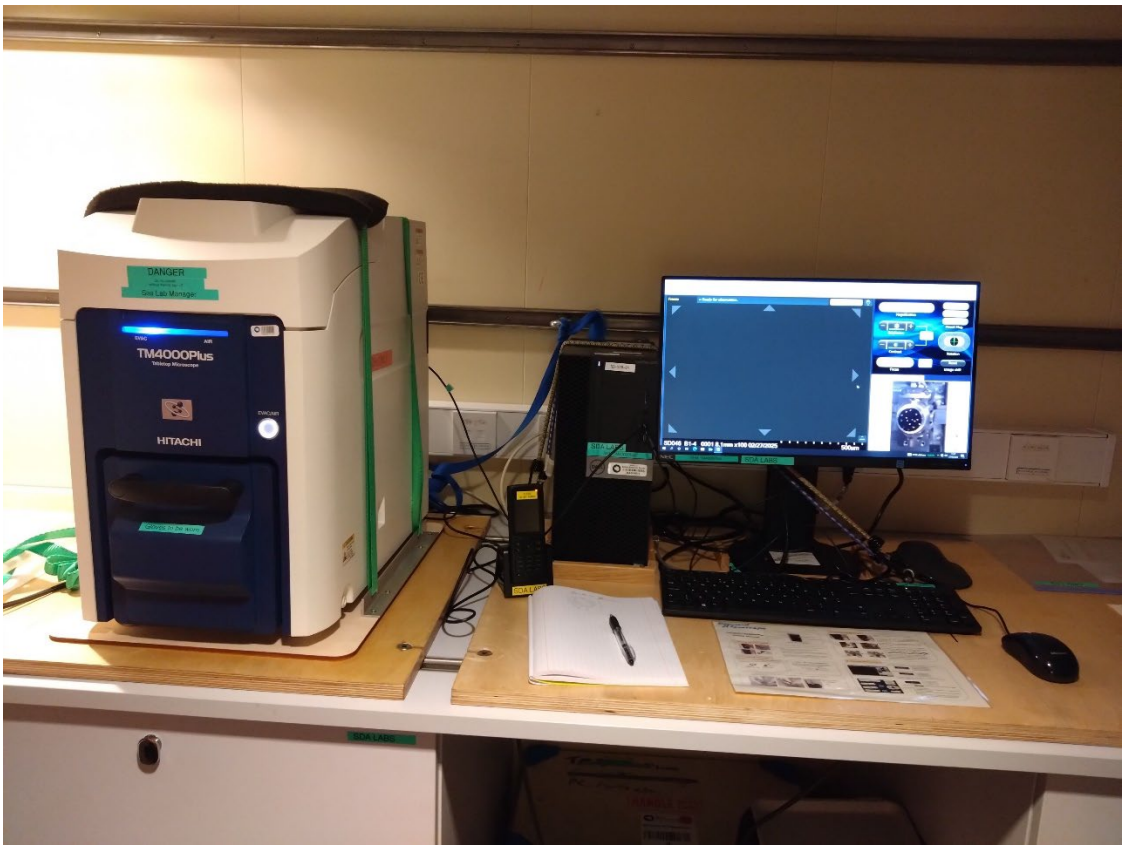


After bolt removal, insert right side panel again.

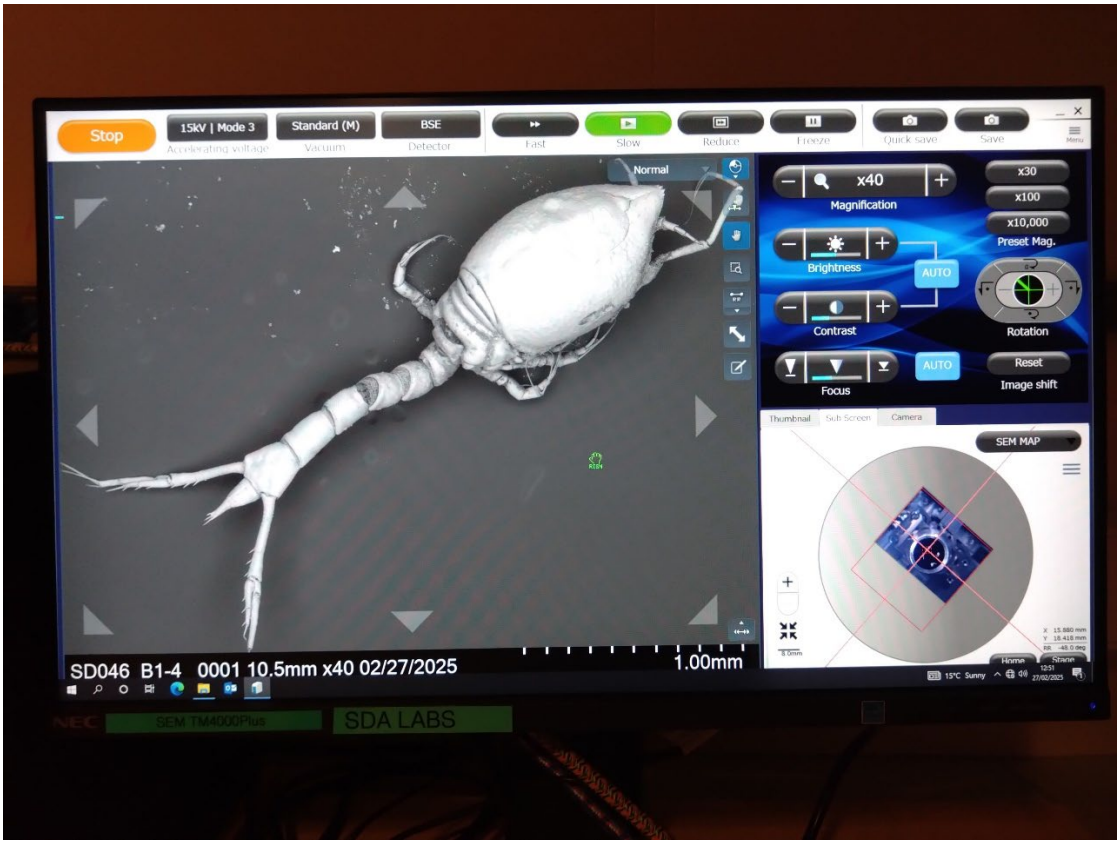
d. Remove left side panel and first remove M6 bolts (green arrows), the M4 bolts (red arrows). Please not that the column slightly drops on removal of the M4 bolts.



e. Insert left side panel again and secure lashing straps. Connect TM4000Plus to power. Start up the SEM and its desktop computer. Follow the instructions on the TM4000/TM4000Plus Simple Manual laminated user guide, available in draw and on PC.



f. Take images and safe on PC in folder as outline in lab manager's guidance.



g. After use, close down application and shut down SEM following the Simple Manual. Remove power cord from power and insert transit bolts, starting with left side and M4 bolts. This will secure the column first. Then insert left side M6 bolts and secure left side panel. Then insert right side M6 bolts and after securing right side panel, secure TM4000Plus with the lashing straps.

h. Download the images onto an extern memory drive. The SEM PC is not networked.

15. Media

15.1 Northern Pictures film crew

Author: Braydon Moloney

A small two-person film crew accompanied the SD046 cruise to document the science and operations, for an upcoming television series. Cinematographer Cam Batten and director Braydon Moloney, representing the Sydney-based factual television company Northern Pictures, were accompanied by BAS Media Facilitator Maddy De Marchis.

Following in-depth consultation with BAS scientists and media department, the series producers identified five key stories about the research being conducted on this cruise, which the crew were then tasked to cover.

Key BAS personnel we've collaborated with to tell these stories include Sophie Fielding, Geraint Tarling, Sally Thorpe, Nadine Johnston, Captain Matt Neill, Mark "Tugsy" Taylor and Simon Wright.

Filming has gone smoothly. Everyone onboard has been extremely accommodating of our requests and the help we've received has allowed us to really raise the bar on how we've covered these stories. The biggest setback we've experienced has be a lack of stormy weather, which we'd hoped to film.

15.2 BAS Communications

Author: Maddy de Marchis

Maddy De Marchis from BAS Communications team was onboard SD046 as Media Facilitator. Maddy facilitated interviews on the SDA with a range of news outlets about A23a's approach to South Georgia throughout March 2025, following media requests received by BAS Press Office. Interviews were delivered for BBC 5 Live, BBC News Channel, BBC Radio 4, BBC Breakfast, BBC World Service, Reuters, BBC Radio Scotland, AP, and CBC, by BAS scientists Geraint Tarling, Nadine Johnston, Huw Griffiths and Laura Taylor. Contact press@bas.ac.uk for further information.

Maddy also documented the science activities of the cruise through photos and videos and delivered social media content for BAS and BIOPOLE platforms to promote BIOPOLE and WCB projects, and the science capabilities of the RRS *Sir David Attenborough.*

16. iDirac

Author: Gabi Stowasser

Other contributors: Floortje Van Den Heuvel, Freya Squires, Ryan Saunders

Background

Clouds are a major source of uncertainty in climate models, particularly in the Southern Ocean. This is largely due to the lack of knowledge and observations of the types and sources of aerosol particles which can act as cloud forming nuclei. Due to the remote nature of the Southern Ocean, the cloud forming particles present are believed to be primarily of natural, marine origin. However, natural sources of aerosol are themselves subject to change in the context of a changing climate. In order to better understand the role of Southern Ocean Clouds in the context of climate change, it is key to understand the sources, composition and abundance of aerosol and cloud forming nuclei in the Southern Ocean. Dimethyl sulfide (DMS, $(CH_3)_2S$) is an important precursor gas for the formation of marine sulfate aerosols through coagulation and condensation. DMS is emitted by marine biogenic processes, amongst which the grazing of Phytoplankton by Zooplankton.

The iDirac is a portable instrument enabling measurement of atmospheric DMS in remote locations. A detailed description of the iDirac instrument is included in Bolas et al. (2020). Briefly, the instrument consists of is a dual-column isothermal oven gas chromatograph with a photoionisation detection (GC-PID). The system can be configured for a range of compounds, though for BIOPOLE the iDirac was only measuring DMS. The iDirac requires nitrogen gas which provides the carrier flow through the instrument and is calibrated using a gas cylinder containing a known concentration of DMS. Figure 16.1 shows a flow diagram for the instrument.

The data collected by the iDirac during the BIOPOLE cruise will contribute to investigating the sources of cloud forming nuclei in the Southern Ocean by allowing the investigation of the link between marine biological activity and DMS concentrations in the atmosphere.

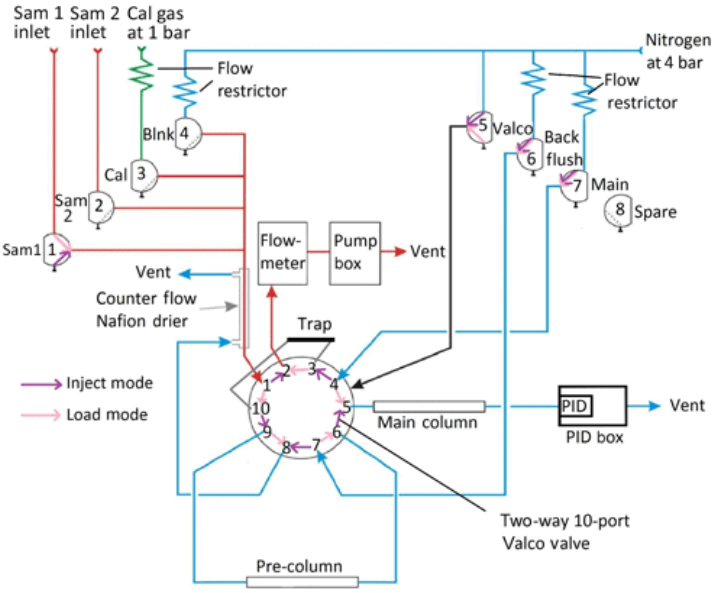


Figure 16.8 Schematic representation of iDirac operation, Figure 2 in Bolas et al. (2020).

Set Up

On the BIOPOLE cruise the iDirac was installed in the Aerosol Lab on deck 10 on the SDA. Calibration gas was stored inside the lab and the nitrogen gas which provides carrier flow was installed on the outside deck. The set-up looked as follows (see Figure 16.2):

Set-up of iDirac in Aerosol lab:
a. instrument, b. pump,
c. rotameter, d. calibration gas

Instrument Issues/Recommendations

The iDirac used a higher than anticipated volume of carrier gas which could indicate an internal leak or a problem with some of the gas line connections between the nitrogen cylinder and the port on the iDirac instrument. In order to maintain measurements for as long as possible during the Western Core Box and BIOPOLE cruise sections the iDirac was switched off and turned on during periods of particular scientific interest (see Table 16.1 below). The instrument should be checked for internal leaks when back in the UK for servicing.

References

Bolas, C. G., Ferracci, V., Robinson, A. D., Mead, M. I., Nadzir, M. S. M., Pyle, J. A., Jones, R. L., & Harris, N. R. P. (2020). IDirac: A field-portable instrument for long-term autonomous measurements of isoprene and selected VOCs. *Atmospheric Measurement Techniques*, *13*(2), 821–838. https://doi.org/10.5194/AMT-13-821-2020

Table 16.1: Eventlog of iDirac operations during SD046							
Time (UTC)	latitude	longitude	action	cylinder pressure (bar)	calibration pressure (bar)	flowrate (L/min)	Comment
17/03/2025 18:00	-60.6412	-42.23	Instrument shut down and last data download	35			Instrument was shut down completely and all gases turned off
17/03/2025 01:00	-62.0736	-42.2151	Instrument paused	35	2.4	2.5	Pressure flow to instrument 4.5. Pressure gauge outside still at 35bar when instrument was stopped.
15/03/2025 17:49	-62.0115	-42.0123	Instrument switch-on	35	2.4	2.5	Pressure flow to instrument 4.2 bar, Station B2_4 (BIOPOLE)
11/03/2025 17:15	-62.6285	-43.2601	Instrument paused	35			Instrument paused due to bad weather and to preserve gas while on transit between stations
11/03/2025 01:14	-63.5868	-41.8214	Instrument check	40	2.4	2.5	pressure gauge still at 40 bar, pressure flow outside cylinder 4.2bar
10/03/2025 02:14	-61.9464	-47.1111	Instrument check	40	2.4	2.5	Still 40 bar outside. very cold temperatures outside so cylinder gauge might have been frozen in place. Pressure flow outside cylinder 4.0 bar
09/03/2025 19:56	-61.9814	-46.794	Instrument check	40	2.4	2.5	Arduino connection vanished, raspberry pi on red and machine was blinking red, at 20:00 switched off and re-started at 21:15. Possible power failure at some point between 07/03 and 09/03
07/03/2025 18:17	-62.0642	-50.5266	Instrument switch-on	40	2.4	2.5	Switched on at station BI2-08, flow pressure outside cylinder 4.2 bar, BIOPOLE
27/02/2025 17:00	-63.5573	-41.8177	2nd data download				Instrument was switched on for data download and then switched off again
21/02/2025 16:00	-55.1953	-34.4827	Instrument switch-off	60			instrument switched off at end of WCB, gas turned off, time of turn-off assumed
15/02/2025 16:00	-63.5565	-41.8187	Instrument check	90	2.4	2.5	Flow pressure outside cylinder 4.2 bar, time of check assumed
14/02/2025 16:00	-62.6285	-43.2601	Instrument check	100	2.4	2.5	pressure flow outside cylinder 4.5, adjusted to 4.2, checking time assumed

12/02/2025 16:00	-54.1826	-36.6856	Instrument check	120	2.4	2.5	flow pressure outside cylinder 4.4 bar, checking time assumed
11/02/2025 16:00	-54.1798	-36.6859	First data download and instrument check	130	2.4	2.5	flow pressure outside cylinder 4.2 bar
10/02/2025 16:00	-53.7916	-37.9353	Instrument check	150	2.4	2.5	time of checking assumed, flow pressure to the instrument 4.2
08/02/2025 22:04	-52.8701	-47.8585	started	160	2.4	3.0	flow pressure outside cylinder 4.2 bar, at start of Western Core Box (WCB)

17. Cruise Reports

The following is the cruise summary report submitted to BODC documenting the scope of data collected on SD046

CRUISE SUMMARY REPORT	FOR COLLATING CENTRE USE **Centre: BODC** **Ref. No.:** Is data exchange restricted ☐ Yes ☐ In part ☐ No

SHIP enter the full name and international radio call sign of the ship from which the data were collected, and indicate the type of ship, for example, research ship; ship of opportunity, naval survey vessel; etc.

Name: RRS Sir David Attenborough **Call Sign:** ZDLQ3

Type of ship: Research Vessel

CRUISE NO. / NAME SD046

enter the unique number, name or acronym assigned to the cruise (or cruise leg, if appropriate).

CRUISE PERIOD start (set sail) 05 / 02/ 2025 (day/ month/ year) to 28 /03 / 2025 (day/ month/ year) end (return to port)

PORT OF DEPARTURE (enter name and country) Punta Arenas, Chile

PORT OF RETURN (enter name and country) Mare Harbour, Falkland Islands

RESPONSIBLE LABORATORY enter name and address of the laboratory responsible for coordinating the scientific planning of the cruise

Name: British Antarctic Survey

Address: High Cross, Madingley Road, Cambridge, CB3 0ET

Country: United Kingdom

CHIEF SCIENTIST(S) enter name and laboratory of the person(s) in charge of the scientific work (chief of mission) during the cruise.

Prof Geraint Tartling, British Antarctic Survey

Dr Sophie Fielding, British Antarctic Survey

OBJECTIVES AND BRIEF NARRATIVE OF CRUISE enter sufficient information about the purpose and nature of the cruise so

as to provide the context in which the report data were collected.

The SD046 is a multidisciplinary science cruise aboard the RRS Sir David Attenborough collecting data and samples in four distinct phases: 1) South Georgia, 2) A23 transect and 3) BIOPOLE and 4) A23a iceberg. The South Georgia phase (**SG**) comprised of the Western Core Box transects, two benthic stations and mooring work at the sites P3, Western Core Box and Eastern Core Box. The A23 transect phase (**A23**) consisted of oceanographic measurements at predefined transect points and mooring work at the South Sandwich Trench sites SSC and SST. The BIOPOLE phase (**BP**) consisted of several stations with intensive biological net and trawl sampling and mooring work at the sites M2, M3, OP1, OP2, OP3 and OP5. The iceberg A23a phase (**iceberg**) sampled underway, plankton community and sea surface ice, and conducted oceanographic measurements around the grounded A23a iceberg. Furthermore, sampling from the uncontaminated seawater system and marine mammal efforts took place in all cruise phases. Several onboard experiments have been conducted using subsamples or individual organisms taken from the acquired samples.

The BIOPOLE phase aims to investigate how nutrients in polar waters drive the global carbon cycle and primary productivity in ocean. Measurements were made for determining ocean circulation and the tracing of nutrient sources to examine the coupling between physical, biogeochemical, and ecological processes during the austral autumn in the area of Powell Basin extending vertically from the surface through the upper water column, the Mixed Layer Depth, into the upper layers of the Circumpolar Deep Water.

The South Georgia phase aims to undertake sampling as part of the POETS Western Core Box, to understand the long-term variability of the marine ecosystem, in particular krill biomass, at South Georgia, to assess mesoscale distribution and abundance of macro-zooplankton and micronekton, and the physical environment they are within at South Georgia, South Atlantic, from 1996 onwards. Furthermore, benthic community composition was analysed at two South Georgia stations.

The A23 repeat transect phase aims to understand warming trends in the dense Antarctic Bottom Water and underlying causes, and to uncouple interannual variability from the long-term warming trend.

The A23a iceberg sampling phase aims to determine the impact on physical and biogeochemical conditions as well as planktonic and benthic community composition, complementing previous iceberg sampling, e.g. A76a (2023), A68a (2021) or A23a (2023).

PROJECT (IF APPLICABLE) if the cruise is designated as part of a larger scale cooperative project (or expedition), then enter the name of the project, and of organisation responsible for co-ordinating the project.

Project name: BIOPOLE (Biogeochemical processes and ecosystem function in changing polar systems and their global impacts), POETS-WCB (Polar Ocean Ecosystem Time Series - Western Core Box), A23 repeat transect

Coordinating body: British Antarctic Survey, United Kingdom

PRINCIPAL INVESTIGATORS: Enter the name and address of the Principal Investigators responsible for the data collected on the cruise and who may be contacted for further information about the data. (The letter assigned below against each Principal Investigator is used on pages 2 and 3, under the column heading 'PI', to identify the data sets for which he/she is responsible)

A. Prof TARLING, Geraint, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, United Kingdom (PSO, gant@bas.ac.uk)

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CC. Dr HENDRY, Katharine, British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, United Kingdom (kathen@bas.ac.uk)

MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS

This section should be used for reporting moorings, bottom mounted gear and drifting systems (both surface and deep) deployed and/or recovered during the cruise. Separate entries should be made for each location (only deployment positions need be given for drifting systems). This section may also be used to report data collected at fixed locations which are returned to routinely in order to construct 'long time series'.

PI	APPROXIMATE POSITION						DATA TYPE	DESCRIPTION
	LATITUDE			LONGITUDE				
See top of page.	deg	min	N/S	deg	min	E/W	enter code(s) from list on last page.	Identify, as appropriate, the nature of the instrumentation the parameters (to be) measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any identifiers given to the site.
A,B, BB, O	62	7.34	S	50	29.69	W	B08,B09, B71,B73,B90,D01, D71,D90,H21	**Site**: BIOPOLE, **recovery** 08/03/2025 (event number 139), **not re-deployed**, **water depth**: 3383m, **instrumentation**: 300kHz RDI Workhorse Sentinel ADCP, SBE37 SMP CTD, McLane sediment trap, Seaguard Current Meter and O2 sensor

A,B,BB,O	52	51.57	S	40	5.36	W	B08,B09,B71,B73,B90,D01,D71,D90,H21,P90	**Site**: P3, **recovery**: 09/02/2025 (event number 10), **deployment:** 22/03/2025 (event number 206), **water depth**: ~3780m, **instrumentation**: 300kHz RDI Workhorse Sentinel ADCP, SBE37 CTD, OPIC – plastic sampler, Phytoplankton sampler, McLane sediment trap, Seaguard Current Meter and O2 sensor
A,B,BB,O	53	47.74	S	37	56.58	W	B08,B09,B28,B71,B73,B90,D71,D90,	**Site**: WCB, **recovery** 10/02/2025 (event number 14), **deployment**: 18/02/2025 (event number 52), **water depth**: ~320m, **instrumentation**: SBE37 CTD, SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, McLane sediment trap, Aquadopp Doppler current profiler, Sonovault passive acoustic hydrophone
A,B,BB,O	54	06.21	S	36	14.41	W	B08,B09,B28,B71,B73,B90,D71,D90,	**Site**: ECB, **recovery** 13/02/2025 (event number 23), **deployment:** 20/02/2025 (event number 64), **water depth**: ~270m, **instrumentation**: SBE37 SMP CTD, 300kHz RDI Workhorse Sentinel ADCP, Simrad WBAT echosounder, McLane sediment trap, Aquadopp Doppler current profiler, Sonovault passive acoustic hydrophone
P	60	13.10	S	25	7.23	W	D01,H10,D90	**Site**: SSTC, **recovery**: 24/02/2025 (event number 83), **not re-deployed**, **water depth**: ~5850m, **instrumentation**: SBE37 SM CTD, Aquadopp 6000 3D Doppler current meter, RBRsoloT
P	60	6.01	S	25	17.96	W	D01,H10,D90	**Site**: SSTW, **recovery**: 25/02/2025 (event number 86), **partially recovered** (SBE37 SM CTD not recovered), **not re-deployed**, **water depth**: ~4380m, **instrumentation**: SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter
Z	60	37.43	S	42	5.49	W	D01,H10,D90	**Site**: OP1, **recovery**: 03/03/2025 (event number 111), **not recovered** (only release remained), **deployment**: 18/03/2025 (event number 190), **water depth**: ~3600m, **instrumentation:** SBE 37 SM CTD, SBE 39 TR, Aquadopp 6000 3D Doppler current meter, RBR soloT
Z	60	38.47	S	42	10.69	W	D01,H10,D90	**Site**: OP2, **recovery**: 03/03/2025 (event number 112), **no instruments recovered** (broken wire), **deployment**: 17/03/2025 (event number 185), **water depth**: ~3200m,

								instrumentation: SBE 37 SM CTD, SBE 39 TR, Aquadopp 6000 3D Doppler current meter, RBR soloT
Z	60	39.33	S	42	13.49	W	D01,H10,D90	**Site**: OP3, **recovery**: 03/03/2025 (event number 110), **not re-deployed**, **water depth**: ~1800m, **instrumentation:** SBE37 SM CTD, SBE39 TR, Aquadopp 6000 3D Doppler current meter
Z	60	36.89	S	41	58.60	W	D01,H10,D90	**Site**: OP5, **recovery**: 04/03/2025 (event number 119), **deployment**: 18/03/2025 (event number 192), **water depth**: ~3400m, **instrumentation:** SBE 37 SMP CTD, Aquadopp 6000 3D Doppler current meter, RBR soloT
Z	63	29.84	S	41	47.86	W	D01,H10,D90	**Site**: M3, **recovery**: 14/03/2025 (event number 168), **deployment**: 14/03/2025 (event number 169), **water depth**: ~4600m, **instrumentation:** SBE37 SMP CTD, SBE39 TR, Aquadopp 6000 Doppler current meter
								Please continue on separate sheet if necessary

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

Except for the data already described on page 2 under 'Moorings, Bottom Mounted Gear and Drifting Systems', this section should include a summary of all data collected on the cruise, whether they be measurements (e.g. temperature, salinity values) or samples (e.g. cores, net hauls).

Separate entries should be made for each distinct and coherent set of measurements or samples. Different modes of data collection (e.g. vertical profiles as opposed to underway measurements) should be clearly distinguished, as should measurements/sampling techniques that imply distinctly different accuracy's or spatial/temporal resolutions. Thus, for example, separate entries would be created for i) BT drops, ii) water bottle stations, iii) CTD casts, iv) towed CTD, v) towed undulating CTD profiler, vi) surface water intake measurements, etc.

Each data set entry should start on a new line – it's description may extend over several lines if necessary.

NO, UNITS : for each data set, enter the estimated amount of data collected expressed in terms of the number of 'stations'; miles' of track; 'days' of recording; 'cores' taken; net 'hauls'; balloon 'ascents'; or whatever unit is most appropriate to the data. The amount should be entered under 'NO' and the counting unit should be identified in plain text under 'UNITS'.

PI	NO	UNITS	DATA TYPE	DESCRIPTION
see page 2	see above	see above	Enter code(s) from list on last page	Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
E,M,N,R,CC,S	71	deployments	B02,B06,B08,B71,B90,D9	Conductivity-temperature-depth casts recording temperature, conductivity, dissolved oxygen, pressure, chlorophyll-a fluorescence, altitude above seabed, backscatter, optical beam transmission. Water samples were collected on some casts for analysis of Seawater collected using Niskin were used to sample

,V, W,X			0, H09,H10, H16,H21, H26,H27,H32,H33,H90, P90	for salts, dissolved oxygen, dissolves nutrients, dissolved inorganic carbon and total alkalinity (DIC/TA), silicon isotopes (d30Si), oxygen isotopes (d18O), dissolved organic carbon (DOC), particulate organic carbon (POC), total organic carbon (TOC), biogenic silica (BSi), chlorophyll-a/Lugol's, phyto-experiments, particulate organic matter (POM), black carbon, eDNA, grazing and microplastics
Y	71	deployments	D71	Lowered Acoustic Doppler Current Profiler (LADCP) recording current velocities, signal return and error in the velocity measured; 300kHz (upward) and 300kHz (downward), free-pinging with no synchronisation between instruments.
F,H, K,N	50	deployments	B09,B13,B72,B90	Bongo net, mesh sizes 100µm–200µm. Sampled copepods, meso-zooplankton for zooplankton community analysis and copepod incubation experiments.
F,H, K,N	17	deployments	B09,B13,B14,B21,B72,B90	Mammoth net collected meso-zooplankton; using 300µm mesh. Sampled copepods, meso-zooplankton for zooplankton community analysis and copepod incubation experiments.
A,R	4	deployments	B09,B13,B14,B21,B90	Mocness net collected zooplankton community up to the depth of 1000m using 300µm mesh
B,Q	16	deployments	B09,B13, B14,B21,B90	RMT8 pelagic trawl system consisting of two nets with a mouth opening of 8 m^2 and 4 mm mesh. Mainly used to catch krill and macrozooplankton.
L	9	deployments	B18,B19,B72,B20	Epibenthic sledge towed along the seabed to stir up the top layer of sediment and collect organisms living just above the seafloor.
I	11	deployments	B18,B19,B20	Agassiz trawl heavy collected samples of organisms living on or just above the seafloor.
A,B	9	deployments	H10	Teledyne Rapid Cast CTD
A,B	16	days	G74	EM124 multibeam echosounder recording.
A,B	51	days	G73	EA640 singlebeam echosounder recording.
T,U	51	days	H71,H16, B02,M06	Routine underway measurements of position, heading, speed from GPS/gyro/log; temperature, salinity, chlorophyll-a fluorescence, optical beam transmission from uncontaminated seawater supply and sensors under hull; air temperature, humidity, sea level pressure, wind speed and direction, solar radiation;

E,M,R,CC,S,V,W	1362	samples	B02,B06,B71,H21,H26,H32,H90	Underway water samples for for DOC, DIC, POC/TOC/BSI, Si isotopes; nutrients; black carbon; chlorophyll/Lugol's; d18O; salinity and POM.
A,B	50	days	G27	Opportunistic gravity meter measurements.
AA,C,G	76	transects	B26	Marine Mammal Observations
A,B	50	days	G90	Rutter Sigma s6 WaMoS II wave radar directional radar measuring wave and surface current parameters
R	19	days	M71	i-Dirac gas chromatograph for long-term measurements of selected halocarbons in the atmosphere
D	51	days	M90	Eddy covariance CO2 flux system consisting of Picarro gas concentration analyser, Metek uSonic3 ultrasonic anemometer and LPMS motion reference unit
J,V	49	days	D71	Vessel-Mounted Acoustic Doppler Current Profiler measurements (VMADCP) 75 kHz (12 days) and 150 kHz (18 days).
B	50	days	B28	Simrad EK80 bioacoustic echosounder
B	13	days	G74	Simrad ME70 multibeam echosounder
				Please continue on separate sheet if necessary

TRACK CHART: You are strongly encouraged to submit, with the completed report, an annotated track chart illustrating the route followed and the points where measurements were taken.	Insert a tick(✔) in **this box if a track chart is supplied**	✔

GENERAL OCEAN AREA(S): Enter the names of the oceans and/or seas in which data were collected during the cruise – please use commonly recognised names (see, for example, International Hydrographic Bureau Special Publication No. 23, 'Limits of Oceans and Seas').

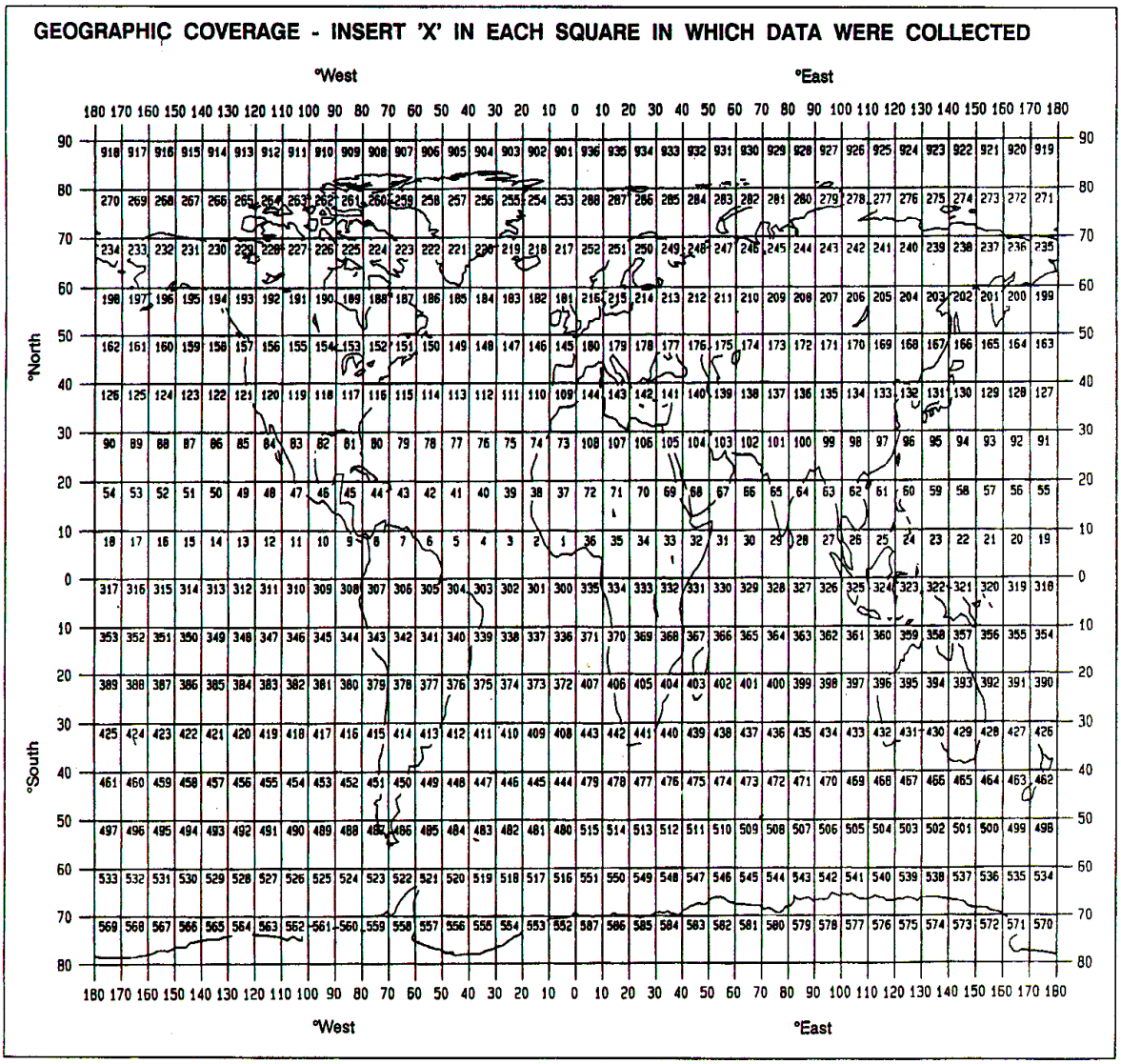
Southern Ocean, Weddell Sea, Scotia Sea

SPECIFIC AREAS: If the cruise activities were concentrated in a specific area(s) of an ocean or sea, then enter a description of the area(s). Such descriptions may include references to local geographic areas, to sea floor features, or to geographic coordinates.

Please insert here the number of each square in which data were collected from the below given chart

482,483,484,518,519,520,

see above


GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED
°West
°East
°North
°South
°West
°East

PARAMETER CODES

METEOROLOGY

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

MARINE BIOLOGY/FISHERIES

B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements

SD046 Annex EL: Bridge Event Log

Time	Event	Lat	Lon	Comment
25/03/2025 00:23		-54.4662	-40.0404	End of NW transect
24/03/2025 20:10		-54.5562	-39.0471	Commence NW transect
24/03/2025 20:02	219	-54.5568	-39.0419	IDIOTS (Intelligently Deployed Ice Overboard Trawling System) completed
24/03/2025 19:44		-54.5683	-39.0433	Off DP
24/03/2025 19:29	218	-54.5683	-39.0433	Bongo net out of the water
24/03/2025 19:17	218	-54.5683	-39.0433	Bongo deployed to 200m
24/03/2025 19:06	218	-54.5683	-39.0433	Bongo in the water
24/03/2025 18:55	217	-54.5682	-39.0433	Bongo out the water
24/03/2025 18:45	217	-54.5682	-39.0433	Bongo deployed
24/03/2025 18:33	217	-54.5682	-39.0433	Bongo in the water
24/03/2025 18:10	216	-54.5682	-39.0433	CTD out the water
24/03/2025 17:43	216	-54.5683	-39.0433	CTD deployed to 213m
24/03/2025 17:31	216	-54.5683	-39.0433	CTD in the water
24/03/2025 17:19		-54.5682	-39.0427	Vessel on DP
24/03/2025 10:42		-54.5069	-38.7311	Crossing sampling point G
24/03/2025 09:37		-54.492	-38.5598	Crossing sampling point F
24/03/2025 08:35		-54.4555	-38.1373	Off DP
24/03/2025 08:28	215	-54.451	-38.1006	Bongos out of the water
24/03/2025 08:14	215	-54.451	-38.1006	Bongos at depth 175m
24/03/2025 08:03	215	-54.4509	-38.1006	Bongos in the water
24/03/2025 07:58	214	-54.4509	-38.1006	Bongos out of the water
24/03/2025 07:45	214	-54.4509	-38.1006	Bongos at depth 175m
24/03/2025 07:33	214	-54.4509	-38.1006	Bongos in the water

24/03/2025 07:05	213	-54.451	-38.1007	CTD out the water
24/03/2025 06:30	213	-54.4509	-38.1007	CTD deployed to 215m
24/03/2025 06:19	213	-54.4509	-38.1007	CTD in the water
24/03/2025 06:09		-54.4514	-38.1003	Vessel on DP at Shelf waypoint
24/03/2025 04:49		-54.6553	-38.0699	Cross sampling point E
24/03/2025 03:31		-54.8713	-38.0868	Cross sampling point C
24/03/2025 02:11		-55.0993	-38.0741	Crossing sampling point A
24/03/2025 00:39	212	-55.3223	-38.0638	CTD out of the water
23/03/2025 23:49	212	-55.3223	-38.0658	CTD at 1020m
23/03/2025 23:26	212	-55.3218	-38.0668	CTD in the water
23/03/2025 22:54		-55.3231	-38.0646	On DP
23/03/2025 22:03		-55.23	-38.2035	Cross sampling point 3 - SE2
23/03/2025 21:25		-55.1407	-38.3401	Cross sampling point 2 - SE2
23/03/2025 20:47		-55.0499	-38.4792	Cross sampling point 1 - SE2
23/03/2025 20:10		-54.962	-38.6205	Off DP
23/03/2025 20:03	211	-54.962	-38.6208	CTD out of the water
23/03/2025 19:27	211	-54.962	-38.6208	CTD at depth 1020m
23/03/2025 18:58	211	-54.962	-38.6207	CTD in the water
23/03/2025 18:44		-54.962	-38.6208	Vessel on DP at SE0
23/03/2025 16:36		-55.0795	-39.1933	Vessel proceeding to SE0
23/03/2025 16:20	210	-55.0774	-39.2008	Basket out the water
23/03/2025 16:17	210	-55.0781	-39.2014	Ice in basket
23/03/2025 16:11	210	-55.079	-39.2021	Ice catching device in the water
23/03/2025 15:54		-55.0666	-39.2183	Off DP
23/03/2025 15:21	209	-55.0657	-39.2158	Bongo on board

23/03/2025 15:17	209	-55.0657	-39.2163	Bongo out the water
23/03/2025 15:10	209	-55.0656	-39.2176	Bongo in the water
23/03/2025 14:10	208	-55.0655	-39.2182	CTD out of the water
23/03/2025 13:23	208	-55.0655	-39.2183	CTD at depth 1020m line out
23/03/2025 12:59	208	-55.0656	-39.2183	CTD in the water
23/03/2025 12:48		-55.0656	-39.2183	Vessel on DP in A23a fjord
23/03/2025 12:16		-55.129	-39.2076	Crossing sampling point 4
23/03/2025 11:45		-55.215	-39.335	Crossing sampling point 3
23/03/2025 11:15		-55.28	-39.5267	Crossing sampling point 2
23/03/2025 10:45		-52.8459	-40.0388	Crossing sampling point 1. 55 20.18 S 039 42.19 W
23/03/2025 10:10		-52.8459	-40.0388	Off DP
23/03/2025 10:01	207	-52.8459	-40.0388	CTD out of water 55 24.0 S 039 54.0 W
23/03/2025 09:12	207	-52.8459	-40.0388	CTD at depth 1020m
23/03/2025 08:46	207	-52.8459	-40.0388	CTD in the water
23/03/2025 08:02		-52.8459	-40.0388	On DP at SW2. 55 24.0 S 039 54.0 W
23/03/2025 08:00		-52.8459	-40.0388	End A23A transect. 55 24.01 S 039 53.92 W
23/03/2025 00:28		-52.8459	-40.0388	Commence A23A transect. 54 00.0 S 040 00.0 W
22/03/2025 18:40		-52.8459	-40.0388	Off DP
22/03/2025 18:12	206	-52.8458	-40.0387	Vessel at trilateration 3 site
22/03/2025 17:48	206	-52.8362	-40.1264	Vessel off DP
22/03/2025 17:47	206	-52.8362	-40.1264	Trilateration 2 site complete. Position 52 50.2'S 040 07.6'W
22/03/2025 17:40	206	-52.8362	-40.1264	On DP at trilateration site 2
22/03/2025 17:13	206	-52.8905	-40.1091	Off DP
22/03/2025 17:12	206	-52.8905	-40.1091	Trilateral complete 52 53.4'S 040 06.5'W
22/03/2025 16:38	206	-52.8904	-40.109	On DP

22/03/2025 16:17	206	-52.8596	-40.0894	Vessel off DP
22/03/2025 16:04	206	-52.85950	-40.0894	P3 Mooring -Weight released 52 51.54'S 040 05.34'W
22/03/2025 12:25	206	-52.8551	-40.0862	P3 top buoy in the water
22/03/2025 10:14		-52.8551	-40.0862	On DP
22/03/2025 09:40		-52.8551	-40.0862	Off DP
22/03/2025 09:05	205	-52.8551	-40.0862	CTD out of the water
22/03/2025 07:58	205	-52.8551	-40.0862	CTD at depth 3792m
22/03/2025 06:47	205	-52.8551	-40.0862	CTD in the water
22/03/2025 06:02	204	-52.8551	-40.0862	Bongo out the water
22/03/2025 05:51	204	-52.8551	-40.0862	Bongo deployed
22/03/2025 05:40	204	-52.8551	-40.0862	Bongo in the water
22/03/2025 05:23	203	-52.8551	-40.0862	Bongo deployed
22/03/2025 05:12	203	-52.8551	-40.0862	Bongo net in water
22/03/2025 05:06	202	-52.8551	-40.0862	Bongo out the water
22/03/2025 04:54	202	-52.8551	-40.0862	Bongo deployed
22/03/2025 04:42	202	-52.8551	-40.0862	Bongo net in water
22/03/2025 04:02	201	-52.8551	-40.0862	Mammoth out the water
22/03/2025 01:46	201	-52.8554	-40.0863	Mammoth net at 2300m line out
22/03/2025 00:15	201	-52.8554	-40.0863	Mammoth net in the water
22/03/2025 00:09		-52.8554	-40.0863	Vessel on DP at P3 mooring site
21/03/2025 05:00		-55.6915	-39.0746	Start A23A transect @10knots
19/03/2025 18:55	200	-60.5395	-40.9658	AGT out the water
19/03/2025 18:04	200	-60.542	-40.9638	870m line deployed
19/03/2025 17:21	200	-60.5454	-40.9611	AGT in the water
19/03/2025 17:01	199	-60.5456	-40.9609	EBS out the water

19/03/2025 16:23	199	-60.5456	-40.9609	Vessel stationary
19/03/2025 16:11	199	-60.5484	-40.9587	900m deployed
19/03/2025 15:30	199	-60.5514	-40.9562	EBS in the water
19/03/2025 15:05		-60.5526	-40.9557	Vessel on DP at New BP2_1 500
19/03/2025 14:03	198	-60.5496	-40.6952	CTD out of the water
19/03/2025 13:11	198	-60.5496	-40.6952	CTD at depth
19/03/2025 12:28	198	-60.5496	-40.6952	CTD in the water
19/03/2025 12:07	197	-60.5495	-40.6951	Bongo nets out of the water
19/03/2025 11:55	197	-60.5495	-40.6951	Bongo nets at 200m
19/03/2025 11:42	197	-60.5495	-40.6951	Bongo nets in the water
19/03/2025 11:34	196	-60.5495	-40.6951	Bongo nets out of the water
19/03/2025 11:22	196	-60.5495	-40.6951	Bongo nets at 200m
19/03/2025 11:08	196	-60.5496	-40.6952	Bongo nets in the water
19/03/2025 10:20	195	-60.5496	-40.6951	Mammoth out of the water
19/03/2025 08:48	195	-60.5473	-40.6936	Mammoth at depth 1500m
19/03/2025 07:41	195	-60.5471	-40.6937	Mammoth in the water
19/03/2025 07:06	194	-60.5472	-40.6936	CTD out of water
19/03/2025 06:41	194	-60.5472	-40.6936	CTD deployed. 105m line out
19/03/2025 06:33	194	-60.5472	-40.6937	CTD in the water
19/03/2025 06:21	193	-60.5471	-40.6936	Mammoth out the water
19/03/2025 04:50	193	-60.5472	-40.6936	Mammoth deployed
19/03/2025 03:46	193	-60.5471	-40.6936	Mammoth net in the water
18/03/2025 21:27		-60.6393	-41.9264	Off DP
18/03/2025 20:51		-60.5875	-41.9264	On DP
18/03/2025 20:20		-60.6152	-41.9783	Off DP

18/03/2025 20:08	192	-60.6149	-41.9769	Mooring weight deployed
18/03/2025 18:44	192	-60.6097	-41.9522	Top float in the water
18/03/2025 18:41		-60.6097	-41.9521	Vessel in position to start deploying mooring OP5
18/03/2025 16:54	191	-60.6131	-41.9684	CTD deployed
18/03/2025 15:50	191	-60.6131	-41.9684	CTD in the water
18/03/2025 15:13		-60.6149	-41.9659	Vessel on DP at OP5 mooring site
18/03/2025 14:42	190	-60.6239	-42.0916	OP1 mooring weight released
18/03/2025 11:29	190	-60.6461	-42.0917	OP1 top buoy in the water
18/03/2025 08:42	189	-60.6277	-42.0924	CTD out of the water
18/03/2025 07:15	189	-60.6277	-42.0924	CTD at depth 3653m
18/03/2025 06:05	189	-60.6277	-42.0924	CTD in the water
18/03/2025 05:48		-60.6276	-42.0929	Vessel on DP at OP1
18/03/2025 05:35		-60.6193	-42.1308	Vessel proceeding to OP1
18/03/2025 05:33		-60.6184	-42.1321	Range 3 on OP2
18/03/2025 04:55		-60.6689	-42.1249	Vessel proceeding to Range 3 site for trilateration
18/03/2025 04:52		-60.6677	-42.1253	Range 2 on OP2
18/03/2025 04:27	188	-60.6646	-42.1298	Mammoth out the water
18/03/2025 02:55	188	-60.6646	-42.1302	Mammoth net at 1500m
18/03/2025 01:37	188	-60.6646	-42.1302	Mammoth net in the water
18/03/2025 00:49	187	-60.6646	-42.1302	CTD out of the water
17/03/2025 23:27	187	-60.6646	-42.1302	CTD at 3214m
17/03/2025 22:17	187	-60.6646	-42.1302	CTD in the water
17/03/2025 22:17	187	-60.6646	-42.1302	CTD in the water
17/03/2025 22:07		-60.6646	-42.1303	On DP
17/03/2025 21:23		-60.6411	-42.23	Off DP

17/03/2025 21:12	186	-60.6411	-42.23	Mammoth on deck
17/03/2025 19:37	186	-60.6412	-42.2301	Mammoth at depth 1500m
17/03/2025 18:31	186	-60.6412	-42.2301	Mammoth net in the water
17/03/2025 16:38	185	-60.6412	-42.1784	OP2 Mooring released from aft end. Position of Aft deck 60Â°38.472'S 042Â°10.645'W
17/03/2025 13:21	185	-60.6412	-42.1316	Top buoy in the water
17/03/2025 12:54		-60.6413	-42.1261	Vessel on DP 2.5km east of OP2 deployment site
17/03/2025 02:49	184	-62.0523	-42.341	RMT-8 out of the water
17/03/2025 01:51	184	-62.0629	-42.2722	RMT-8 at 745m line out
17/03/2025 00:54	184	-62.0746	-42.2077	RMT-8 in the water
16/03/2025 23:54	183	-62.0743	-42.2037	CTD out of the water
16/03/2025 23:01	183	-62.0743	-42.2037	CTD at 1756m
16/03/2025 22:26	183	-62.0743	-42.2037	CTD in the water
16/03/2025 22:02	182	-62.0744	-42.2012	MOCNESS out of the water
16/03/2025 20:22	182	-62.0786	-42.0833	MOCNESS at depth
16/03/2025 18:45	182	-62.0828	-41.9689	MOCNESS in the water
16/03/2025 17:33		-62.0831	-41.9607	Vessel on DP at BP2_4_2000
16/03/2025 16:25		-61.8665	-42.1761	Vessel off DP
16/03/2025 16:02	181	-61.8664	-42.1761	EBS out the water
16/03/2025 15:15	181	-61.8663	-42.1701	EBS on the seabed. 900m line out. Vessel speed brought up to 1knot
16/03/2025 14:34	181	-61.8661	-42.163	EBS in the water
16/03/2025 13:57	180	-61.8661	-42.1616	AGT out of the water
16/03/2025 13:16	180	-61.8661	-42.1612	Vessel stopped
16/03/2025 13:05	180	-61.8659	-42.1553	AGT at 880m line out
16/03/2025 12:22	180	-61.8658	-42.148	AGT in the water
16/03/2025 12:15		-61.8655	-42.1416	Vessel on at at BP2_4_500

16/03/2025 10:25	179	-62.0835	-41.9617	CTD recovered to deck
16/03/2025 09:42	179	-62.0835	-41.9617	CTD out of the water
16/03/2025 08:33	179	-62.0835	-41.9617	CTD at depth 1977m
16/03/2025 07:54	179	-62.0835	-41.9617	CTD in water
16/03/2025 06:45	178	-62.0834	-41.9616	CTD out the water
16/03/2025 06:25	178	-62.0834	-41.9616	CTD deployed to 100m
16/03/2025 06:09	178	-62.0834	-41.9616	CTD in the water
16/03/2025 05:39	177	-62.0834	-41.9616	Bongo net out the water
16/03/2025 05:26	177	-62.0834	-41.9616	Bongo nets deployed to 200m
16/03/2025 05:12	177	-62.0837	-41.9613	Bongo in the water
16/03/2025 05:06	176	-62.0837	-41.9613	Bongo out the water
16/03/2025 04:53	176	-62.0837	-41.9613	Deployed to 200m. Start recovering
16/03/2025 04:39	176	-62.0841	-41.961	Bongo net in the water
16/03/2025 04:05	175	-62.0841	-41.961	Mammoth net out the water
16/03/2025 02:35	175	-62.0841	-41.961	Mammoth net at 1500m
16/03/2025 01:08	175	-62.0845	-41.9614	Mammoth net in the water
16/03/2025 00:04	174	-62.0846	-41.9614	Mammoth out the water
15/03/2025 22:35	174	-62.0845	-41.9614	Mammoth at depth 1500m
15/03/2025 21:30	174	-62.0843	-41.9622	Mammoth in the water
15/03/2025 20:20		-62.0845	-41.9621	On DP at BP2_4_2000
15/03/2025 18:57		-62.0115	-42.0122	Vessel off DP
15/03/2025 18:27	173	-62.0116	-42.0123	EBS out the water
15/03/2025 17:05	173	-62.0093	-42.0079	2000m line out
15/03/2025 16:35	173	-62.0077	-42.0046	EBS on the seabed
15/03/2025 15:48	173	-62.006	-41.9998	EBS in the water

15/03/2025 15:29	172	-62.006	-41.9998	EBS out the water
15/03/2025 15:25	172	-62.006	-41.9998	EBS in the water
15/03/2025 15:22	171	-62.006	-41.9998	EBS out the water
15/03/2025 15:17	171	-62.006	-41.9998	EBS in the water
15/03/2025 14:44	170	-62.006	-41.9998	AGT out of the water
15/03/2025 13:21	170	-62.006	-41.9998	Vessel stopped
15/03/2025 13:09	170	-62.0036	-41.9962	AGT at 2000m line out
15/03/2025 11:41	170	-61.9978	-41.9874	AGT in the water
15/03/2025 11:29		-61.9971	-41.9861	Vessel on DP at BP2_4_1500
15/03/2025 01:54		-63.4973	-41.7976	M3 mooring trilaterated to position 63 31.92'S 041 46.247'W
14/03/2025 23:21	169	-63.5334	-41.7771	Weight released
14/03/2025 21:00	169	-63.531	-41.7966	Commenced deployment of mooring
14/03/2025 14:43	168	-63.5287	-41.7363	Mooring recovered
14/03/2025 12:47	168	-63.532	-41.7535	Mooring alongside
14/03/2025 12:18	168	-63.5412	-41.7902	M3 mooring sighted
14/03/2025 11:24	168	-63.5412	-41.7895	M3 mooring released
14/03/2025 07:27	167	-63.5205	-41.7363	CTD out
14/03/2025 06:55	167	-63.5205	-41.7363	CTD on the way down to 105m
14/03/2025 06:47	167	-63.5205	-41.7363	CTD at 40m and recovering to 10m
14/03/2025 06:30		-63.5205	-41.7363	Issues with sensors due to cold
14/03/2025 06:09	167	-63.5205	-41.7363	CTD in the water
14/03/2025 04:39	166	-63.5205	-41.7363	Bongo out the water
14/03/2025 04:26	166	-63.5205	-41.7363	Bongo deployed to 200m
14/03/2025 04:14	166	-63.5205	-41.7363	Bongo net in the water
14/03/2025 04:09	165	-63.5205	-41.7363	Bongo out the water

14/03/2025 03:58	165	-63.5205	-41.7363	Bongo deployed to 200m
14/03/2025 03:45	165	-63.5205	-41.7363	Bongo in the water
14/03/2025 02:41	164	-63.5205	-41.7363	Bongo nets out of the water
14/03/2025 02:26	164	-63.5205	-41.7363	Bongo nets at 200m
14/03/2025 02:14	164	-63.5205	-41.7363	Bongo nets in the water
14/03/2025 01:51	163	-63.5205	-41.7336	CTD out of the water
14/03/2025 00:07	163	-63.5204	-41.7323	CTD at depth
13/03/2025 22:42	163	-63.5198	-41.7314	CTD in the water
13/03/2025 21:14	162	-63.5309	-41.7649	CTD out of the water
13/03/2025 21:06	162	-63.5334	-41.7676	CTD in the water
13/03/2025 13:04		-63.5326	-41.7655	Vessel on DP at M3 mooring site
12/03/2025 08:55		-63.5368	-41.8429	On DP
12/03/2025 00:49		-62.6285	-43.2602	Off DP
11/03/2025 21:06	161	-62.6285	-43.2603	CTD recovered to deck
11/03/2025 21:01	161	-62.6285	-43.2603	CTD out of the water
11/03/2025 20:26	161	-62.6285	-43.2603	CTD at depth 758m
11/03/2025 20:03	161	-62.6285	-43.2603	CTD in the water
11/03/2025 19:47	160	-62.6284	-43.2603	CTD out of the water
11/03/2025 19:40	160	-62.6285	-43.2603	CTD in water for filming
11/03/2025 18:02	159	-62.6285	-43.2602	CTD out the water
11/03/2025 16:40	159	-62.6285	-43.2602	CTD deployed to 3074m
11/03/2025 15:40	159	-62.6285	-43.2602	CTD in the water
11/03/2025 14:21	158	-62.6285	-43.2602	3rd trilateration position
11/03/2025 13:50	158	-62.6019	-43.2601	2nd trilateration position
11/03/2025 12:05	158	-62.6162	-43.2106	M2 mooring release attempted

11/03/2025 10:53		-62.6149	-43.2436	On DP at M2
11/03/2025 01:11	157	-61.9936	-47.0282	Bongo nets out of the water
11/03/2025 00:57	157	-61.9936	-47.0282	Bongo nets at 200m
11/03/2025 00:45	157	-61.9936	-47.0282	Bongo nets in the water
11/03/2025 00:41	156	-61.9936	-47.0282	Bongo nets out of the water
11/03/2025 00:27	156	-61.9936	-47.0282	Bongo nets at 200m
11/03/2025 00:15	156	-61.9936	-47.0282	Bongo nets in the water
10/03/2025 23:37	155	-61.9936	-47.0282	Mammoth net out of the water
10/03/2025 22:07	155	-61.9936	-47.0282	Mammoth at depth 1550m
10/03/2025 20:58	155	-61.9936	-47.0282	Mammoth in the water
10/03/2025 19:30		-61.9936	-47.0283	On DP
10/03/2025 18:17		-61.8222	-46.6844	Vessel off DP
10/03/2025 17:49	154	-61.8222	-46.6844	EBS out the water
10/03/2025 17:15	154	-61.8222	-46.6844	Vessel stopped
10/03/2025 17:04	154	-61.8243	-46.6806	EBS deployed
10/03/2025 16:21	154	-61.8267	-46.6764	EBS in the water
10/03/2025 15:44	153	-61.8267	-46.6764	AGT out the water
10/03/2025 14:57	153	-61.827	-46.6758	Vessel stopped
10/03/2025 14:47	153	-61.829	-46.6723	AGT at 900m line out
10/03/2025 14:05	153	-61.8315	-46.6678	AGT in the water at BP2_6_500
10/03/2025 11:56	152	-61.9946	-47.0165	CTD out of the water
10/03/2025 11:02	152	-61.9946	-47.0165	CTD line out 1987m
10/03/2025 10:19	152	-61.9946	-47.0164	CTD in the water
10/03/2025 09:57	151	-61.9945	-47.0163	Bongo net out of the water
10/03/2025 09:44	151	-61.9945	-47.0166	Bongo net at depth 200m - recovering

10/03/2025 09:33	151	-61.9945	-47.0166	Bongo net in the water
10/03/2025 09:28	150	-61.9945	-47.0166	Bongo nets out of the water
10/03/2025 09:15	150	-61.9945	-47.0167	Bongo at depth 200m
10/03/2025 09:04	150	-61.9945	-47.0166	Bongo nets in the water
10/03/2025 08:41	149	-61.9946	-47.0167	CTD out of the water
10/03/2025 08:01	149	-61.9946	-47.0168	CTD at depth 1020m
10/03/2025 07:36	149	-61.9946	-47.0167	CTD in the water
10/03/2025 07:16	148	-61.9946	-47.0168	Mammoth out of the water
10/03/2025 05:42	148	-61.9949	-47.026	Mammoth deployed to 1550m
10/03/2025 04:41	148	-61.9936	-47.0287	Mammoth in the water
10/03/2025 04:32	147	-61.9936	-47.0287	Mammoth out the water
10/03/2025 04:28	147	-61.9936	-47.0287	Recovering Mammoth net due to technical issue
10/03/2025 04:25	147	-61.9936	-47.0287	Mammoth net in the water
10/03/2025 04:02		-61.9943	-47.032	Vessel on DP at BP2_6 2000
10/03/2025 03:23		-61.9942	-47.0316	Vessel off DP
10/03/2025 03:09	146	-61.9257	-47.1635	Net out the water
10/03/2025 01:12	146	-61.9685	-47.0554	MOCNESS at 1573m line out
10/03/2025 00:01	146	-61.9993	-47.0034	MOCNESS in the water
09/03/2025 20:51		-61.9994	-46.9927	On DP
09/03/2025 20:03		-61.9814	-46.794	Off DP
09/03/2025 19:37	145	-61.9814	-46.794	EBS out of the water
09/03/2025 18:29	145	-61.982	-46.795	Vessel stopped
09/03/2025 18:17	145	-61.9819	-46.7895	EBS deployed to 2000m. Ships speed 1 knot
09/03/2025 17:03	145	-61.9818	-46.7802	EBS in the water
09/03/2025 16:22	144	-61.9821	-46.8006	AGT out the water

09/03/2025 15:07	144	-61.9821	-46.8006	Vessel stopped
09/03/2025 14:55	144	-61.982	-46.7942	Vessel at 1kt
09/03/2025 14:54	144	-61.982	-46.794	AGT at 2000m line out
09/03/2025 13:33	144	-61.9818	-46.7801	AGT in the water
09/03/2025 13:16		-61.9818	-46.7797	Vessel on DP at BP_6_1500
09/03/2025 05:33		-62.139	-50.623	Vessel proceeding to BP2-6 1500m
09/03/2025 04:33	143	-62.1301	-50.5702	RMT out the water
09/03/2025 03:10	143	-62.1217	-50.4735	RMT deployed to 750m
09/03/2025 01:59	143	-62.078	-50.4595	RMT-8 in the water
08/03/2025 23:17	142	-62.0676	-50.4711	CTD out of the water
08/03/2025 22:46	142	-62.0676	-50.4711	CTD at depth 1020m
08/03/2025 22:20	142	-62.0674	-50.4718	CTD in the water
08/03/2025 21:33	141	-62.0678	-50.4738	CTD recovered to deck
08/03/2025 21:22	141	-62.0678	-50.4738	CTD deployment aborted - instrument issues. Recovering to deck
08/03/2025 21:14	141	-62.0678	-50.474	CTD in the water
08/03/2025 20:02	140	-62.0678	-50.4739	Mammoth out of the water
08/03/2025 18:35	140	-62.0678	-50.4736	Mammoth net deployed to 1500m
08/03/2025 17:24	140	-62.068	-50.4752	Mammoth net in the water
08/03/2025 16:19		-62.0656	-50.4725	Vessel on DP
08/03/2025 15:43		-62.0671	-50.4743	Vessel of DP
08/03/2025 15:40	139	-62.0671	-50.4743	Mooring out the water
08/03/2025 13:15	139	-62.1521	-50.4513	Top float on deck
08/03/2025 13:00	139	-62.1516	-50.4511	Mooring alongside
08/03/2025 12:32	139	-62.133	-50.4863	Mooring sighted
08/03/2025 12:00	139	-62.1225	-50.4948	Mooring released

08/03/2025 11:03		-62.1506	-50.4808	On DP at BP_8 mooring
08/03/2025 10:22		-62.1284	-50.4815	Off DP
08/03/2025 10:01	138	-62.0661	-50.4802	Bongo net out of the water
08/03/2025 09:48	138	-62.0663	-50.4796	Bongo at depth 200m
08/03/2025 09:36	138	-62.0665	-50.479	Bongo net in the water
08/03/2025 09:33	137	-62.0665	-50.479	Bongo net out of the water
08/03/2025 09:20	137	-62.0665	-50.479	Bongo net at depth 200m
08/03/2025 09:08	137	-62.0665	-50.4789	Bongo net in the water
08/03/2025 09:04	136	-62.0669	-50.4777	Bongo net out of the water
08/03/2025 08:51	136	-62.0669	-50.4775	Bongo net at 200m
08/03/2025 08:41	136	-62.0669	-50.4774	Bongo net in the water
08/03/2025 07:58	135	-62.0669	-50.4772	Mammoth out of the water
08/03/2025 06:15	135	-62.0675	-50.4759	Mammoth deployed to 1550m
08/03/2025 05:05	135	-62.0684	-50.4754	Mammoth net in the water
08/03/2025 04:05	134	-62.0685	-50.4754	Mammoth net out the water
08/03/2025 02:29	134	-62.0689	-50.4754	Mammoth net at 1500m
08/03/2025 01:09	134	-62.0687	-50.4752	Mammoth in the water
08/03/2025 00:16	133	-62.0688	-50.4754	Bongo nets out of the water
08/03/2025 00:05	133	-62.0688	-50.4753	Bongo nets at 200m
07/03/2025 23:54	133	-62.0689	-50.4754	Bongo nets in the water
07/03/2025 23:47	132	-62.0689	-50.4753	Bongo nets out of the water
07/03/2025 23:36	132	-62.0689	-50.4753	Bongo nets at 200m
07/03/2025 23:25	132	-62.0689	-50.4753	Bongo nets in the water
07/03/2025 23:18	131	-62.0689	-50.4753	Bongo nets out of the water
07/03/2025 23:04	131	-62.0689	-50.4753	Bongo nets at 200m

07/03/2025 22:51	131	-62.0689	-50.4753	Bongo nets in the water
07/03/2025 21:27		-62.0689	-50.4754	On DP
07/03/2025 21:00		-62.0638	-50.534	Off DP
07/03/2025 20:37	130	-62.0638	-50.534	EBS out of the water
07/03/2025 18:35	130	-62.0639	-50.5333	Vessel stopped
07/03/2025 18:27	130	-62.0643	-50.5286	Speed 1knot ahead
07/03/2025 18:25	130	-62.0643	-50.528	EBS deployed to 4000m
07/03/2025 16:21	130	-62.0651	-50.5162	EBS in the water
07/03/2025 15:48	129	-62.0651	-50.5162	AGT out the water
07/03/2025 13:23	129	-62.0651	-50.5161	Vessel stopped
07/03/2025 13:02	129	-62.0661	-50.5041	Vessel speed 1kt
07/03/2025 12:53	129	-62.0664	-50.5027	AGT at 4400m line out
07/03/2025 09:50	129	-62.069	-50.4737	AGT in the water
07/03/2025 07:33	128	-62.0689	-50.4733	CTD out of the water
07/03/2025 07:03	128	-62.0689	-50.4735	CTD at depth 100m
07/03/2025 06:54	128	-62.0689	-50.4735	CTD in the water
07/03/2025 05:16	127	-62.0689	-50.4738	CTD out the water
07/03/2025 03:42	127	-62.0684	-50.4749	CTD deployed to 3402m
07/03/2025 02:36	127	-62.0683	-50.475	CTD in the water
07/03/2025 00:30		-62.1509	-50.4797	Vessel on DP at BP_8
06/03/2025 12:58	126	-60.544	-47.6809	AGT out of the water
06/03/2025 11:29	126	-60.544	-47.6809	Vessel stopped
06/03/2025 11:17	126	-60.543	-47.6751	AGT at 1200m line out
06/03/2025 09:43	126	-60.5407	-47.6605	AGT in the water
06/03/2025 09:00	125	-60.5405	-47.6596	Bongo net out of the water

06/03/2025 08:48	125	-60.5402	-47.6584	Bongo net at depth 200m
06/03/2025 08:35	125	-60.54	-47.6574	Bongo net in the water
06/03/2025 08:29	124	-60.54	-47.6572	Bongo out of the water
06/03/2025 08:16	124	-60.5399	-47.6563	Bongo at depth 200m
06/03/2025 08:05	124	-60.5398	-47.6558	Bongo in the water
06/03/2025 07:33	123	-60.5398	-47.6558	CTD out of the water
06/03/2025 06:32	123	-60.5399	-47.6556	CTD deployed to 1468m
06/03/2025 05:56	123	-60.5397	-47.6558	CTD in the water
06/03/2025 05:18	122	-60.5397	-47.6558	Mammoth out the water
06/03/2025 03:55	122	-60.5399	-47.6557	Mammoth net deployed to 1300m
06/03/2025 02:32	122	-60.5401	-47.6537	Mammoth net in the water
06/03/2025 01:42	121	-60.5401	-47.6552	Mammoth net out of the water
06/03/2025 00:10	121	-60.5401	-47.6542	Mammoth net at depth
05/03/2025 23:15		-60.5401	-47.6542	PS HPR pole lowered
05/03/2025 22:44	121	-60.54	-47.6539	Mammoth in the water @ BP2_7_1500
05/03/2025 22:10		-60.5399	-47.6539	On DP
05/03/2025 21:35		-60.4999	-47.6005	Off DP
05/03/2025 21:26	120	-60.4999	-47.6005	Mammoth out of the water
05/03/2025 21:05	120	-60.4999	-47.6005	Mammoth at 250m test depth
05/03/2025 20:46	120	-60.4999	-47.6005	Mammoth in the water
05/03/2025 18:38		-60.4997	-47.6022	Vessel on DP
05/03/2025 17:02		-60.2918	-47.7545	Off DP
05/03/2025 16:56		-60.2918	-47.7545	Weight out the water
05/03/2025 15:02		-60.2918	-47.7545	Commence recovery
05/03/2025 13:27		-60.2911	-47.7536	Clump weight in water for respooling of metal free winch

04/03/2025 20:45		-60.6064	-42.0172	Off DP
04/03/2025 20:36	119	-60.6145	-41.9609	Mooring fully recovered to deck
04/03/2025 19:27	119	-60.6145	-41.9609	Mooring OP5 alongside
04/03/2025 19:04	119	-60.6189	-41.9549	OP 5 sighted
04/03/2025 18:51		-60.6228	-41.9424	Off DP
04/03/2025 18:24	119	-60.6204	-41.9383	Mooring OP5 released
04/03/2025 18:18		-60.6203	-41.9381	Vessel in position to release OP5
04/03/2025 18:16		-60.6203	-41.938	Vessel on DP
04/03/2025 18:03		-60.613	-41.9681	Vessel off DP
04/03/2025 17:31	118	-60.6149	-41.975	CTD out the water
04/03/2025 16:15	118	-60.6149	-41.975	CTD deployed to 3340m
04/03/2025 15:11	118	-60.6149	-41.975	CTD in the water
04/03/2025 13:29		-60.6149	-41.975	Vessel on DP at OP5 mooring site
04/03/2025 11:38	117	-60.675	-42.4544	EBS out of the water
04/03/2025 11:03	117	-60.6751	-42.4548	Vessel stopped
04/03/2025 10:52	117	-60.6763	-42.4598	EBS at 750m cable paid out
04/03/2025 10:14	117	-60.6777	-42.4655	EBS in the water
04/03/2025 09:41	116	-60.6781	-42.4669	AGT out of the water
04/03/2025 08:38	116	-60.6795	-42.472	AGT at depth
04/03/2025 08:00	116	-60.6811	-42.4774	AGT in the water
04/03/2025 07:43		-60.6813	-42.4784	On DP at BP2_3_500
04/03/2025 06:37		-60.6564	-42.2279	Vessel off DP proceeding to BP2_3 500
04/03/2025 06:18	115	-60.6564	-42.2278	CTD out the water
04/03/2025 05:25	115	-60.6564	-42.2278	CTD deployed to 1697m
04/03/2025 04:48	115	-60.6564	-42.2278	CTD in the water at OP3 mooring site

04/03/2025 04:12		-60.6571	-42.2298	Vessel on DP at OP3
04/03/2025 03:53		-60.6417	-42.1698	Off DP
04/03/2025 03:43	114	-60.6417	-42.1698	CTD out the water
04/03/2025 02:21	114	-60.6417	-42.1698	CTD at 3067m
04/03/2025 01:20	114	-60.6417	-42.1698	CTD in the water at OP2 mooring site
04/03/2025 00:40		-60.6415	-42.1683	Vessel on DP at OP2 mooring site
03/03/2025 23:54	113	-60.6284	-42.0908	CTD out of the water
03/03/2025 22:21	113	-60.6284	-42.0909	CTD at depth 3589m
03/03/2025 21:13	113	-60.6285	-42.0916	CTD in the water at OP1 mooring site
03/03/2025 19:48		-60.6396	-42.1739	Off DP
03/03/2025 19:11	112	-60.6397	-42.174	OP2 mooring alongside
03/03/2025 18:54	112	-60.6432	-42.1777	OP2 mooring sighted
03/03/2025 17:55	112	-60.6326	-42.1752	Vessel at OP2 site on DP
03/03/2025 17:27	111	-60.6366	-42.0992	OP1 Mooring release unsuccessful
03/03/2025 14:44	111	-60.6347	-42.1031	Vessel on DP 0.5nm from OP1 mooring site
03/03/2025 14:00	110	-60.6576	-42.2261	OP3 mooring on board
03/03/2025 13:10	110	-60.6556	-42.225	Commence recovery of OP3 mooring
03/03/2025 13:00	110	-60.6556	-42.2252	OP3 mooring alongside
03/03/2025 12:22	110	-60.6613	-42.242	Mooring OP3 released
03/03/2025 12:05	110	-60.6613	-42.2419	Vessel on DP 0.5nm from mooring site
03/03/2025 11:14	109	-60.6738	-42.2734	EBS out of the water
03/03/2025 09:48	109	-60.6714	-42.2676	Vsl stopped to begin recovery of EBS
03/03/2025 09:37	109	-60.6699	-42.263	EBS at depth
03/03/2025 08:07	109	-60.6671	-42.2545	EBS in the water
03/03/2025 07:01	108	-60.6667	-42.2535	CTD out of the water

03/03/2025 05:56	108	-60.6667	-42.2535	CTD deployed. Line out 1485m
03/03/2025 05:21	108	-60.6667	-42.2535	CTD in the water
03/03/2025 04:47	107	-60.6667	-42.2535	Bongo nets out the water
03/03/2025 04:33	107	-60.6667	-42.2535	Bongo nets at 200m
03/03/2025 04:23	107	-60.6667	-42.2535	Bongo in the water
03/03/2025 04:16	106	-60.6667	-42.2535	Bongo out the water
03/03/2025 04:05	106	-60.6667	-42.2535	Bongo nets at 200m
03/03/2025 03:54	106	-60.6667	-42.2535	Bongo in the water
03/03/2025 02:50	105	-60.6667	-42.2535	Bongo nets out of the water
03/03/2025 02:38	105	-60.6667	-42.2535	Bongo nets at 200m
03/03/2025 02:26	105	-60.6668	-42.2534	Bongo nets in the water
03/03/2025 02:21	104	-60.6668	-42.2534	Bongo nets out of the water
03/03/2025 02:08	104	-60.6668	-42.2534	Bongo nets at 200m
03/03/2025 01:55	104	-60.6669	-42.2534	Bongo nets in the water
02/03/2025 21:17		-60.6681	-42.2602	Vessel relocating for Bongo deployment
02/03/2025 21:13	103	-60.668	-42.2602	Mammoth recovered to deck
02/03/2025 19:52	103	-60.6673	-42.2561	Mammoth at depth 1300m
02/03/2025 18:55	103	-60.667	-42.2531	Mammoth in water
02/03/2025 18:13		-60.6663	-42.2476	Vessel on DP
02/03/2025 17:51		-60.6714	-42.2838	Off DP
02/03/2025 17:34	102	-60.6712	-42.2828	AGT trawl out the water
02/03/2025 16:06	102	-60.6697	-42.2747	Vessel stopped. Commence recovery
02/03/2025 15:55	102	-60.669	-42.2692	Ships speed at 1knot
02/03/2025 15:53	102	-60.669	-42.2687	2000m deployed
02/03/2025 14:23	102	-60.6671	-42.2545	AGT in the water

02/03/2025 08:55		-60.6668	-42.2525	Vessel on station at BP2_3_1500
01/03/2025 05:36		-59.0497	-30.8285	Vessel off DP
01/03/2025 05:05	101	-59.0498	-30.8288	CTD out the water
01/03/2025 03:30	101	-59.0497	-30.8285	CTD deployed
01/03/2025 02:28	101	-59.0496	-30.8285	CTD in the water
01/03/2025 01:48	100	-59.0497	-30.8287	Bongo nets out of the water
01/03/2025 01:35	100	-59.0501	-30.8298	Bongo nets at 200m
01/03/2025 01:24	100	-59.0503	-30.8303	Bongo nets in the water
01/03/2025 01:17	99	-59.0503	-30.8303	Bongo nets out of the water
01/03/2025 01:04	99	-59.0503	-30.8303	Bongo nets at 200m
01/03/2025 00:52	99	-59.0503	-30.8303	Bongo nets in the water
01/03/2025 00:37		-59.0502	-30.8308	Vessel on DP at A23-40
28/02/2025 22:30		-59.4358	-30.8601	Off DP
28/02/2025 21:46	98	-59.4358	-30.86	CTD out of the water
28/02/2025 20:37	98	-59.4358	-30.86	CTD at depth 3414m
28/02/2025 19:32	98	-59.4358	-30.86	CTD in the water
28/02/2025 18:58	97	-59.4358	-30.8601	Mammoth out of the water
28/02/2025 18:40	97	-59.4358	-30.8601	Mammoth deployed to 250m
28/02/2025 18:21	97	-59.4358	-30.8601	Mammoth net in the water
28/02/2025 17:26		-59.4359	-30.8573	Vessel on DP at A23-39
28/02/2025 15:48		-59.7664	-30.9056	Vessel off DP
28/02/2025 15:22	96	-59.7664	-30.9056	CTD out of the water
28/02/2025 14:07	96	-59.7664	-30.9056	CTD at depth
28/02/2025 12:56	96	-59.7664	-30.9057	CTD in the water
28/02/2025 12:43		-59.7664	-30.9057	Vessel on DP at A23-37

28/02/2025 10:07		-60.3156	-30.9582	Off DP
28/02/2025 09:55	95	-60.3156	-30.9582	CTD out of the water
28/02/2025 08:40	95	-60.3158	-30.9585	CTD at depth 2710m
28/02/2025 07:42	95	-60.3158	-30.9585	CTD in the water
28/02/2025 07:26		-60.3158	-30.9585	On DP at A23-35
28/02/2025 03:30		-61.1092	-31.0412	Vessel off DP proceeding to A23-35
28/02/2025 03:14	94	-61.1092	-31.0412	CTD out the water
28/02/2025 01:33	94	-61.1092	-31.0412	CTD at depth
28/02/2025 00:38	94	-61.1091	-31.0412	CTD in the water
27/02/2025 23:29	93	-61.1091	-31.0412	Bongo nets out of the water
27/02/2025 23:15	93	-61.1092	-31.0412	Bongo nets at 200m
27/02/2025 23:04	93	-61.1092	-31.0412	Bongo nets in the water
27/02/2025 22:51	92	-61.1091	-31.0412	Bongo nets out of the water
27/02/2025 22:51	92	-61.1091	-31.0412	Bongo nets out of the water
27/02/2025 22:28	92	-61.1091	-31.0412	Bongo net in the water
27/02/2025 22:15		-61.1092	-31.0412	On DP at A23-33
27/02/2025 20:05		-61.5514	-31.1042	Off DP
27/02/2025 19:40	91	-61.5514	-31.1043	CTD out of the water
27/02/2025 18:08	91	-61.5514	-31.1043	CTD deployed to 4032m
27/02/2025 16:55	91	-61.5514	-31.1043	CTD in the water
27/02/2025 08:30		-61.5514	-31.1043	On DP at A23-31
27/02/2025 08:30		-61.5514	-31.1043	On DP at A23-31
27/02/2025 05:49		-62.0755	-31.1836	Vessel off DP
27/02/2025 05:21	90	-62.0755	-31.1836	CTD out of the water
27/02/2025 01:40	90	-62.0755	-31.1836	CTD at depth

27/02/2025 00:10	90	-62.0755	-31.1836	CTD in the water
26/02/2025 23:49	89	-62.0755	-31.1836	CTD out of the water
26/02/2025 23:47	89	-62.0755	-31.1836	CTD in the water for test
26/02/2025 22:15		-62.0755	-31.1836	On DP at A23-29
26/02/2025 22:15		-62.0755	-31.1836	On DP at A23-29
26/02/2025 18:45		-62.7532	-30.715	Vessel off DP
26/02/2025 18:29	88	-62.784	-30.6957	CTD out of the water
26/02/2025 16:47	88	-62.784	-30.6957	CTD deployed. 4872m line out
26/02/2025 15:18	88	-62.7841	-30.6961	CTD in the water
26/02/2025 15:12		-62.7842	-30.6965	Vessel on DP at A23-27
26/02/2025 11:21	87	-63.3466	-29.5688	CTD out of the water
26/02/2025 09:32	87	-63.3466	-29.5688	CTD at depth 4778m
26/02/2025 09:32	87	-63.3466	-29.5688	CTD at depth 4778m
26/02/2025 08:06	87	-63.3465	-29.5688	CTD in the water
26/02/2025 08:00		-63.3466	-29.5687	On DP at A23-25
25/02/2025 13:08	86	-60.1002	-25.2994	Mooring recovered
25/02/2025 11:34	86	-60.1004	-25.2972	SST-W Buoy alongside
25/02/2025 11:20	86	-60.1061	-25.2911	SST-W Buoy sighted
25/02/2025 08:00	85	-60.1285	-25.3763	CTD out of the water
25/02/2025 08:00	85	-60.1285	-25.3763	CTD out of the water
25/02/2025 06:07	85	-60.1285	-25.3763	CTD deployed
25/02/2025 06:07	85	-60.1285	-25.3763	CTD deployed
25/02/2025 04:49	85	-60.1285	-25.3762	CTD in the water
25/02/2025 04:32		-60.1295	-25.3761	Vessel on DP
25/02/2025 03:32		-60.2137	-25.1219	Off DP

25/02/2025 03:17	84	-60.2137	-25.1219	CTD out the water
25/02/2025 00:51	84	-60.2137	-25.1219	CTD deployed. Line out 6059m
24/02/2025 22:45	84	-60.2137	-25.1218	CTD in the water
24/02/2025 22:45	84	-60.2137	-25.1218	CTD in the water
24/02/2025 22:40	84	-60.2137	-25.1219	CTD deployment commenced over mooring SST-C position
24/02/2025 21:55	83	-60.2183	-25.1206	Mooring recovered
24/02/2025 19:34	83	-60.2195	-25.1156	Commence recovering mooring
24/02/2025 19:11	83	-60.2176	-25.1213	Mooring buoy alongside
24/02/2025 18:50	83	-60.2221	-25.1371	SST C Mooring buoy sighted
24/02/2025 04:22		-60.2348	-25.2208	Vessel at SST4
24/02/2025 03:15		-60.2575	-25.0741	Vessel at SST5
24/02/2025 02:27		-60.1839	-25.0858	Vessel at SST WPT6
24/02/2025 01:16		-60.1107	-25.2293	Vessel at SST WPT7
24/02/2025 00:09		-60.1498	-25.3769	Vessel at SST WPT2
23/02/2025 23:07		-60.0811	-25.3774	Vessel at SST WPT1
23/02/2025 03:51		-57.4585	-31.3357	Vessel off DP. Proceeding to SST W mooring
23/02/2025 03:25	82	-57.4585	-31.3353	Bongo net out the water
23/02/2025 03:12	82	-57.4584	-31.3336	Bongo net deployed to 200m
23/02/2025 03:02	82	-57.4583	-31.3326	Bongo nets in the water
23/02/2025 02:56	81	-57.4583	-31.3326	Bongo nets out of the water
23/02/2025 02:45	81	-57.4583	-31.3315	Bongo nets at 200m
23/02/2025 02:35	81	-57.4582	-31.3305	Bongo nets in the water
23/02/2025 02:29	80	-57.4582	-31.3303	Bongo nets out of the water
23/02/2025 02:18	80	-57.4582	-31.3294	Bongo nets at 200m
23/02/2025 02:07	80	-57.4581	-31.3287	Bongo nets in the water

23/02/2025 01:44	79	-57.4583	-31.3288	CTD out of the water
22/02/2025 23:56	79	-57.4583	-31.3288	CTD at 3785m
22/02/2025 22:47	79	-57.4583	-31.3288	CTD in the water
22/02/2025 22:47	79	-57.4583	-31.3288	CTD in the water
22/02/2025 22:47	79	-57.4583	-31.3288	CTD in the water
22/02/2025 22:40		-57.4583	-31.3288	On DP at A23-44
22/02/2025 20:25		-57.1186	-31.8145	Off DP
22/02/2025 20:20	78	-57.1186	-31.8145	CTD out of the water
22/02/2025 19:01	78	-57.1186	-31.8145	CTD deployed. Line out 3485m
22/02/2025 17:57	78	-57.1186	-31.8144	CTD in the water
22/02/2025 17:50		-57.1172	-31.8141	Vessel on DP at A23-45
22/02/2025 13:43		-56.3805	-32.8717	Vessel off DP
22/02/2025 13:34	77	-56.3805	-32.8717	CTD out of the water
22/02/2025 12:17	77	-56.3805	-32.8717	CTD deployed. Line out 3162m
22/02/2025 11:17	77	-56.3805	-32.8717	CTD in the water
22/02/2025 11:17	77	-56.3805	-32.8717	CTD in the water
22/02/2025 10:55		-56.3802	-32.8699	Vessel on DP at A23-47
22/02/2025 07:09		-55.7107	-33.778	Off DP
22/02/2025 06:54	76	-55.7107	-33.7769	Bongo out the water
22/02/2025 06:41	76	-55.7131	-33.7783	Bongo deployed to 200m
22/02/2025 06:29	76	-55.7153	-33.7795	Bongo in the water
22/02/2025 06:22	75	-55.716	-33.7799	Bongo out the water
22/02/2025 06:11	75	-55.7179	-33.7809	Bongo deployed to 200m
22/02/2025 05:58	75	-55.7192	-33.7817	Bongo net in water
22/02/2025 05:13	74	-55.7192	-33.7817	CTD out the water

22/02/2025 03:34	74	-55.723	-33.7841	CTD deployed. Line out 3496m
22/02/2025 02:28	74	-55.725	-33.7854	CTD in the water
22/02/2025 02:14		-55.7242	-33.7848	Vessel on DP at A23-49
22/02/2025 00:17	73	-55.4848	-34.1343	CTD out of the water
21/02/2025 22:55	73	-55.4849	-34.1343	CTD line out 2468m
21/02/2025 22:10	73	-55.4849	-34.1343	CTD in the water
21/02/2025 22:10	73	-55.4849	-34.1343	CTD in the water
21/02/2025 22:00		-55.4849	-34.1343	On DP for CTD deployment A23-50
21/02/2025 20:05		-55.2598	-34.4431	Off DP
21/02/2025 19:29	72	-55.2598	-34.4431	CTD out of the water
21/02/2025 18:40	72	-55.2597	-34.4431	CTD deployed to 1517m
21/02/2025 18:09	72	-55.2598	-34.4431	CTD in the water
21/02/2025 17:40		-55.2593	-34.4405	Vessel on DP at A23-51
21/02/2025 17:11		-55.2138	-34.5072	Vessel off DP
21/02/2025 17:06	71	-55.2138	-34.5072	CTD out the water
21/02/2025 16:34	71	-55.2138	-34.5072	CTD deployed
21/02/2025 16:19	71	-55.2138	-34.5072	CTD in the water
21/02/2025 16:13		-55.2137	-34.5071	Vessel on DP at station A23-52
21/02/2025 09:00		-54.3401	-35.2498	Off DP heading to A23
21/02/2025 09:00		-54.3401	-35.2498	Off DP heading to A23
21/02/2025 08:54	70	-54.3401	-35.2498	Bongo net out of the water
21/02/2025 08:38	70	-54.3401	-35.2498	Bongo net at depth 200m - recovering
21/02/2025 08:27	70	-54.3401	-35.2498	Bongo net in the water
21/02/2025 08:21	69	-54.3401	-35.2498	Bongo net out of the water
21/02/2025 08:11	69	-54.3401	-35.2498	Bongo net at depth 200m - recovering

21/02/2025 07:59	69	-54.3401	-35.2498	Bongo net in the water
21/02/2025 07:54	68	-54.3401	-35.2498	Bongo net out of the water
21/02/2025 07:41	68	-54.3401	-35.2498	Bongo net at depth 200m - recovering
21/02/2025 07:30	68	-54.3401	-35.2498	Bongo net in the water
21/02/2025 07:00	67	-54.3401	-35.2498	CTD out of water
21/02/2025 06:21	67	-54.3401	-35.2498	CTD deployed to 357m
21/02/2025 06:07	67	-54.3401	-35.2498	CTD in the water
21/02/2025 06:00		-54.3401	-35.2498	Vessel on DP
20/02/2025 22:35		-53.8406	-36.0766	Off DP heading to A23
20/02/2025 22:35		-53.8406	-36.0766	Off DP heading to A23
20/02/2025 21:51	66	-53.8404	-36.0749	EBS recovered - not safe to deploy due to sea conditions
20/02/2025 21:49	66	-53.8404	-36.0746	EBS in the water
20/02/2025 20:41		-53.8404	-36.0728	Vessel stationary on DP
20/02/2025 20:36	65	-53.8404	-36.0722	AGT out of the water
20/02/2025 19:42	65	-53.8404	-36.0674	AGT being recovered
20/02/2025 19:32	65	-53.8404	-36.063	AGT at depth - 1066m cable out
20/02/2025 18:38	65	-53.8404	-36.0557	AGT in the water
20/02/2025 18:19		-53.8404	-36.0549	Vessel on DP
20/02/2025 15:39	64	-54.1035	-36.2401	ECB mooring directly below the vessel on EA640
20/02/2025 14:59	64	-54.1035	-36.2417	EBC mooring deployed
20/02/2025 13:54	64	-54.1038	-36.2326	Commence ECB mooring deployment
20/02/2025 10:40	63	-54.1033	-36.2469	CTD out of the water
20/02/2025 10:40	63	-54.1033	-36.2469	CTD out of the water
20/02/2025 10:18	63	-54.1033	-36.2468	CTD at depth
20/02/2025 10:01	63	-54.1033	-36.2469	CTD in the water

20/02/2025 09:30		-54.1024	-36.252	Stopped on DP at ECB Mooring
20/02/2025 02:10		-53.6737	-37.7408	Vessel off DP
20/02/2025 01:51	62	-53.6737	-37.7407	Bongo nets out of the water
20/02/2025 01:45	62	-53.6737	-37.7408	Bongo nets at 100m
20/02/2025 01:40	62	-53.6737	-37.7408	Bongo nets in the water
20/02/2025 01:34	61	-53.6737	-37.7407	Bongo nets out of the water
20/02/2025 01:29	61	-53.6737	-37.7407	Bongo nets at 100m
20/02/2025 01:23	61	-53.6737	-37.7407	Bongo nets in the water
20/02/2025 01:10		-53.6737	-37.7408	Vessel on DP
20/02/2025 00:04	60	-53.6782	-37.6689	RMT8 out of the water
19/02/2025 23:43	60	-53.6791	-37.6478	RMT8 at depth 38m
19/02/2025 23:34	60	-53.6799	-37.6394	RMT8 in the water
19/02/2025 22:37		-53.6749	-37.7145	ME70 down
19/02/2025 22:37		-53.6749	-37.7145	ME70 down
19/02/2025 20:08	59	-53.3325	-37.8406	RMT8 out of the water
19/02/2025 18:36	59	-53.3277	-37.7514	RMT in the water
19/02/2025 17:46		-53.325	-37.7709	Vessel off DP
19/02/2025 17:38	58	-53.3252	-37.7709	CTD out the water
19/02/2025 17:07	58	-53.3252	-37.7709	CTD deployed to 1010m
19/02/2025 16:45	58	-53.3252	-37.7709	CTD in the water
19/02/2025 16:30		-53.3252	-37.7709	Vessel on DP
19/02/2025 14:59	57	-53.3703	-38.1431	RMT8 out of the water
19/02/2025 14:06	57	-53.3621	-38.0849	RMT8 at depth 348m cable out
19/02/2025 13:21	57	-53.3545	-38.0355	RMT8 in the water
19/02/2025 12:08	56	-53.3614	-38.0818	CTD out of the water

19/02/2025 11:37	56	-53.3614	-38.0818	CTD at 1010m
19/02/2025 11:37	56	-53.3614	-38.0818	CTD at 1010m
19/02/2025 11:37	56	-53.3614	-38.0818	CTD at 1010m
19/02/2025 11:08	56	-53.3614	-38.0818	CTD in the water
19/02/2025 10:45		-53.3614	-38.0818	Vsl on DP at 3.2Nst
19/02/2025 08:01		-53.6693	-37.6631	Off DP
19/02/2025 07:42	55	-53.6781	-37.6501	CTD out of the water
19/02/2025 07:20	55	-53.6781	-37.6501	CTD at depth 117m
19/02/2025 07:10	55	-53.6781	-37.6501	CTD in the water
19/02/2025 06:56		-53.6781	-37.6501	Vessel on DP
19/02/2025 06:30	54	-53.6751	-37.6829	RMT out the water
19/02/2025 05:50	54	-53.6881	-37.6466	RMT deployed
19/02/2025 05:19	54	-53.7035	-37.6281	RMT in the water
19/02/2025 04:07	53	-53.6472	-37.6237	RMT out the water
19/02/2025 04:07	53	-53.6472	-37.6237	RMT out the water
19/02/2025 03:37	53	-53.6655	-37.6132	Deployed to 49m
19/02/2025 03:23	53	-53.6732	-37.609	RMT 8 in the water
18/02/2025 23:24	52	-53.7956	-37.9429	WCB mooring located
18/02/2025 23:24	52	-53.7956	-37.9429	WCB mooring located
18/02/2025 23:01	52	-53.7954	-37.9433	WCB mooring deployed
18/02/2025 21:39	52	-53.8057	-37.9311	Commence deployment of WCB mooring
18/02/2025 20:09	51	-53.7991	-37.9382	CTD out of the water
18/02/2025 19:33	51	-53.7991	-37.9382	CTD at depth 286m
18/02/2025 19:22	51	-53.7991	-37.9382	CTD in the water
18/02/2025 19:10		-53.7991	-37.9382	Vessel on DP at WCB Mooring

18/02/2025 17:36		-53.3628	-37.7601	End of acoustic transect. Vessel passing through WCB 4.2S
18/02/2025 13:14		-53.1435	-37.8348	Commence WCB 4.2 transect
18/02/2025 12:41		-53.1659	-37.9633	Complete WCB 4.1 transect
18/02/2025 08:25		-53.8409	-37.7375	Passing through WCB 4.1S
18/02/2025 08:25		-53.8409	-37.7375	Passing through WCB 4.1S
18/02/2025 06:12	50	-53.7125	-37.9134	Bongo out of the water
18/02/2025 06:06	50	-53.7125	-37.9135	Bongo deployed to 75m and recovering
18/02/2025 06:03	50	-53.7125	-37.9135	Bongo net in water
18/02/2025 05:57	49	-53.7125	-37.9135	Bongo out the water
18/02/2025 05:53	49	-53.7125	-37.9134	Bongo deployed to 75m and recovering
18/02/2025 05:46	49	-53.7125	-37.9134	Bongo net in water
18/02/2025 05:28		-53.7125	-37.9134	Vessel on DP
18/02/2025 05:17	48	-53.7059	-37.9019	RMT8 out the water
18/02/2025 04:54	48	-53.6979	-37.8843	RMT8 deployed
18/02/2025 04:27	48	-53.6865	-37.864	RMT8 in the water
18/02/2025 03:56		-53.676	-37.8531	Commence turn
18/02/2025 01:37	47	-53.713	-37.9601	RMT8 out of the water
18/02/2025 01:04	47	-53.6941	-37.9499	RMT8 92m cable out
18/02/2025 00:49	47	-53.686	-37.9428	RMT8 in the water
17/02/2025 23:34	46	-53.7142	-37.9655	CTD out of the water
17/02/2025 23:17	46	-53.7142	-37.9654	CTD at 124m
17/02/2025 23:09	46	-53.7142	-37.9655	CTD in the water
17/02/2025 22:48	45	-53.7142	-37.9655	CTD back on board due to DP error
17/02/2025 22:32	45	-53.7142	-37.9654	CTD in the water
17/02/2025 22:22		-53.7143	-37.9655	Vessel on DP at WCB 3.2 Sst

17/02/2025 19:55		-53.3506	-38.061	Off DP
17/02/2025 19:39		-53.3471	-38.0599	Vessel on DP 1nm downwind of WCB 3.2Nst
17/02/2025 18:27		-53.1873	-38.1394	Finish WCB 3.2 transect
17/02/2025 13:58		-53.8887	-37.8751	Commence WCB 3.2 transect
17/02/2025 13:58		-53.8887	-37.8751	Commence WCB 3.2 transect
17/02/2025 12:32		-53.9261	-38.2201	Complete WCB 3.1 transect
17/02/2025 08:10		-53.2129	-38.4505	Passing through WCB 3.1N
17/02/2025 08:10		-53.2129	-38.4505	Passing through WCB 3.1N
17/02/2025 06:34	44	-53.4141	-38.7261	CTD out the water
17/02/2025 05:51	44	-53.414	-38.7261	CTD deployed. 1010m line out
17/02/2025 05:29	44	-53.414	-38.7261	CTD in the water
17/02/2025 05:14		-53.4141	-38.7261	Vessel on DP
17/02/2025 05:14		-53.4141	-38.7261	Vessel on DP
17/02/2025 05:05	43	-53.4167	-38.721	RMT 8 out the water
17/02/2025 04:21	43	-53.4351	-38.6887	RMT deployed
17/02/2025 03:41	43	-53.4536	-38.6633	RMT 8 in the water
17/02/2025 01:02	42	-53.7938	-38.5734	RMT8 net out of the water
17/02/2025 00:34	42	-53.804	-38.5567	RMT8 net at 75m
17/02/2025 00:24	42	-53.8117	-38.5453	RMT8 in the water
16/02/2025 23:09	41	-53.7851	-38.5835	CTD out the water
16/02/2025 22:46	41	-53.7851	-38.5835	CTD at depth 195m
16/02/2025 22:46	41	-53.7851	-38.5835	CTD at depth 195m
16/02/2025 22:34	41	-53.7851	-38.5835	CTD in the water
16/02/2025 22:18		-53.7851	-38.5836	On DP for CTD deployment at 2.2Sst
16/02/2025 21:40	40	-53.7645	-38.6249	RMT8 out of the water

16/02/2025 20:53	40	-53.7862	-38.5849	RMT 8 at depth. Line out 342m. Commenced recovery.
16/02/2025 20:17	40	-53.804	-38.5557	RMT8 in the water
16/02/2025 19:59		-53.8107	-38.5443	Vessel at 2 kts and in position for RMT8 deployment
16/02/2025 18:50		-53.9598	-38.5277	Transect finished. Vessel passing through WCB 2.2S
16/02/2025 14:26		-53.2503	-38.752	Commence WCB 2.2 transect
16/02/2025 13:15		-53.288	-39.0378	Complete WCB 2.1 transect
16/02/2025 08:55		-53.9926	-38.8189	Passing WCB 2.1S to commence transect
16/02/2025 08:55		-53.9926	-38.8189	Passing WCB 2.1S to commence transect
16/02/2025 07:07		-53.8279	-39.1646	Vessel off DP moving to WCB 2.1S
16/02/2025 07:07		-53.8279	-39.1646	Vessel off DP moving to WCB 2.1S
16/02/2025 06:44	39	-53.8278	-39.1648	CTD out the water
16/02/2025 06:16	39	-53.8277	-39.1649	CTD deployed. Line out 306m
16/02/2025 06:04	39	-53.8277	-39.1648	CTD in the water
16/02/2025 05:52		-53.8278	-39.165	Vessel on DP
16/02/2025 05:38	38	-53.8367	-39.1558	RMT out the water
16/02/2025 04:52	38	-53.859	-39.134	RMT deployed
16/02/2025 04:11	38	-53.8845	-39.1199	RMT 8 in the water
15/02/2025 23:54	37	-53.4927	-39.2506	CTD out of the water
15/02/2025 23:17	37	-53.4927	-39.2506	CTD at 1010m
15/02/2025 22:54	37	-53.4927	-39.2506	CTD in the water
15/02/2025 22:49		-53.4927	-39.2506	In position over 1.2 Nst for CTD
15/02/2025 21:57	36	-53.4588	-39.2779	RMT8 out of the water
15/02/2025 21:17	36	-53.4833	-39.252	RMT8 at depth
15/02/2025 20:35	36	-53.5101	-39.244	RMT8 in the water
15/02/2025 20:09		-53.5274	-39.2386	Preparing for RMT8 deployment

15/02/2025 19:02		-53.3138	-39.3035	Vessel passing through WCB1.2N End of acoustic transect
15/02/2025 14:39		-54.0266	-39.0878	Commence transect WCB 1.2
15/02/2025 13:23		-54.0536	-39.3922	Transect WCB 1.1 complete
15/02/2025 11:21	35	-53.7353	-39.4858	Rapidcast on board
15/02/2025 10:30	35	-53.7187	-39.4914	Problem with RapidCast recovery
15/02/2025 10:13	35	-53.6876	-39.501	RapidCast at depth
15/02/2025 10:07	35	-53.6742	-39.5046	RapidCast in the water
15/02/2025 09:14	34	-53.5262	-39.5488	RapidCast out of the water - error message received
15/02/2025 09:07	34	-53.5104	-39.553	RapidCast in the water
15/02/2025 08:29	33	-53.4085	-39.5836	RapidCast out of the water
15/02/2025 08:08	33	-53.3626	-39.5973	RapidCast at depth 418m
15/02/2025 08:02	33	-53.3506	-39.6005	RapidCast in the water
15/02/2025 08:00		-53.3469	-39.6014	Pass through WCB 1.1N
15/02/2025 04:00		-52.8997	-40.1037	Vessel off DP
15/02/2025 03:32	32	-52.8886	-40.117	Bongo net out of the water
15/02/2025 03:21	32	-52.8886	-40.117	Bongo nets deployed to 200m
15/02/2025 03:11	32	-52.8886	-40.117	Bongo nets in the water
15/02/2025 03:05	31	-52.8886	-40.117	Bongo nets out of the water
15/02/2025 02:52	31	-52.8886	-40.117	Bongo nets at 200m
15/02/2025 02:40	31	-52.8886	-40.117	Bongo nets in the water
15/02/2025 02:35	30	-52.8886	-40.117	Bongo nets out of the water
15/02/2025 02:19	30	-52.8886	-40.117	Bongo nets at 200m
15/02/2025 02:04	30	-52.8886	-40.117	Bongo nets in the water
15/02/2025 01:28	29	-52.8858	-40.1136	MOCNESS out of the water
15/02/2025 00:24	29	-52.8572	-40.0788	MOCNESS at depth 1000m

14/02/2025 23:11	29	-52.8246	-40.0392	MOCNESS in the water
14/02/2025 21:04	28	-52.8203	-40.034	P3 mooring deployment aborted
14/02/2025 20:50	28	-52.8203	-40.034	Top float back on board. Reviewing approach.
14/02/2025 20:34	28	-52.8187	-40.0319	Commence deployment of P3 mooring
14/02/2025 20:20		-52.8168	-40.0302	On station for mooring deployment
14/02/2025 17:50	27	-52.8549	-40.0866	CTD out the water
14/02/2025 16:22	27	-52.855	-40.0866	CTD deployed to 3m above seabed. 3791m line out
14/02/2025 16:22	27	-52.855	-40.0866	CTD deployed to 3m above seabed. 3791m line out
14/02/2025 16:22	27	-52.855	-40.0866	CTD deployed to 3m above seabed. 3791m line out
14/02/2025 15:12	27	-52.855	-40.0866	CTD in the water
14/02/2025 14:07		-52.8538	-40.0849	Vessel on DP at P3 mooring
13/02/2025 22:51	26	-54.0763	-36.2626	MOCNESS out of the water
13/02/2025 22:27	26	-54.0888	-36.2549	MOCNESS at depth
13/02/2025 22:06	26	-54.0992	-36.2485	MOCNESS in the water
13/02/2025 20:19	25	-54.1035	-36.2459	CTD back on board
13/02/2025 20:14	25	-54.1035	-36.2459	CTD out of the water
13/02/2025 19:40	25	-54.1035	-36.2459	CTD at depth 265m
13/02/2025 19:27	25	-54.1035	-36.2459	CTD in the water
13/02/2025 17:15	24	-54.1034	-36.2463	CTD out the water
13/02/2025 17:13	24	-54.1033	-36.2463	Issue with an instrument on CTD. Deployed to 10m. Commence recovery
13/02/2025 17:01	24	-54.1034	-36.2462	CTD in the water
13/02/2025 16:29	23	-54.1013	-36.2474	Mooring clear of the water
13/02/2025 16:00	23	-54.1015	-36.2473	Main buoy out the water
13/02/2025 15:39	23	-54.1061	-36.2454	Mooring sighted
13/02/2025 15:36	23	-54.1061	-36.2454	Released

13/02/2025 14:46		-54.1034	-36.2462	ECB mooring located on EA640
13/02/2025 13:30		-54.1038	-36.2466	Vessel on DP at ECB mooring
13/02/2025 01:41	22	-54.1784	-36.6639	WBAT out of the water
13/02/2025 01:10	22	-54.1784	-36.6639	WBAT in the water
13/02/2025 00:30	21	-54.1784	-36.6639	WBAT out of the water
12/02/2025 23:04	21	-54.1784	-36.6639	WBAT in the water
12/02/2025 20:18	20	-54.1825	-36.6855	CTD out of the water
12/02/2025 19:55	20	-54.1827	-36.6854	CTD in the water
12/02/2025 19:32	19	-54.1827	-36.6854	CTD out of the water
12/02/2025 19:12	19	-54.1826	-36.6855	CTD in the water
11/02/2025 16:17	18	-54.1795	-36.6855	CTD out the water
11/02/2025 16:13	18	-54.1797	-36.6858	RapidCAST in the water. Deployed from light towing boom
11/02/2025 03:12	17	-53.5782	-37.0654	EBS on deck
11/02/2025 03:09	17	-53.5782	-37.0654	Out the water
11/02/2025 02:35	17	-53.5782	-37.0654	Vessel speed 0kts
11/02/2025 02:33	17	-53.578	-37.065	10 minute run complete
11/02/2025 02:22	17	-53.5768	-37.0604	Vessel speed 1kt
11/02/2025 02:21	17	-53.5767	-37.0603	800m paid out
11/02/2025 01:42	17	-53.5754	-37.0555	EBS in the water
11/02/2025 00:50	16	-53.5751	-37.0544	AGT out of the water
11/02/2025 00:13	16	-53.5751	-37.0544	Vessel speed 0kts
11/02/2025 00:10	16	-53.5749	-37.0537	10 minute run complete
11/02/2025 00:02	16	-53.574	-37.0504	Vessel speed 1kt
11/02/2025 00:00	16	-53.5739	-37.0499	850m paid out
10/02/2025 23:31	16	-53.5729	-37.0463	AGT in the water

10/02/2025 23:26		-53.5728	-37.046	Vessel on DP at BEN1
10/02/2025 19:22		-53.7973	-37.9439	Vessel off DP
10/02/2025 19:21	15	-53.7975	-37.943	RapidCast out of the water
10/02/2025 19:15	15	-53.7982	-37.9375	RapidCast in the water
10/02/2025 19:12		-53.7986	-37.9347	Vessel off DP
10/02/2025 18:54	14	-53.7987	-37.9335	Mooring clear of the water
10/02/2025 18:10	14	-53.7987	-37.9334	Main buoy on deck
10/02/2025 18:00	14	-53.7987	-37.9335	Main buoy out the water
10/02/2025 17:40	14	-53.7987	-37.9334	Mooring grappled
10/02/2025 17:35	14	-53.7987	-37.9335	Mooring sighted
10/02/2025 17:30	14	-53.7988	-37.9334	WCB Mooring Released
10/02/2025 14:02		-53.7907	-37.9341	Vessel on DP mode at WCB mooring
10/02/2025 04:59		-52.8177	-40.0937	Vessel off DP
10/02/2025 04:55	13	-52.8177	-40.0937	CTD out of the water
10/02/2025 04:43	13	-52.8157	-40.0976	Rapid cast CTD at depth
10/02/2025 04:35	13	-52.8129	-40.1033	Rapid cast CTD in the water
10/02/2025 04:34	12	-52.8125	-40.104	CTD out the water
10/02/2025 04:25	12	-52.8093	-40.1103	overload alarm
10/02/2025 04:18	12	-52.8068	-40.1152	Rapid cast CTD in the water
10/02/2025 04:00	11	-52.8053	-40.1182	Bongo net out the water
10/02/2025 03:54	11	-52.8053	-40.1182	Bongo nets deployed to 50m
10/02/2025 03:51	11	-52.8053	-40.1182	Bongo nets in the water
10/02/2025 03:01		-52.8053	-40.1182	CTD winch test weight back on deck
10/02/2025 02:20		-52.8053	-40.1182	Commence CTD winch test
10/02/2025 00:40	10	-52.8054	-40.1181	P3 Mooring clear of the water

10/02/2025 00:08	10	-52.8054	-40.1181	Sediment trap and Seaguard on deck
09/02/2025 23:57	10	-52.8054	-40.1181	Trimson buoy cluster on deck
09/02/2025 23:57	10	-52.8054	-40.1181	Trimson buoy cluster on deck
09/02/2025 23:30	10	-52.8054	-40.1181	OPIC on board
09/02/2025 22:35	10	-52.8054	-40.1181	P3 buoy hooked up on stern gantry
09/02/2025 22:12	10	-52.8056	-40.1169	Mooring P3 alongside
09/02/2025 20:53		-52.855	-40.0877	Vessel off DP moving towards mooring position
09/02/2025 18:23		-52.8546	-40.0829	In position on DP for P3
08/02/2025 22:15		-52.8701	-47.8586	Vessel off DP and underway
08/02/2025 22:07	9	-52.8702	-47.8586	CTD out of the water
08/02/2025 21:42	9	-52.8702	-47.8586	CTD stopped at 26m due to alarm
08/02/2025 21:30	9	-52.8702	-47.8586	CTD in the water
08/02/2025 20:20		-52.8702	-47.8586	Vessel on DP
08/02/2025 19:57	8	-52.8613	-47.8532	RMT8 out of the water
08/02/2025 19:39	8	-52.8473	-47.8475	RMT8 deployed to 200m
08/02/2025 19:25	8	-52.8368	-47.8424	RMT8 in the water
08/02/2025 18:35		-52.8058	-47.8248	Vessel off DP
08/02/2025 18:33	7	-52.7996	-47.8194	RMT out the water
08/02/2025 18:13	7	-52.7885	-47.8057	RMT deployed to 62m
08/02/2025 17:59	7	-52.778	-47.7926	RMT in the water
08/02/2025 15:30		-52.7738	-47.7873	Vessel on DP
08/02/2025 01:07	6	-52.7374	-53.2368	Rapidcast out of the water
08/02/2025 01:01	6	-52.7381	-53.2508	Rapidcast in the water
08/02/2025 00:56	5	-52.7389	-53.2624	Rapidcast recovered
08/02/2025 00:53	5	-52.7394	-53.2694	Rapidcast in the water

08/02/2025 00:12	4	-52.7455	-53.3154	CTD out of the water
07/02/2025 23:19	4	-52.7455	-53.3154	CTD at 100m
07/02/2025 23:10	4	-52.7455	-53.3154	CTD at 16m
07/02/2025 23:08	4	-52.7455	-53.3154	CTD in the water
07/02/2025 22:34	3	-52.7455	-53.3151	AGT deployment end
07/02/2025 22:29	3	-52.7454	-53.3145	AGT out of the water
07/02/2025 22:20	3	-52.7451	-53.3134	AGT at depth 50m
07/02/2025 22:14	3	-52.745	-53.3126	AGT in the water
07/02/2025 22:04	2	-52.7447	-53.3114	AGT deployment end
07/02/2025 22:00	2	-52.7446	-53.3108	AGT out of the water
07/02/2025 21:52	2	-52.7443	-53.3099	AGT at depth 50m
07/02/2025 21:44	2	-52.7441	-53.3089	AGT in the water
07/02/2025 21:35	1	-52.7439	-53.3079	AGT deployment end
07/02/2025 21:32	1	-52.7438	-53.3075	AGT out of the water
07/02/2025 21:26	1	-52.7437	-53.3068	AGT at depth 50m
07/02/2025 21:19	1	-52.7435	-53.3059	AGT test launch
07/02/2025 17:46		-52.7433	-53.3051	Issues remain. Not deployed
07/02/2025 17:42		-52.7433	-53.3052	Green light for deployment
07/02/2025 16:37		-52.7433	-53.3051	Issue with CTD boom controller
07/02/2025 16:33		-52.7433	-53.3051	Commence deployment of CTD
07/02/2025 15:29		-52.7433	-53.3051	Vessel on DP

SD046 Annex CS Cetacean Survey

Effort, sightings and species codes used in the Event Logger

Annex Section 1 Cetacean survey protocol.

SDA CETACEAN SIGHTING PROTOCOL

1 INTRODUCTION

The Scotia Arc (spanning the Scotia Sea in the South Atlantic) was at the epicentre of modern whaling in the Southern Hemisphere during the early 20th century. During the summer this is an area of importance for multiple baleen and toothed whale species who use it as a seasonal feeding habitat, with at least seven species sighted and caught there (humpback, fin, blue, minke, sei, southern right and sperm whales). Since whaling ended, few sightings surveys have been conducted to estimate the density and distribution patterns of these recovering populations and most only cover parts of this area (e.g. Branch 2011; Williams *et al.,* 2014; Viquerat & Herr 2017).

In 2019, UK and Norwegian vessels worked in collaboration to conduct a cetacean survey across the Scotia Arc, including parts of South Georgia and South Sandwich Islands, generating the first estimates of abundance of humpback and fin whales from the Scotia Arc since whaling ended (Baines et al., 2021; Biuw et al., 2024) as well as an analysis of the spatial covariation between humpback whales and krill (Baines et al. 2022) and estimates of the total regional consumption of krill by both species.

Six years on, the SDA will be crossing extensive areas of the Scotia Arc, providing a second opportunity for a dedicated team to collect cetacean sightings and monitor the distribution and relative abundance of cetaceans in the Scotia Arc. In parallel, this survey will also endeavour to collect quantitative measures of fur seal density using a protocol derived from recent winter surveys of krill predators at South Georgia.

CONSIDERATIONS BEFORE STARTING SURVEYS

- Synchronise all watches, cameras, laptops, other relevant electronic devices with UTC time
- Set up the means to rapidly obtain GPS information to report effort and sightings - via ships feed, record time and can use event logger to extract other ships/met data required
- Decide whether to view from the Bridge, the Observation deck or outside on the Bridge wings. The Bridge has less objects interfering with the sea view, so the Bridge is preferred as the observer platform where possible.
- Measure "eye-height" - height of deck plus height of binoculars from floor and record it with sighting notes. The height of the Bridge is 21.6m from sea level. The height of the Observation Deck is 25.05m from sea level. Observer heights on the Bridge and Observation Deck are therefore ~23.1m and 26.55m respectively (assuming eye height is 1.5m from the floor)
- Set up GPS/NMEA feeds on each laptop to populate environmental report fields and collect ship trackline information for post-cruise review of data (eg through Wincruz or Pamguard)
- Use effort recording every 30 minutes

2 DATA COLLECTION

Sightings will be collected by a team of three on the SDA Bridge, with two observers (OBS) standing port and starboard on the bridge and one/two people in support as environmental data recorders (DR), and to assist with sightings recording. Each observer will have a laptop for recording sightings. All sightings and environmental data will be recorded using the SDA's Event Logger system (https://eventlog.sda.bas.ac.uk). The observers will enter sightings details with assistance from the DR when required (i.e. with sightings identification, characterising large/complex groups of cetaceans). PAMGUARD and Wincruz are also available on laptops to provide backup

Laptops will be set to time zone UTC for the duration of the survey, and all survey data will be collected using UTC even if "ship time" is different. To ensure consistency, all observers should also have access to a watch set to UTC in case there are computer crashes or they are making paper notes about timings. Some data, for example the location of the ship, will be recorded automatically into the database.

Effort and weather data will be entered by the DR in real-time. All observers will take turns being the DR and observers are responsible for recording data as carefully and as accurately as possible. Effort and weather data will be recorded every 30 minutes, or when the conditions change significantly. If the Event Logger cannot be used, for example if a laptop computer crashes, all data will be recorded on paper forms.

Effort data is the priority and particular care should be taken to make sure that the end of effort is recorded as an event (this is easy to forget and causes a lot of problems). The wind data should be recorded from the vessel so the main environmental data to record are visibility and sea state.

There may be occasions when not all the information can be recorded into the Event Logger at the time, for example in areas of high animal density. In this instance, the observers should record sightings onto paper forms. Missing data must then be entered into the database, preferably at the end of each day so that the sightings are still fresh in the minds of the observers.

Parameters to be included in BAS event logger on SDA for environmental monitoring:
Date; Time (UTC); Effort status; Observer initials; DR initials; GGA: Lat; GGA: Long; Weather state; Ships heading; Ship speed; Wind Speed*; Wind Direction (true)*; Beaufort State; swell height; Visibility; Sightability, Sun glare; ice levels

See “Lookup” table in folder for dropdown menu of codes for environmental and sighting variables, also Section 6.5.

*Identify if true or apparent in column header

DR will record weather data at start and end of effort, every 30 minutes or if there is a significant change in the weather conditions.

3 SURVEY PROCEDURE

Sighting surveys will take place whilst the vessel is making way (speed approx. 9 knots), there is sufficient daylight, wind speed is up to 27 knots and sea state is up to Beaufort 6. Occasionally there are sightable conditions in higher winds; the team leader can decide to continue observations in these conditions if appropriate. When krill trawls are in progress, make a particular note if cetacean surveys are conducted over this time, as vessel speeds will be slower than normal.

Whilst on effort, where possible, there will be a minimum of two observers on watch at all times and one or two data recorders supporting sightings identification and data recording. Watches will run throughout the day, to maximise the time available within the constraints of the working hours specified by the UK’s Natural Environment Research Council. Watch periods will run during daylight hours and within that will be flexible according to survey constraints and weather. The survey team will rotate position every 30 minutes with each observer spending one hour watching and the following hour either as DR or off watch, to minimise exposure if outdoors. In conditions where cold exposure is heightened, the watch period can be reduced..

3.1. OBSERVERS (ON EFFORT)

Observers will search with naked eyes, scanning their search area in a consistent manner without focussing on particular regions. With this in mind, the search pattern is as follows

- Port observer: searches the area from 90^{o} port to about 10^{o} starboard,
- Starboard observer: searches the area from 90^{o} starboard to about 10^{o} port.

This ensures that the trackline should be covered by both observers. All species of cetacean should be recorded.

The main responsibility of the observer team is to obtain accurate information on the time, angle, radial distance, species identification and school size of as many cetacean sightings as possible. It is important to get estimates of angle and distance to the initial sighting position, to minimise bias arising from responsive movement of the animals to the ship.

Each observer will have 7x50 binoculars with reticles, a laptop and watch set to UTC and paper sightings forms & pencils to be used if the Event Logger fails. Angle boards will be mounted to the platform (0° indicating directly ahead of the vessel). Radial distances to sightings should be estimated using reticles to measure distance based on the angle of dip from the horizon. A reticle reference cheat sheet will be provided for each observer based on the height of the Bridge. Angles from the trackline to the sighting should be read from pointers on the mounted angle boards.

On detecting a cue, the observer should immediately record the sighting information straight into the Event Logger, or provide it verbally to the DR if the DR is operating the laptop. When one observer makes a detection, the other observer should keep searching in their usual way unless assistance with taxonomic ID is requested. Re-sightings of the same animals should not be recorded. For more detail of observer activities see Section 3.3.

3.2. DATA RECORDER

The data recorder is responsible for recording effort and weather data accurately into the Event Logger (or paper forms if necessary). It is important that any changes in the type of search effort being applied or environmental conditions which may affect the detection of animals, is recorded, and this person is responsible for doing that. Since each observer has their own laptop nearby, the DR will also assist with entering sightings as they occur.

Sightings data should be recorded as a priority. When an observer reports a sighting, they or the DR will open a form containing the fields to be completed. These should be filled out as completely as possible. If a second sighting occurs before the DR has finished entering data from a previous sighting, then the team should save as much data has been entered for the first sighting and then start entering data for the new sighting – essentially the recorder should always enter data from the latest sighting at least to the extent of making sure the time for each sighting is accurate.

In order to minimise disturbance to personnel on the Bridge, two laptops are provided so that in an ideal situation the Port and Starboard observers each have a laptop and dedicated DR to support their sightings reports. For this reason, the SDA Event Logger will run two sightings databases simultaneously, a Port one and a Starboard one. These will be used to preface two sets of sighting numbers (X) as "PX"and "SX". A key task for the DR is to identify any duplicate sightings made by both observers and classify this as such in the sighting record under "Duplicates".

Effort status should be recorded at the start of going on effort (and, equally, when effort status changes or stops, this should also be recorded). To avoid a slow drift in environmental conditions going unnoticed, the environmental conditions (sea state, wind speed, cloud cover, precipitation) should be recorded every 30 minutes, as well as when conditions change. This should happen throughout the survey period regardless of weather and sighting conditions (except during the period where krill trawling is taking place).

Effort Activity status: ON (start sighting effort), VT visual transect (observers on effort), WX weather change, OFF (end sighting effort).

3.3. WHEN A SIGHTING IS MADE

OBSERVERS (WITH DR SUPPORT)

On sighting a cue, the observers should:

1. Notify the DR immediately even if unsure whether it is a marine mammal or not. It should be stressed there is no shame in an aborted sighting; do not hesitate to inform the DR (the initial timestamp of the first time 'something' is observed is vital for subsequent analyses). The observer or DR will open a new sighting which assigns a time and position to the sighting.
2. Estimate the reticle reading to the sighting. Try to give reticles to the nearest tenth of a reticle.
3. Using the pointer on the angle board, estimate the angle from the bow of the ship to the sighting, to the nearest degree.
4. Enter the key sighting information (listed below), or using the suggested commentary (see below), relay the information to the DR.
5. Continue watching for additional cues, to identify the species and number of animals in the school.
6. Once the information has been recorded, return to scanning for new sightings.
7. If the other primary observer also sees the same sighting, then he/she may provide help with species identification and school size determination. However, the other observer must, as quickly as possible, return to scanning for other animals.
8. If it turns out to be a false alarm, inform the DR who can then cancel that sighting.

COMMENTARY FOR OBSERVERS

The following commentaries are suggested for the observers when relaying sighting information to the DR.
I've a sighting on the PORT/STARBOARD (DR opens sighting form).
The bearing is [X] degrees
The distance is [X] metres/reticules
The estimated group size is [XX]
The species is [XX]
Behaviour / cue / aspect
For all sightings the absolute minimum information to be recorded is sighting number, time, angle, radial distance, species and school size and observer. Cue type is also a handy piece of information to record. See Section 6.5 for details of reporting codes to use for cue type and behaviour.

DATA RECORDER

1. Enter weather/effort data whenever going on effort (i.e. at the start of each day, after an off-effort break). See Section 6.5 for reporting codes to use for weather.
2. Every 30 minutes enter weather/effort data onto the computer (ideally, set an alarm as a reminder). This should not compromise sightings data, which take priority.
3. Enter onto the computer significant changes in effort status (observer rotation, survey mode, waypoints) and weather when they occur.
4. When either the observers have a sighting – the time of sighting and position of the ship will automatically be recorded. Complete as much of the sighting form as possible. Make sure at the end of a sighting event that at the minimum, initial time, angle and distance, observer, species, best school size estimate has been recorded. This may not always be possible, but the database should have recorded the time and position of the sighting – other information must then be completed later.
5. Keep a close eye on both Port and Starboard sightings logs to identify any potential duplicate sightings.
6. Ensure efficient and accurate data recording.
7. Vessel position is recorded automatically using the GPS unit.

PHOTOGRAPHER
If a photographer is present to help verify a sighting, the following steps will help to make the images useful:
1. Synchronise camera time to ships time
2. Record image number and associated sighting number recorded by the observer[s].

3.4. DAILY ACTIONS AFTER SURVEY

1. Back up Event Log to external hard drive.
2. Run script to check consistency of sighting, weather and effort terms within observation dataset and correct any typos
3. Download and back up all photographic images of sightings. Incorporate relevant sighting numbers into name of associated photographic image
4. On WCB leg, Dr Sally Thorpe can assist with data checks at the end of the day (identifying typos and checking for standard formatting). Once the team is at full complement after the South Georgia legs, this job can be carried out by a team member.

3.5. THINGS TO LOOK OUT FOR

1. SCHOOL SIZE DEFINITION

In the case of clustered animals, the distance and angle measurement should be estimated to the geometric centre of the cluster. Difficulties can arise when populations are not distributed in tight, easily defined clusters, but in loose aggregations whose boundaries, and size, must be determined subjectively. It is better to identify smaller, homogeneous groups within the aggregation, each associated with a precise distance, angle and size estimate. It should however, be noted in a comment on the form, that the groups appear to belong to the same aggregation.

A group can be defined as containing individuals not more than 2-3 animal body lengths from each other (depends on species), and also exhibiting the same swimming pattern and/or general behaviour (although it is often difficult to judge whether animals are a 'group' if they are milling or feeding; proximity is often the best way to decide whether animals form a group). The group may be clearly travelling with individuals showing a unidirectional swimming pattern, although not necessarily a synchronised surfacing pattern (so be careful in group size estimation; watch a group for some time to try to estimate group size, but recognise it can be frustrating to try to estimate group size). A group may be more stationary, the animals resting at the surface or milling in an asynchronous pattern. Since the distances between individuals within the same group will depend on the species, a group can also be thought of as the smallest unit that can be tracked.

In case of a looser aggregation distributed non-homogeneously over a larger area, it is better to identify smaller homogeneous groups. The boundaries of groups can be taken as the discontinuities in animal distribution. Isolated individuals should be recorded as group size 1.

Problems arise when a group is formed of animals swimming in a long line at relatively equal distance from each other (e.g. pilot whales and some dolphin species). Again group boundaries can be taken as any small discontinuities in distribution and/or as a distance greater than 2-3 body lengths relative to other animals.

Each observer should make three estimates of abundance for each school, "best", "high" and "low". The high and low estimates define the range within whose limits the observer is confident the school's abundance falls. In rare cases, only a low estimate is possible. Since an extended sighting of the group isn't always possible due to weather, restrictions on vessel movement or vessel movement, resulting in loss of contact with a sighting and uncertainty regarding school size. In these cases observers make their estimates based on the information they have, using a wider range between high and low estimates of abundance than for a school that was better observed.
Determining whether a surfacing animal has already been detected and assigned a sighting number or is a new sighting can be difficult.

SPECIES ID

When recording a sighting, the species is recorded, along with an estimate of confidence in the species identification. In order to maximise the utility of the data collected, it is important that as much detail as possible is given about the species. So, for example, if the sighting is of a large baleen whale, and the observer suspects the animal to be a fin whale, but can't be certain, record this as Species: "Like Fin whale" rather than Species: "unidentified large rorqual", Confidence: "High / Definite" (in the "Species Code" column). The "Unidentified" categories should only be used when absolutely no species ID is possible. The DR and other observer can assist with species ID if a second opinion is required. Some group codes are available for hard to distinguish species (e.g. *Lagenorhynchus* sp. or *Mesoplodon* sp.). An important aspect of the data is relating whales to krill distribution thus even if species cannot be identified if it is possible to identify the sighting as a baleen whale then 'unid large baleen' is a useful category.

The marine mammal sighting form completed for each sighting should ideally contain a brief narrative of the features used in determining the identification, along with behavioural notes. It is initiated by the observer who first made the sighting. These can be made as hand written notes during the sighting and edited to the relevant sightings form later, depending on the conditions.

IWC SOWER Species Codes will be used to record sightings with reference copies available at Port and Starboard for the DR (Section 6.3). Record Antarctic fur seals as species code **100**.

2. CUES

If a second sighting is made due to the presence of the first sighting, then the cue for the second sighting should be recorded as such. For example: a large baleen whale blow is seen. Observer calls the DR to initiate a sighting, then looks at the whale through their binoculars to ascertain species ID. Whilst looking through their binoculars, the observer sees a group of dolphins behind the whale which they had not previously seen. Observer should then initiate a second sighting for the dolphins. This sighting would have the cue recorded as the previous sightings.

3.6 POOR WEATHER PERIODS

During periods when weather conditions do not permit survey (see Section 3), recording of environmental conditions by the DR should continue every 15 minutes, with the DR on an hourly watch and responsible for informing the team when weather conditions have improved sufficiently to allow the survey to continue.

4 EQUIPMENT LIST

7 X 50 BINOCULARS WITH RETICLES (X 2) Fujinon Mariner 7x50 WPC-XLPorro Prism binoculars supplied on vessel
ANGLE BOARDS (X 2)
MONOPOD AND ADAPTERS FOR SUPPORTING BINOCULARS x 2
SMALL G-CLAMPS TO ATTACH ANGLE BOARDS x 2
WATCHES OR STOPWATCHES SET TO UTC (X 2)
WEARTHER-PROOF CLIPBOARD
PRINTED SIGHTINGS/ ENVIRONMENT/EFFORT FORMS IN CASE OF COMPUTER FAILURE
OBSERVER COMMENTARY/SPECIES CODES/RETICLE DISTANCES LAMINATED PROMPT SHEETS
APPROPRIATE THERMAL CLOTHING INCLUDING JACKETS, HATS AND GLOVES

LAPTOPS CONTAINING PAMGUARD WITH LOGGER FORMS MODULE, SQLITE AND WINCRUZ x 2
EXTERNAL HARD DRIVES FOR BACKING UP DATA (X 2)
UHF RADIOS (X 2) TO COMMUNICATE BETWEEN TEAM MEMBERS IF REQUIRED
CHARGER FOR RADIOS (X 1)
DRY WIPE MARKER AND SMALL BOARD

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Annex Section 2. Fur seal survey protocol.

Protocol for counting fur seals at sea around South Georgia

20/01/2025

Estimating densities of fur seals at sea presents a number of challenges for standard Distance sampling techniques:

1. They can occur in very large groups which are difficult to count
2. Their time at the surface and detectability are affected by their behaviour, of which there are a number of different types (feeding, resting, travelling)
3. Detectability is much more affected by wind and sea state than blows from large whales
4. They can travel very fast or stay in one place if resting or feeding
5. They often react to approaching vessels and sometimes may only be seen once they have reacted.

Relating fur seal distribution to krill is further complicated because the majority of their feeding activity is at night. Fur seal distribution can be very variable. On some Winter Krill surveys in the Eastern Core Box there were thousands of seals recorded, and on others almost none.

On the Winter Krill surveys from Pharos almost all the sightings of fur seals were within a radial distance of 1000m. We suggest limiting observations to within 1000m of the vessel. Practice with the reticle binoculars to refine your estimate of how far away 1000m is. This is a realistic distance to count groups, allows for detection of that seals would not have reacted to the approaching vessel, and can avoid observers being overwhelmed with sightings in high density areas.

We suggest four behavioural categories:

1. **Resting at the surface**
   Seals are seen lying motionless at the surface in the 'jug handle' position where the flippers are held out of the water.

Figure 1. Example of resting group with seals showing 'jug handles'.

Figure 2. Example of resting group with some seals showing both sets of flippers (this can sometimes make it seem like there are more individuals than is the case).

2. **Feeding/surface active group**

Seals are remaining broadly in the same area making repeated dives with quite a lot of splashing. Seals returning to the surface appear head out rather than on their side as for resting. There may be a small amount of porpoising but just to reposition a few tens of metres rather than consistent travel.

Figure 3. Seals in a surface active group. Lots of splashing and heads sometimes well out of the water.

Figure 4. Seals in a surface active group. Lots of splashing and sometimes short bursts of porpoising.

3. **Travelling**
   Seals are porpoising (like penguins) at speed in a consistent direction but do not appear to have reacted to the ship.

Figure 5. Porpoising seals all heading in the same direction, indicative of travelling (often heading to or from the colonies on shore).

4. **Reacting to survey vessel**
   Seals may be porpoising close to the bow but tending to head away from the ship or swimming alongside the ship.

Figure 6. Seals that have responded to the vessel. Often lots of splashing and just rear end views as seals head away.

On first sighting

If the group is more than 1000m away you are unlikely to be able to get accurate information. So best to wait until they are within 1000m to record the sighting. at perpendicular distances > 1000m can be ignored.

1. Record distance and angle to the 'centre' of the group. Large groups can be quite dispersed and sometimes made up of aggregations of smaller groups but you just have to make a judgement on where the centre is or whether you will record them as separate groups. Obtaining separate perpendicular distance estimates and estimates of group size for different subgroups will provide a more accurate estimate of detection probability and a better estimate of mean group size, but if you are not able to keep up with data entry and searching for new groups and cetaceans then some aggregation of subgroups may be necessary.
2. Record the behaviour you observed at the time you estimated the distance and angle (hopefully before there was any reaction to the vessel – typically seals within 300m will probably have reacted but this can be variable depending on the vessel and seal behaviour). If the seals are first seen close to the ship and you think they have already reacted then it is important to count them, but the distance and angle would not be used and behaviour is recorded as reacting. If the seals react to the vessel after you have recorded the behaviour you first observed, this does not need to be recorded.
3. Estimate the group size:
    a) Low – the maximum number of animals that you have seen at any one time
    b) Best – your best estimate of the number of animals within the group taking into account that they may not all be visible at the same time
    c) High – your estimate of the maximum number that could possibly be within the group

    For large groups (which can be several hundred animals) it can work to scan across the group estimating in batches of 10, or if there are distinct subgroups then try to record these separately.

Fur seals and whales often occur in the same area so don't get so distracted by fur seals that you stop looking for whales.

Annex Section 3. Effort form.

EFFORT & ENVIRONMENTAL REPORTING - CETACEAN PROJECT SDA046

Date (UTC)	Time (UTC)	Transect #	Tran Type	Effort	Obs Port	Obs Stbd	DR1	DR2	Weather	Comments
LAT		LON			Beaufort	Swell	W Spd T	W Dir T	Visibility	Sightability	Glare	Ice	Ice type

Date (UTC)	Time (UTC)	Transect #	Tran Type	Effort	Obs Port	Obs Stbd	DR1	DR2	Weather	Comments
LAT		LON			Beaufort	Swell	W Spd T	W Dir T	Visibility	Sightability	Glare	Ice	Ice type

Date (UTC)	Time (UTC)	Transect #	Tran Type	Effort	Obs Port	Obs Stbd	DR1	DR2	Weather	Comments
LAT		LON			Beaufort	Swell	W Spd T	W Dir T	Visibility	Sightability	Glare	Ice	Ice type

Date (UTC)	Time (UTC)	Transect #	Tran Type	Effort	Obs Port	Obs Stbd	DR1	DR2	Weather	Comments
LAT		LON			Beaufort	Swell	W Spd T	W Dir T	Visibility	Sightability	Glare	Ice	Ice type

Annex Section 4. Sighting form.

SIGHTINGS - CETACEAN PROJECT SDA046

Sighting #	Angle	Reticles	Cue	Method	Est dist	Date (UTC)	Time (UTC)	LAT	LON
Sp Code/Name	N Min	N Max	N Best	N Groups	Calves	Swim Dir	CetBehaviour	FSBehaviour	
Transect #	Effort	Observer	Duplicate?	DupID	Photo?	Camera	Photo #	Comments	

Sighting #	Angle	Reticles	Cue	Method	Est dist	Date (UTC)	Time (UTC)	LAT	LON
Sp Code/Name	N Min	N Max	N Best	N Groups	Calves	Swim Dir	CetBehaviour	FSBehaviour	
Transect #	Effort	Observer	Duplicate?	DupID	Photo?	Camera	Photo #	Comments	

Sighting #	Angle	Reticles	Cue	Method	Est dist	Date (UTC)	Time (UTC)	LAT	LON
Sp Code/Name	N Min	N Max	N Best	N Groups	Calves	Swim Dir	CetBehaviour	FSBehaviour	
Transect #	Effort	Observer	Duplicate?	DupID	Photo?	Camera	Photo #	Comments	

Annex Section 5. Codes for the effort form.

Effort	Code	Text
Transect #	T00	
Transect Type	VT	Visual transect
Transect Type	KT	Krill transect
Transect	OFF	Off transect
Effort	BEG	Beginning of effort
Effort	END	End of effort
Effort	CC	Change of Conditions
Effort	RP	Rotation of Personel
Obs/DR	**Code**	**Text**
	MB	Manuela Bassoi
	HM	Hayley McLennan
	HC	Hannah Cubaynes
	EJ	Elena Josso
	HV	Hugh Venables
	MM	Madeline de Marchis
Environmental	**Code**	**Text**
Weather	FA	Fair
Weather	H	Haze
Weather	M	Mist
Weather	DR	Drizzle
Weather	R	Rain
Weather	FO	Fog
Weather	SN	Snow
Beaufort	0	glassy mirror-like
Beaufort	1	scale ripples
Beaufort	2	small wavelets
Beaufort	3	occassional w'caps
Beaufort	4	numerous w'caps
Beaufort	5	many w'caps/wave
Beaufort	6	foam crests/spray
Beaufort	7	Heaped streaked sea
Beaufort	8	High waves/spindrift

Environmental	Code	Text
Swell (m)	0	No swell
Swell (m)	1	Low swell:short<2m
Swell (m)	2	Low swell: long<2m
Swell (m)	3	Mod: short 2-4m
Swell (m)	4	Mod; average 2-4m
Swell (m)	5	Mod; long 2-4m
Swell (m)	6	Heavy; short>4m
Swell (m)	7	Heavy; average>4m
Swell (m)	8	Heavy; long>4m
Swell (m)	10	Confused
Visibility (nm)	0	Fog (<1000m)
Visibility (nm)	1	Poor (1000 - 2nm)
Visibility (nm)	2	Moderate (2-5 nm)
Visibility (nm)	3	Good (>5 nm)
Sightability	0	Very poor
Sightability	1	Poor
Sightability	2	Moderate
Sightability	3	Good
Sightability	4	Excellent
Glare	0	None
Glare	1	Moderate
Glare	2	Severe
Ice	0	None
Ice	1	Few small bergy bits
Ice	2	Multiple bergy bits
Ice	3	Patches of 50% cover
Ice	4	1/10 cover
Ice	5	2/10 cover
Ice	6	3/10 cover
Ice	7	4/10 cover
Ice	8	5/10 cover
Ice	9	6/10 cover
Ice	10	7/10 cover
Ice	11	8/10 cover
Ice	12	9/10 cover
Ice	13	10/10 cover
IceType	Y1	1st year
IceType	Y2	2nd year
IceType	BE	Bergs
obsXdr	PORT	If DR1 data recorder ONLY for port
obsXdr	STBD	If DR2 data recorder ONLY for stbd
obsXdr	NA	If ONLY one DR for both sides

Annex Section 6. Codes for the sighting form.

Species	Code	Text
Species	07	Humpback whale
Species	71	Like humpback wha
Species	08	Right whale
Species	95	Like right whale
Species	99	Blue whale
Species	94	Like blue whale
Species	01	Antarctic Blue whale
Species	98	Like Antarctic blue
Species	56	Pygmy blue whale
Species	96	Like pygmy blue
Species	02	Fin whale
Species	66	Like fin whale
Species	03	Sei whale
Species	60	Like sei whale
Species	91	Minke whale
Species	92	Like minke
Species	04	Antarctic minke
Species	39	Like Antarctic minke
Species	74	Dwarf minke
Species	90	Like Dwarf minke
Species	10	Killer whale
Species	70	Killer whale type A
Species	72	Killer whale type B
Species	79	Killer whale type C
Species	05	Sperm whale
Species	62	Like sperm whale
Species	13	Cruciger dolphin
Species	68	Like cruciger dolphin
Species	41	Long finned pilot w
Species	77	Like pilot whale
Species	55	Spectacled porpoise
Species	14	S Right whale dolph

Species	Code	Text
Species	16	Unid whale/dolphin
Species	64	Unid large baleen
Species	63	Unid small whale
Species	67	Unid large whale
Species	09	Unid whale
Species	15	Unid dolphin
Species	76	Unid small cetacean
Species	59	Peale's dolphin
Species	22	Dusky dolphin
Species	58	Commerson's dolphin
Species	33	Pygmy killer whale
Species	11	Ziphiidae
Species	24	S Bottlenose whale
Species	61	Like S bottlenose whale
Species	25	Arnoux's beaked
Species	35	Cuvier's beaked whale
Species	36	Gray's beaked whale
Species	37	Layard's beaked whale
Species	48	Blainville's beaked w
Species	49	True's beaked w
Species	81	Baird's beaked whale
Species	87	Steineger's beaked
Species	38	Mesoplodon sp.
Species	44	Dwarf sperm whale
Species	45	Pygmy sperm whale
Species	50	Pygmy right whale
Species	52	Dwarf/pygmy sperm

Species	SK	Surface krill

Species	100	Antarctic fur seal

SD046 Annex AME-E: E&T Scientific Ship Systems Cruise Report

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Report Compiled on: 31 JAN 2025
For Cruise: SD046

Contents

Cruise Summary

Cruise	Departure	Arrival	AME Engineer(s)
SD046	05/08/25 (Punta Arenas)	DD/MM/YY (Location)	Christopher Gray (chray@bas.ac.uk) Liam Tracy (liatra@bas.ac.uk)

The ecosystems at both poles are structured in very similar ways, with the same functional groups occupying analogous niches, each shaped by extreme seasonality, low temperatures and sea-ice – this symmetry is key to understanding the global consequences of changing polar systems. Polar ecosystems are under stress from a multitude of factors including ocean warming, sea- and glacial-ice melt, changes in nutrient supply from the deep-ocean, rivers and glaciers, and increased fishing pressure. Polar oceans control marine productivity, fisheries resources and climate at global scales, driven by processes at the poles that sequester carbon and supply nutrients to other oceans. Our limited understanding of these processes prevents us from predicting their response to environmental change and its wider, global consequences. BIOPOLE will recognise and exploit Polar ecosystem symmetries to inform models and improve prediction of global consequences of physical changes at both poles, particularly for climate and food security. The new major polar research platform (RRS Sir David Attenborough), supported in S.Ocean by a capable fleet of autonomous instrumentation, will provide a new and unique opportunity to make major progress in this research field.

Instrumentation

Systems used on cruise

Instrument	#SN if Used	Make and Model	Comments
Acoustic			
Bio Multi-beam(ME70)	Yes		
Bio Multi-beam(MS70)	Yes		
Bio Multi-freq (EK80)	Yes		
Omnidirectional SU94	No		
Omnidirectional SC94	No		
Scanmar net system	No		
Echo sounder (EA640)	Yes		
Bottom profile (Topas)	No		
Swath (EM124)	Yes		
Swath (EM712)	Yes		
ADCP 75kHz	#SN/No		
ADCP 120kHz	#SN/No		
USBL	329980-001	WMT 6 Omni 2012 and 2013. Directional 2714	
Underway Mini SVS	#SN/No		
K-Sync	Yes		
Meteorological			
Air Temperature and Humidity 1 foremast	U0221024	Vaisala HMP-155	
Air Temperature and Humidity 2 science mast 1 inboard	S0850275	Vaisala HMP-155	
Air Temperature and Humidity 3 science mast 1 outboard	S0850273	Vaisala HMP-155	
3D Winds foremast	0115018894	Metek uSonic-3 Cl.AH	
3D Winds science mast 2 port	0111016979	Metek uSonic-3 Cl.AH	
3D Winds science mast 2 stbd	0111016986	Metek uSonic-3 Cl.AH	
Dew Point PT100	174768	Mitchell Inst. Opti-Dew 2	
Dew Point Chilled Mirror	174220	Mitchell Inst. Opti-Dew 2	
Ceilometer	PARSERICSA-2212	Vaisala CL31	
PAR Sensor foremast	SATPRS2212	Seabird PAR-SER ICSA	
PAR Sensor science mast	SATPRS2040	Seabird PAR-SER ICSA	
Precipitation	0490	TheisClima Drisdrometer	
Freezing Rain	13316	Rosemount 0871LH1	
Radiometric SST 1 port	13317	Heitronics CT15.85	
Radiometric SST 2 stbd	190029	Heitronics CT15.85	
Solar Radiation SW foremast	190057	Kipp & Zonen SMP22-A	

Solar Radiation LW foremast	190056	Kipp & Zonen SGR4-A	
Solar Radiation SW science mast	190028	Kipp & Zonen SMP22-A	
Solar Radiation LW science mast	190057	Kipp & Zonen SGR4-A	
Visibility Sensor	N2410065		
Barometer 1 upper	U0250643	Vaisala PTB 330	
Barometer 2 lower	U0221024	Vaisala PTB 330	
Underway Sea Water			
Fluorometer	1498	Chelsea Technologys	
Transmissometer	1279DR	C-Star	
Thermosalinograph	4538936-0130	SBE45	
Temperature 1	38-0767	SBE38	
Temperature 2	38-0771	SBE38	
Flow Meter	24/414055	Litre-miter	
Towed Systems			
Magnetometer	No		
XBT	No		
Rapid cast (CTD)	69835	Rapid Pro CTD	
Rapid cast (SVP)	#SN/No	Rapid Pro SVP	

Instrument	#SN if Used	Make and Model	Comments
Other Ship Science Systems			
Gravity Meter	#SN/No	Dynamic Gravity Systems AT1M	
Piccaro	#SN/No		
Black Carbon	#SN/No		
TE49i	#SN/No		
Goniomiter	#SN/No		
Ship wave recorder	#SN/No		
Ti CTD			
Deck unit 1	No	SBE11plus	
Underwater ACD/ Depth	No	SBE9plus	
Temp1	No	SBE3plus	
Temp2	No	SBE3plus	
Cond1	No	SBE 4C	
Cond2	No	SBE 4C	
Pump1	No	SBE5T	
Pump2	No	SBE5T	
Standards Thermometer	No	SBE35	

Transmissometer	No	C-Star	
Oxygen sensor	No	SBE43	
PAR sensor	No	QCP2350	
Fluorometer	No	CTG Aqua Tracker MkIII	
Altimeter	No	Tritech S10127 232	
CTD swivel linkage	No	Focal Technologies Group	
LADCP Master Down	No	TeleDyne WHM300	
LADCP Slave Up	No	TeleDyne WHM300	
Pylon	No	SBE32	
SS CTD			
Deck unit 1	90876	SBE11plus	
Underwater ACD/ Depth	0480 then 1225	SBE9plus	0480 removed after cast 005
Temp1	32307	SBE3plus	
Temp2	34874	SBE3plus	
Cond1	41913	SBE 4C	
Cond2	42813 then 43248	SBE 4C	42813 removed after cast 007
Pump1	52395	SBE5T	
Pump2	51807	SBE5T	
Standards Thermometer	0051	SBE35	
Transmissometer	1497	C-Star	
Oxygen sensor1	430242 then 432291	SBE43	430242 removed on cast 002
Oxygen sensor2	430620 then 434244 (Ti)	SBE43	430620 removed after cast 007
PAR sensor	70687	Biospherical Instruments Inc. QCP-2350	
Fluorometer	088-216	CTG Aqua Tracker MkIII	
Altimeter	10127.27001	PA200	
CTD swivel linkage	**#SN/No**	Focal Technologies Group	
LADCP Master Down	14897	TeleDyne WHM300	
LADCP Slave Up	15060	TeleDyne WHM300	
Back Scatter Flouromiter	No	Wetlabs EcoBB	
Eco Flouromiter	No	Wetlabs Eco CDOM	
Pylon	3270740-1106	SBE32	
Workboat Systems			
EM2040	No		
EK80	No		
Seapath	No		
SVS	No		
System(s) brought by science team (non-AME)			

EXTRA NOTEWORTHY Sensors	Yes/No	MAKE	SEE YYY NOTES

Notes Towed Systems Used

Magnetometer

Rapidcast and associated sensors

Built rapidCAST system and wired everything up in Punta on 02/02/2025. Tested the local control of the system and everything worked. Ran Liam through the building and operating side of the RapidCast system: the SOP needs a bit of work. IT had some issues with the network switches in the rough workshop, they managed to get it sorted and we were able to test the system through the Remote Desktop Connection. We then put the SVT and CTD on charge, ready for a test cast when at sea.

Python and batch scripts were loaded onto the PC on 03/02/2025. The next day IT sorted out automatic data transfer from the Rapidcast PC onto the leg drive, so it is now like our other instruments.

Ran 2 test casts on 07/02/2025, 50m with test probe and 200m with CTD. Ship was travelling at 6 knots and we used the rapidPRO CTD dive table.

Ran 2 casts on 10/02/2025, to a target depth of 700m, with the ship travelling at 2kts. First cast threw tension error at ~1000m line out, second was a full cast – end depth 767m (1296m lineout).

Tested using the processed data from Chris' code by loading it into the EM712 system, all worked.

Ran a cast after mooring collected on 10/02/2025. Again, ship travelling at 2kts, aimed for 270m depth at 90% coverage – got to 272m final depth. This svp was used for benthic sled surveying instead of using another cast.

Deployed rapidPRO CTD from light towing boom to 34m on 11/02/2025.

Did three casts on 15/02/2025, with the ship travelling at 8kts. There was an issue on the first (007) when going to 500m (end depth 418m at 110% coverage). The winch motor struggled to bring the probe back in. Had to use manual control to bring the CTD back, motor did not sound good.

Cast again to 500m, this time coverage set to 130%. Loose line error on down cast, cast cancelled.

Cast for a third time (009) to 500m, coverage set to 130%, ship still going at 8knots. On downcast, high-tension error. Could not retrieve probe with PC control or local control. Had to use emergency recovery procedure by using mooring winch to bring in the line.

After recovered the CTD to deck, opened up the rapidCAST winch housing. We found the motor cable connector had melted itself together, the motor cable had its outer sheath melted and the motor smelt like it was burnt. This, along with the PSO being concerned about bird strikes, meant rapidCAST would no longer be used on the cruise.

Cleaned and packed away rapidCAST on 19/02/2025. The following day opened the control box to inspect it. There was no obvious damage, blown fuses or burnt wires. It was then closed up and packed away.

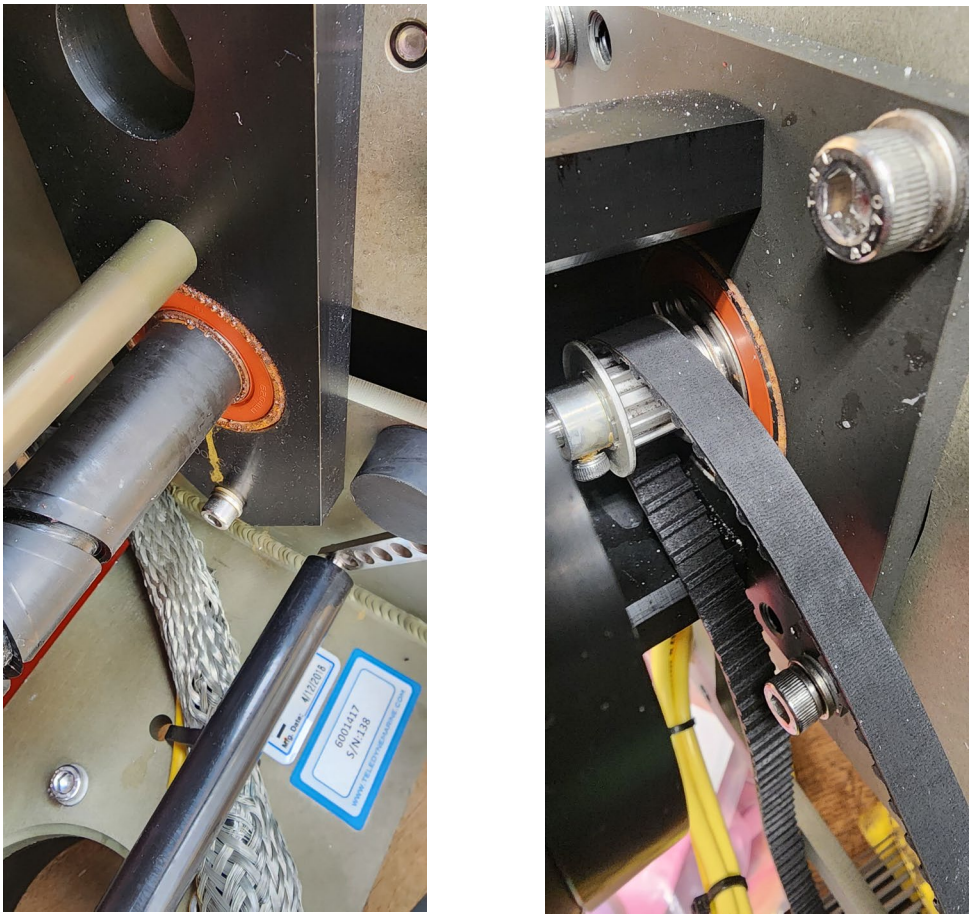

Figure 1: rapidCAST bearings

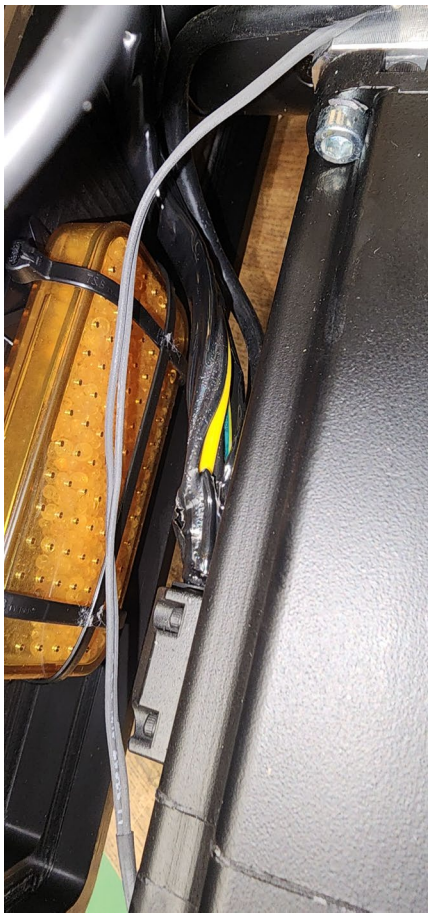

Figure 2: Burnt rapidCAST motor cable

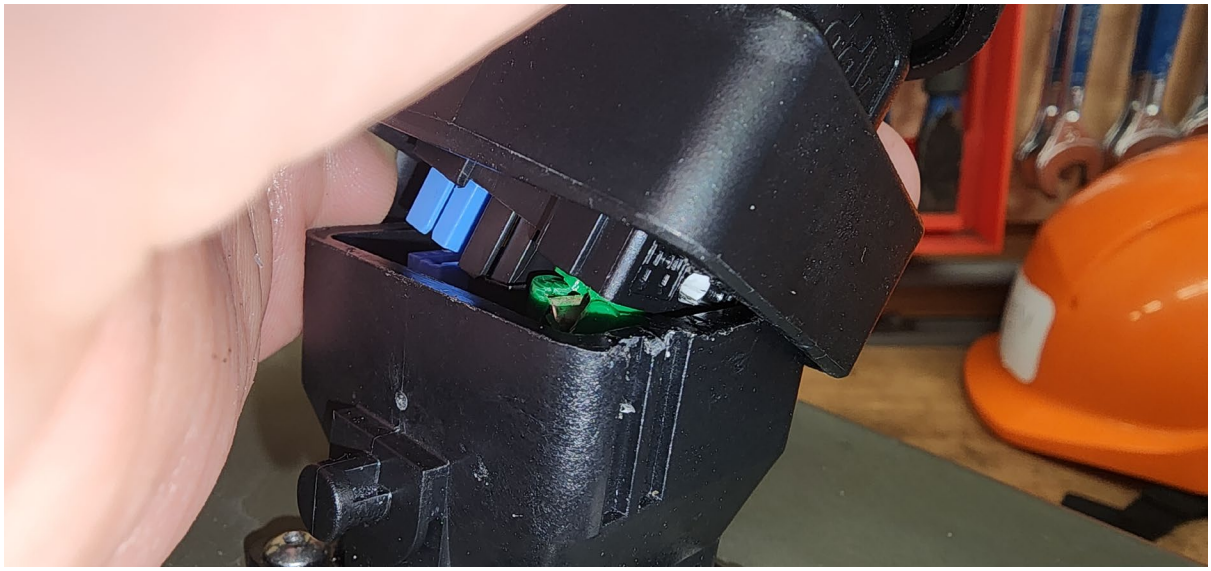

Figure 3: Fused rapidCAST motor plug

XBT

Basic Stats			
Number Deployed		Number of Successful Casts	
		Number of Failures	

Notes for Acoustic Systems used

Tasking Table		
System (Expected State when not on a science cruise)	State when you arrived	State when you left the Ship
ADCP (all powered down)	OFF	OFF
ME70 (Pole up and all powered down)	OFF	OFF
MS70 (Pole up and all powered down)	OFF	OFF
EK80 (all powered down)	OFF	OFF
SU94 (Poles up and all powered down)	OFF	OFF
SC94 (Pole up and all powered down)	OFF	OFF
Scanmar (all powered down)	OFF	OFF
EA640 (Hand to EO for their choice)	ON	ON
Additional Transducer (Disconnected)	OFF	OFF
TOPAS (all powered down)	OFF	OFF
EM122 (all powered down)	OFF	OFF
EM712 (all powered down)	OFF	OFF
Underway SVS (Powered Up)	OFF	OFF
USBL (Pole up and all powered down)	OFF	OFF

While in Punta we had to wait for the divers to finish their hull survey, they took a few days longer than expected so all instruments were turned on once we left Argentinian waters after leaving Punta on 05/02/2025.

There was an issue with accessing EK80 PC over network, it was an issue with BlackBox units which IT sorted out.

ADCP

Turned ON, on 05/02/2025. Turned OFF, on 27/03/2025.

IT installed the new UHDAS PC into the server room on 27/03/2025.

Figure 4: UHDAS PC front

Figure 5: UHDAS PC back

Bio Multi-beam(ME70)

Turned ON, 07/02/2025 and used during the test station and everything worked correctly. Turned OFF, on 27/03/2025.

On the 18/02/2025 there was noisy data approximately every 6 pings. Restarted the ME70 unit and software, no improvement. Ended up being sea conditions affecting acoustics.

Bio Multi-beam(MS70)

Turned ON, 07/02/2025 and turned OFF, on 27/03/2025.

Bio Multi-freq (EK80)

Turned ON, on 05/02/2025. Turned OFF, on 27/03/2025.

Omni directional sonar (SU94)

Omni directional sonar (SC94)

Scanmar net system

Spot Depth Echosounder (EA640)

The instrument was ON when we arrived in port. On 07/03/2025 the PC froze – mouse could move but keyboard unresponsive and no updates from EA640. Rebooted PC in server room, then reset software – all working again. Limits needed adjusting to get correct readings after reboot.

The system was left running when for the ship to use for navigation.

Additional 12Khz Transducer

Bottom profile (Topas)

Swath (EM124)

Turned ON, on 05/02/2025. Turned OFF, on 27/03/2025.

On 14/02/2025 we attempted to start system, no instrument detected. Tried power cycling but had missed the processing unit in Sensor Junction Room 1. Reset this and unit was working. Labelled the unit afterwards.

Figure 6: EM124 Processing Unit

Swath (EM712)

Turned ON, on 05/02/2025. Turned OFF, on 27/03/2025.

On 10/02/2025 there was an issue with RX channel during BIST test, restarted entire system and reseated cables on processor unit and this got it working.

Underway Mini SVS

Turned ON, on 07/02/2025. Turned OFF, on 27/03/2025.

USBL

Before the science began, we checked all USBL batteries were disconnected and if not, we disconnected them.

We fitted an omni USBL beacon onto CTD frame and prepared the directional for deep (>3000m) casts.

We also setup the second omni for the benthic team. The used it a few times and were able to see the beacon on the bridge USBL system, though the KVM needed to be restarted. This seemed to be the case every time we wanted to use the bridge USBL system.

Tried to get science USBL system running to record sled's movements. Plugged in NSH in winch room, asked bridge to deploy starboard pole (as per SOP). Was unable to get science system to detect the beacon. Seems in software the system is configured to use the Port side pole. The issue was the wrong pole was down, bridge SOP should be updated to state which USBL pole is which.

On 17/02/2025 we swapped USBL beacon on CTD to #2013 as no response on #2012 when checking battery with wand – assumed that the battery was flat. Put it on charge. Later we discovered that beacon #2012 was not charging at all and the battery voltage stayed at 52%. All other functions seem healthy, and responds to wand/serial commands.

N.B. Wand USB power supply is broken (no output). Need to replace this.

Bridge USBL

Continuous dropping out of system, required fuses to be flipped to restart KVM. This is still an issue.

Notes about the Met Systems

Before we left Punta we climbed to inspect all the system and to retrieve all the serial numbers. Pyrometer cable on deck 11 science mast seems to have some external damage to it - will keep an eye on it.

Figure 7: Burns on Pyrometer cable

Barometer inlet tubes were badly twisted, with one getting trapped in the outside door. We fixed this and both are tracking again.

Figure 8: Barometer tubes when we arrived

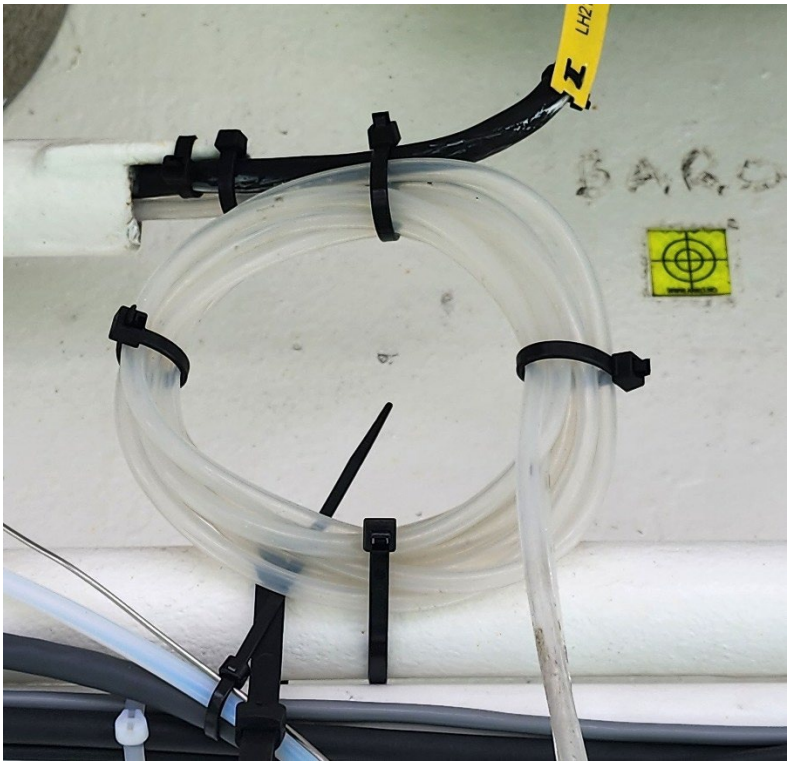

Figure 9: Barometer tubes after we fixed them

Inspected PCO2 filter, all looked good and showed labs managers location of it. There was some slight condensation in it but both Engineers and lab managers were okay with the it.

Everything went down at around 11:17am on 04/02/2025, POPS never came back. Went back to inspect it and it had power, reseated the network cables and came back.

The Opti-Dew 2 was turned off on 27/03/2025.

Notes about the Underway Water Systems

Turned ON once outside of Argentinean waters, on 06/02/2025. The system required flushed and cleaning out several times.

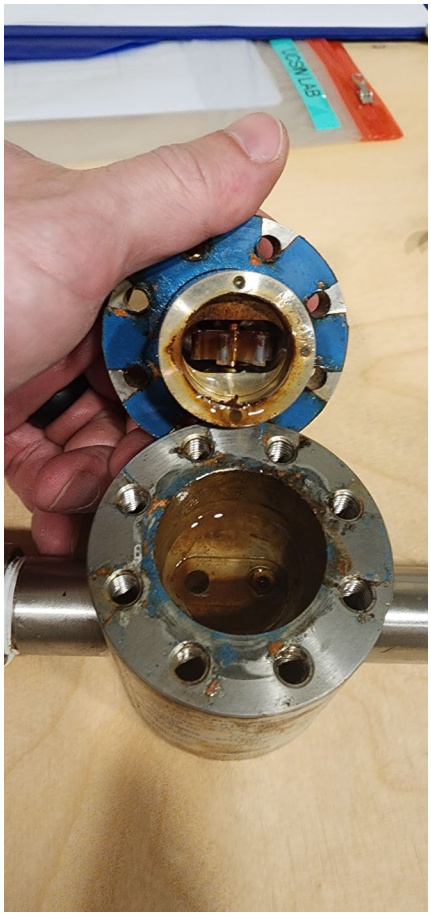

Figure 10: UCSW flow meter

On 09/02/2025 at about 03:00am, flow rate dropped, cleaned out flow meter. Flow back to about 1.2l/m. Checked again after the pole was deployed after mooring recovery: flow rate back up to ~1.3l/m after pole deployed.

On 11/02/2025 issue flagged by scientist that flow rate on Grafana sometimes doesn't update for several minutes. Checked and seems other channel on same Moxa doesn't have this issue – apparently this is a known issue with data/server side of system.

On 22/02/2025, flow rate down to around 0.9L/min. Flushed system with fresh water, improved flow rate. Also opened flow sensor and flushed out with fresh water. Rate returned up to >1.2L/min

On 24/02/2025, flow rate dropped suddenly again to around 0.9L/min. Flushed system, improved to 1.1L/min. Inspected the inlet flow regulator – this seemed to be causing the issue (removing it increased flow rate to 1.4L/min). Cleaned it, and replaced the plastic pipe fittings which had debris in. Flow rate up to 1.29L/min after. Prepped/tested a replacement regulator in UCSW spares box.

On 12/03/2025, flow rate dropped again. System flushed but flow rate still quite low (~1.1L/min). Changed out flow regulator for larger one, flow rate up to 1.2L/min. Noticed a fair amount of gunk in the tubes on either side of the flow regulator.

Figure 11: Plankton in UCSW tubing – caused clogging of regulator

On 15/03/2025, flow rate down to 0.2L/min. This was same for PCo2. Deck engineer cleared filter – full of krill/ice. Ice blockages happened quite often around A23a – deck engineer raised pole until it was needed for sampling to avoid damage.

The system was flushed with clean water, drained and turned OFF on27/03/2025.

Notes About Gas Chemistry Systems

Picarro

Black Carbon

On 04/02/2025 during instrument inspections, we saw that there was an error on the system. The actual flow rate was higher than the expected flow rate (>9l/min instead of 5l/min). This found to be due to the vacuum pump being connected in line with the Black Carbon unit. The Dryer also had an error: the inlet and outlet temperature/humidity was the same. Spare parts for the drier are to be ordered for maintenance.

The pump connections were then moved to be across the drier which solved the flow rate issue, and the temperature/humidity error on the drier.

The black carbon unit was then running at 5 l/m and the dryer seemed to be working better as well.

On 07/02/2025, the scientists turned the instrument OFF, we spoke to them about not touching it or turning off random plugs that are in use.

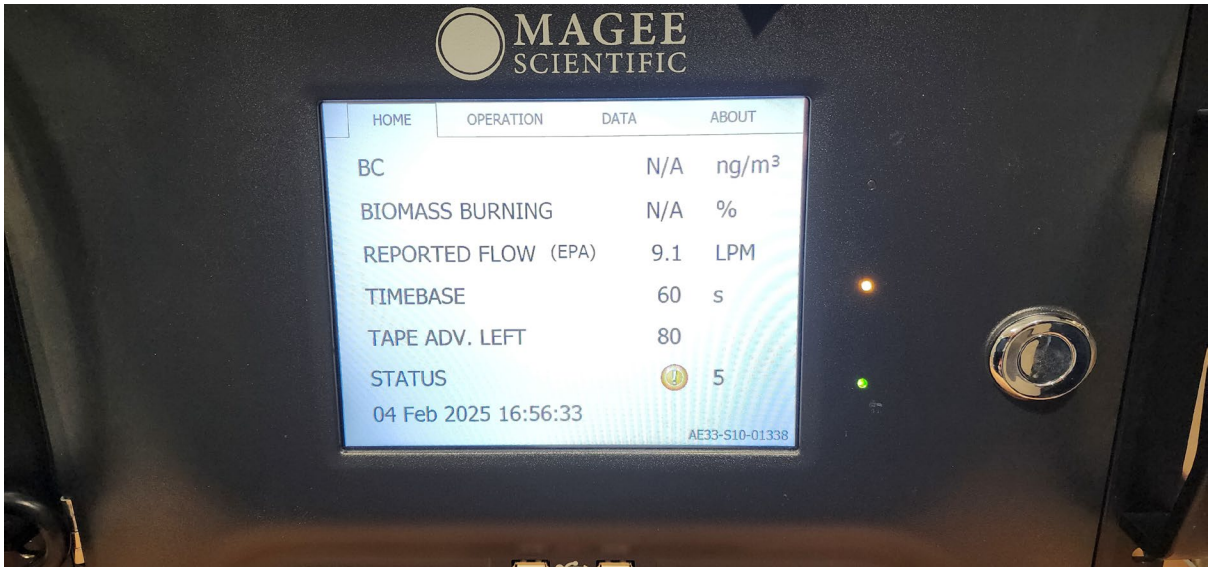

Figure 12: Black Carbon error message

Figure 13: Black Carbon dryer error

Figure 14: After redoing vacuum pump connections

Te49i

Notes about the Workboat Systems

EM2040

EK80

Seapath

Before leaving Punta we were told Seapath 1 antenna had failed and we only have Seapath 2 up and running but that is also slightly off due to the antenna position being incorrect on the survey dimensions.

Notes about the CTD

Basic Stats			
No#Of Casts SS	071	No#of Successful Casts (SS)	067
Max Depth of SS	5993	Min Depth of SS	10m
Cable Removed Standard (m)	12.3m	No# of Re-terminations (elect.)	5
No#Of Casts Titanium	N/A	No# of Successful Casts (Titanium)	N/A
Max Depth of Titanium	N/A	Min Depth of Titanium	N/A
Cable Removed Titanium (m)	4m	No# of Re-terminations (elect.)	2

Liam built up the CTD before arriving and when Chris got onboard, on 31/01/2025, we went through the PC setup and operations, testing the CTD through the hangar connection.

On 01/02/2025, we then did the mechanical and electrical (oil filled junction box) termination of the SS wire. The termination was mega-tested afterwards and 250V and 500V values were correct, > 220M @ 250V, > 550M @ 500V, still shorting @ 1000V. There was a large kink in the wire and we had to cut off 9.3m. We also put all the niskins on the frame with their spigots.

We did not connect the battery charger as there were bunkering operations and cargo operations inside the hanger. We spoke to the PSO and captain about letting both AME Electrical and Mechanical know when bunkering operations are scheduled to happen as this made cutting and hot work operations difficult. If we had known we could have changed to order of things to do all hot works before the bunkering day.

If the OFJB is used it should be removed from the wire after a cruise to ensure the longevity of the part as some parts showed corrosion from Kang-Glac. It was also found that if the potting compound is used for the OFJB, the bottom section will need to be replaced. Gareth mentioned that MEK or acetone can be used to break down the compound, though it was never tested.

Figure 15: Oil filled junction box after Kang-Glac

Figure 16: Unable to remove cable from oil filled junction box when potting compound is used

We cut off the ends of the wire strands on CTD cable on 02/02/2025, the potting took long to set so we left it overnight and then started again before bunkering continued. After this we put whole termination and bullet together, ready for load testing. The USBL was put on charge, was at 100% and battery was not disconnected. We ran through all the USBL's on board to make sure all the batteries were disconnected.

On 03/02/2024, we load tested to 2.2 tonnes for 2 minutes, attached swivel, LADCP's were put on charge, bottles strapped and tested comms on the PC. During the cruise the Science Bosun made mention that the winch and boom experience 2 tonnes of load during actual CTD operations and asked the question "Should we not be doing the load test to 4 tonnes?", this is something we should discuss back in Cambridge.

We talked with Oceanography science leads about CTD operations and procedures, on 04/02/2025, and answered any questions they had and ran Liam through the pre and post cast procedures.

We did the final touch ups on the CTD, on 05/02/2025, like clipping oil filled junction Jubilee onto the swivel and fitting the USBL to frame (address 2012)

On 07/02/2025 we had our first test station, where we experienced an issue with boom sequence, cast cancelled before going in water. We then did cast 001 and had an issue with the winch spooling gear. The deck crew spent a long time trying to sort this out but when they couldn't solve the issue we fired all bottles at 10m to check leaks on the niskin bottles, of which there were none.

We tried another test station on 08/02/2025 and had spool gear issues again and the winch was stopped at 30m. All the bottles were fired for scientists to practice taking water samples. We had a spooling error again right on the surface, CTD stayed there for a while, while the Deck Engineers sorted it out.

Niksins 1-19 spigots were changed out to the smaller black spigots 09/02/2025 and then we did a cast with dummy weight in place of CTD to test/debug winch spooling. Error still present, so no further casts on the SS wire while the Deck Engineers debug the issue. Later on in the cruise a loose electrical connection in the spooling gear was found to be the issue.

While the SS spooling issue was being investigated we prepped the Ti bullet for changing over to MF winch on 10/02/2025 if the spooling gear could not be fixed. During disassembly of the old cup/cone termination, it was found that the Paralock compound had set mainly at the top of the inner cone. When making the new termination poured paralock down the side of the inner cone, which was loosely fitted at the start of the pour. When enough Paralock had been poured down the sides, the cone was pulled tight into the cup, before pouring the rest into the top of the cup.

Figure 17: Ti cup/cone pot from previous cruise

Figure 18: Making new Ti Termination. Pulled cone to one side to allow Paralock to fill base of cup, before pulling tight and finishing pouring

On 11/02/2025 the Deck engineers did some testing on winch spooling but the issue remained. The decision was made to change to metal free on CTD boom and use stainless on starboard gantry. We cut off the SS bullet, then completed potting of both CTD cones and used WireLock booster from the Science Bosun for the Stainless Steel to speed up cure time (recommended for use in temperatures <9°C). We also prepped the second oil filled junction body, threaded it to take a bulkhead, and wired in to chock block for metal free. We ended up not using the OFJB on the MF wire as the inner core is too thick for the rubber parts.

Figure 19: Wirelock booster kit

The MF was electrically terminated on 12/02/2025 and mega-tested, > 220M @ 250V, > 550M @ 500V, 11G @ 1000V. The SS wire was not electrically terminated as we only had 1 rubber part left and we wanted to be sure that we were going to use the STBD gantry. We did 2 tests casts and both went well from the winch operator's side. The CTD however did not start its pumps. The deck unit beeped when it tried and the LADCP files were not the same size. Both wires were load tested and were successful. Stainless wire then got damaged in winch room, when the Science Bosun went to do the load test on the MF wire he did not select the correct wire on the belly box and ended up pulling the mechanical termination on the SS apart. The wire was re-terminated bullet using wirelock + booster kit. N.B damage to 5mm allen screwheads on bullet, we should get some more. The LADCPs were run in air to check their files and file sizes matched (within a few bytes). The pumps were debugged, first we tried to manually start them through Seasave but this feature is not available to us, eventually got pumps running using seawater and syringes, with same cables & pumps. During debugging pumps noticed a host of errors in the Seasave Log, which started on this day. E.g. *"02/13/2025 00:17:51 From SeasaveAcq: 001B 0000004B FFFFFFFF Unsupported modem message: xx xx xx from SBECarousel".* Seemed taking SBE35 out of the loop fixed this, but no obvious problem with either SBE35 or SBE32. This error was checked at the end of the cruise and seemed to occur at random points throughout, with no noticeable effect.

The pump issue reappeared during the cast on 13/02/2025, the deck unit it seemed like it tried for a second and then went off. Cast abortred and brought the CTD back onboard, tried syringes with salt water, new conductivity primary sensor and the replaced SBE9+ and pump cable which got the

pumps working again working. The following cast pumps worked but PAR sensor was showing nil for whole cast, but this was just an issue with Seasave (removing and adding the channel to the plot fixed it).

On 14/02/2024, conductivity 2 and DO 2 failed during cast, CTD boom had an issue during the recovery and the CTD sat for about 30 minutes before getting onto the deck. Conductivity 2 and DO 2 were replaced after cast, calibrations updated in Seasave.

We had a 1000m cast on 16/02/2025, this improved spooling on winch which had some bad turns in it. There were issues with LADCPs hanging during setup, reran setup procedure but files not same size. LADCP end cap on cable was off after cast.

The LADCP cable from bulkhead and from CTD side was cleaned up, on 17/02/2025. Cast 012 was aborted due to ship DP issue, cast earlier in the day cancelled due to swell. The male connector pigtail on the hangar LADCP lead was replaced. Had to use old connector as no new ones in stock. Worked better but still a little iffy. Later in the cruise we found some stock in the LADCP spares box.

From here things calmed down a lot, there were the usual O-ring replacements and mega-tests done. Niskin #7 didn't fire a few times, the pin released but didn't move, the screws were tightened and mechanism inspected, then pin 7 and 8 latches were swapped around, surface rust was cleaned off of it and the issue didn't happen again. The LADCP cable had several issues which required swapping out both ends of the cable for new parts or cleaning throughout the cruise. It is advised that we buy new LADCP cable assemblies (all existing ones corroded) and find a better solution to the arcing issue experienced by the cable. Some of the instruments required cleaning of their connectors which improved data quality.

The Deck Engineer also made a nylon collar for the MF bullet to be able to lock the bullet into place, in the end this was swapped out for the metal collar as the proximity sensor on the locking head didn't work with the nylon collar.

Figure 20: Nylon collar made by Deck Engineer

There were also plans made to prepare for a deep cast in South Sandwich Trench, we had to decide if we wanted to take instruments off but ultimately, we decide to stop the cast before the 6000m mark. This proved to be the better decision as the CTD stopped at 5993m which was 10m from the seabed.

After the deep cast in the South Sandwich Trench the MF cable did not spool back onto the drum correctly and was spooling over itself and snapping into place as it was spooling on. We ran the CTD off the STBD gantry with the SS wire until the deck crew could sort out the spooling on the MF wire. We load tested and then did the electrical termination on the SS using the OFJB and potting compound but found seawater to be getting into junction.

Figure 21: Seawater "bubbles" at bottom of OFJB

Oil was either leaking out from the seals (tried replacing all the o-rings, didn't solve issue) or down the cable core, it was difficult to tell. This meant that for a few casts we had to empty/re-fill the OFJB before each cast as the mega-testing failed. There was a lull in CTD casts on 01/03/2025 so we cut the OFJB off and replaced it with the self-amalgamating tape termination.

On 03/03/2025, niskin 13 didn't fire, the pin was still locked on the release and niskin 12 came off the rosette: the bottom aluminium block to hold spring/rod had come off. The screws seemed to have come loose and the block fell off. Re-tapped threads with ¼" UNC tap, thread locked and refitted screws. Top mount seemed fine.

Figure 22: Bottle 12 – problem with rear mount

The electrical termination failed its mega-test and had to be redone before cast 043 on 04/03/2025.

On 05/03/2025, we got a chance to respool the MF cable to 6000m using a 500kg dummy weight but after the cast the electrical termination had failed (open-circuit) and had to be redone. The MF cable was used for the remainder of the cruise.

From 03/03/2025 the weather was quite cold for a couple of weeks and we had some issues with the water freezing in the CTD sensors, both Milli-Q and seawater. We made the decision to keep the shutter doors shut whenever possible to avoid this issue.

The Microcats which were recovered from moorings were attached to several CTD casts for calibration.

On 16/03/2025 the CTD got stuck outboard on the boom. The Deck Engineer inspected the inside of the boom where the bullet slides into and found damage on the metal in this area. He filed, grinded and cleaned up this area until it was smooth and grooves were removed. This should be a refit request to either clean it or inspect the boom for damage and should be inspected at the start and end of each cruise. We mega-tested and comms tested the wire afterwards, all fine. When we put the boom back into place the deck crew used ropes to guide the collar with worked well.

Figure 23: Damage inside CTD collar - 1

Figure 24: Damage inside CTD collar – 2

Figure 25: Damage inside CTD collar - 3

Figure 26: Damage inside CTD collar - 4

Figure 27: Damage on CTD collar

Figure 28: CTD collar after cleaning

After the cast on 18/03/2025, the SBE35 showed 0 samples but when we tried to download the data all the firing times were in the file.

The last cast we did on 24/03/2025, the scientists wanted us to get a close to the seabed as possible so we stopped 2m off the seabed for 2 bottle fires.

The SS frame was stored in port aft hold 2 at the end of the cruise.

The lifting gear was packed on 28/03/2025 and sent back to Cambridge via the commercial container, the stock sent back is:

- 2x SS swivels
    - M527 and M528
- 1x Box of SS bullet termination lifting gear
    - M523
- 1x complete bullet and 3m SS cable
- 2x Ti swivels
    - M533 and M 547
- 1x Box of Ti bullet termination lifting gear
    - M525
- 1x complete bullet and 3.8m MF cable

At the end of the cruise our termination stock is as follows:

- 5x Paralock
- 7x Wirelock
- 0x Rubber inserts for OFJB
- 2x Rubber inserts for potting compounds
- 2x Potting compounds

Casts

Cast 001

Date: 07/02/2025
Cruise: SD046
Event number: 004
Operator: Liam
Frame: SS
Requested depth: 100m
CTD depth at bottom: 100m
Altimeter: N/A
Comments

- Test cast.
- Niskin 5 bottom spigot needs O-ring replaced.
- Active heave control ON.
- Primary DO had an issue, needs to be replaced. Swopped out with 432291
- Winch issue with the spooling gear, stopped at 43m.

- Transmissometer data was wrong, after the cast it was looked at and the values were not saved to the xmlcon file when setup was done.
- All bottles fired for leak detection, no leaks.

Cast 002

Date: 08/02/2025
Cruise: SD046
Event number: 009
Operator: Liam
Frame: SS
Requested depth: 100m
CTD depth at bottom: 30m
Altimeter: N/A
Comments

- Test cast.
- Niskin 16 bottom spigot needs O-ring replaced.
- Active heave control OFF.
- Primary DO looked better
- Winch issue with the spooling gear, stopped at 30m.
- Transmissometer data looked better.
- All bottles fired for leak detection, no leaks.
- CTD got stuck right on the surface because there was another spooling error

Cast 003 & 004

Date: 12/02/2025
Cruise: SD046
Event number:
Operator: Liam
Frame: SS
Requested depth: 40m
CTD depth at bottom: 20m then 40m
Altimeter: N/A
Comments

- Ran 2 test casts on metal free cable to test winch
- Pump issue – whenever pump attempted to start, SBE11 kicked an error (buzzer) and pump went off straight away again. Happened twice on second cast
- Noticed LADCP files were too small, and mismatched file size between master and slave (37kB vs 129kB)

Cast 005

Date: 13/02/2025
Cruise: SD046
Event number:
Operator: Chris
Frame: SS
Requested depth: 40m
CTD depth at bottom: 20m then 40m
Altimeter: N/A
Comments

- Cast 005 aborted after pump issue returned. SBE9+ and pump cable replaced

Cast 006
Date: 13/02/2025
Cruise: SD046
Event number:
Operator: Liam
Frame: SS
Requested depth: 265m
CTD depth at bottom: 261m
Altimeter: 10.0m
Comments

- PAR sensor seemed to be reading nil, but found after cast this was just Seasave display issue
- Pump issue seems resolved
- Altimeter had a lot of noise

Cast 007
Date: 14/02/2025
Event number:
Operator: Chris
Frame: SS
Requested depth: 3779m
CTD depth at bottom: 3744m
Altimeter: 9.0m
Comments

- Conductivity difference large after 500m (conductivity sensor 2)
- Dissolved Oxygen had massive spike around 3300m and didn't follow graph after
- CTD Boom issue during recovery

Cast 008
Date: 15/02/2025
Event number: 037
Operator: Liam
Frame: SS
Requested depth: 1000m
CTD depth at bottom: 1000m
Altimeter: N/A (3143m water depth)
Comments

- Large DO difference at start

Cast 009
Date: 16/02/2025
Event number: 039
Operator: Liam
Frame: SS
Requested depth: 308m

CTD depth at bottom: 303m
Altimeter: 12.3m
Comments

- Altimeter noisy at start

Cast 010

Date: 16/02/2025
Event number: 041
Operator: Liam
Frame: SS
Requested depth: 197m
CTD depth at bottom: 194m
Altimeter: 10.3m
Comments

- EA640 having big jumps during cast (from 206m to 58m water depth)
- Spike in beam attenuation at 100m

Cast 011

Date: 17/02/2025
Event number: 044
Operator: Liam
Frame: SS
Requested depth: 1010m
CTD depth at bottom: 1001m
Altimeter: N/A (3541m water depth)
Comments

- LADCPs hung during setup. Restarted the whole setup process a second time
- LADCP files not the same size after cast
- LADCP end cap not connected after cast

Cast 012

Date: 17/02/2025
Event number: 045
Operator: Liam
Frame: SS
Requested depth: 122m
CTD depth at bottom: N/A
Altimeter: N/A
Comments

- Aborted cast at stability check due to ship DP issue

Cast 013

Date: 17/02/2025
Event number: 046
Operator: Liam
Frame: SS
Requested depth: 122m

CTD depth at bottom: 125
Altimeter: 9.2m
Comments
N/A

Cast 014

Date: 18/02/2025
Event number: 051
Operator: Liam
Frame: SS
Requested depth: 286m
CTD depth at bottom: 285
Altimeter: 10.2m
Comments

- Leaks from bottles 11, 14, 17 – changed after cast
- LADCP charger not connecting properly post cast
- Breather valve on bottle 20 possibly open during cast

Cast 015

Date: 19/02/2025
Event number: 055
Operator: Chris
Frame: SS
Requested depth: 115m
CTD depth at bottom: 118.8m
Altimeter: 8.5m
Comments

- Large DO difference at top of water column
- AHC on at 70m, off at 25m

Cast 016

Date: 19/02/2025
Event number: 056
Operator: Chris
Frame: SS
Requested depth: 1010m
CTD depth at bottom: 1001.5m
Altimeter: N/A (2659m water depth)
Comments

- Large DO difference at top of water column
- AHC on at 80m, tried at 30m but didn't engage
- AHC off at 25m

Cast 017

Date: 19/02/2025
Event number: 058
Operator: Chris
Frame: SS
Requested depth: 1010m

CTD depth at bottom: 1000m
Altimeter: N/A (2771m water depth)
Comments

- Large DO difference at top of water column
- AHC on at 25m
- AHC off at 25m

Cast 018

Cast 019

Date: 21/02/2025
Event number: 067
Operator: Liam
Frame: SS
Requested depth: 345m
CTD depth at bottom: 355m
Altimeter: 10.1m
Comments

- Lots of altimeter noise at 100m depth on downcast
- Scientists reported bottle 19 leaking – inspected o-ring and seemed okay

Cast 022

Date: 21/02/2025
Event number: 067
Operator: Liam
Frame: SS
Requested depth: 2453m
CTD depth at bottom: 2442m
Altimeter: 10.1m

- Winch control panel restarted at 1000m on upcast

Cast 023

Date: 21/02/2025
Event number: 067
Operator: Liam
Frame: SS
Requested depth: 3458m
CTD depth at bottom: 3449m
Altimeter: 6.0m

- LADCP hung during predeploy, restarted procedure. Files seemed normal after
- Winch left in automatic until bottom
- Altimeter very noisy between 180m and 270m
- Winch cable had big lead towards front of ship

Cast 024

Date: 22/02/2025
Event number: 077
Operator: Chris

Frame: SS
Requested depth: 3141m
CTD depth at bottom: 3125m
Altimeter: 10.0m

- Large DO difference
- Time on SBE35 changed

Cast 025

Date: 22/02/2025
Event number: 078
Operator: Chris
Frame: SS
Requested depth: 3440m
CTD depth at bottom: 3441.5m
Altimeter: 9.7m

- Large DO Difference
- Altimeter only started 80m above seabed. Very noising @ 10m above

Cast 026

Date: 22/02/2025
Event number: 079
Operator: Liam
Frame: SS
Requested depth: 3756m
CTD depth at bottom: 3742m
Altimeter: 9.0m

Cast 027

Date: 24/02/2025
Event number: 084
Operator: Liam
Frame: SS
Requested depth: 5836m
CTD depth at bottom: 5993.2m
Altimeter: 10.0m

- Manual control from 5846m on downcast. AHC turned off here to try fix spooling

Cast 028

Date: 25/02/2025
Event number: 085
Operator: Liam
Frame: SS
Requested depth: 4028m
CTD depth at bottom: 4014m
Altimeter: 11.0m

Cast 029

Date: 26/02/2025
Event number: 087
Operator: Liam

Frame: SS
Requested depth: 4727m
CTD depth at bottom: 4724m
Altimeter: 10.3m

- SBE911 timeout when starting logging. Restarted SBE11, restarted logging in Seasave – issue resolved.
- AHC off on upcast, spooling adjusted on way up
- LADCP cable cleaned

Cast 030

Date: 26/02/2025
Event number: 088
Operator: Chris
Frame: SS
Requested depth: 4849m
CTD depth at bottom: 4817m
Altimeter: 9.8m

- Cable didn't spool back on correctly. Wrapping over itself at the ends then snapping across drum.
- Slight leak on niskin 20, bottom o-ring replaced

Cast 031

Date: 26/02/2025
Event number: 089
Operator: Liam
Frame: SS
Requested depth: 10m
CTD depth at bottom: 10m
Altimeter: N/A

- Test cast with steel cable off starboard gantry
- Electrical termination done before cast – OFJ.

Cast 032

Date: 27/02/2025
Event number: 090
Operator: Liam
Frame: SS
Requested depth: 4861m
CTD depth at bottom: 4839m
Altimeter: 8.9m

- Using steel cable, SB gantry.
- Winch operator mistake near bottom – fast pay out, stopped at 4m on altimeter
- Long pause at 4070m to adjust spooling
- Bottle 3 did not fire. Latch still closed on return to surface
- Bottles 12 & 15 bottom o-rings replaced
- Seawater in OFJ spotted before cast. Rubber seal failed

Cast 033

Date: 27/02/2025
Event number: 091
Operator: Chris
Frame: SS
Requested depth: 4081m
CTD depth at bottom: 4066m
Altimeter: 10m

- Oil filled junction redone with epoxy pot for this cast.
- Mega tested before

Cast 034

Date: 27/02/2025
Event number: 094
Operator: Liam
Frame: SS
Requested depth: 2478m
CTD depth at bottom: 2557m
Altimeter: 10m

- Added 8x micro-cat CTDs for mooring calibration
- Noticed seawater in OFJ again. Failed Mega test. Tried changing all o-rings, replaced oil
- Spikes in DO sensor 2

Cast 035

Date: 28/02/2025
Event number: 095
Operator: Liam
Frame: SS
Requested depth: 2682m
CTD depth at bottom: 2736.5m
Altimeter: 10.5m

- Spikes in DO sensor 2
- Noticed seawater in OFJ again, replaced oil
- Mega tested okay

Cast 036

Date: 28/02/2025
Event number: 096
Operator: Chris
Frame: SS
Requested depth: 3826m
CTD depth at bottom: 3780m
Altimeter: 10m

- AHC ON
- Spikes on DO2 again from about 375m down to 650m
- Some water in OFJ, replaced the oil and mega tested afterwards.

Cast 037

Date: 28/02/2025
Event number: 098

Operator: Chris
Frame: SS
Requested depth: 3466m
CTD depth at bottom: 3439m
Altimeter: 11m

- Spikes in DO sensor 2
- Some water in OFJ, replaced the oil and mega tested afterwards.
- AHC ON

Cast 038

Date: 01/03/2025
Event number: 101
Operator: Liam
Frame: SS
Requested depth: 3146m
CTD depth at bottom: 3108m
Altimeter: 10m

- Smaller spikes in DO sensor 2
- Some water in OFJ, replaced the oil and mega tested afterwards.
- AHC OFF

Cast 039

Date: 28/02/2025
Event number: 108
Operator: Liam
Frame: SS
Requested depth: 1508m
CTD depth at bottom: 1502m
Altimeter: 10m

- OFJ removed and changed to self amalg termination before cast.
- Niskin 13 didn't release
- Niskin 12 fell down rosette.
- AHC OFF

Cast 040

Date 03/03/2025
Event number: 113
Operator: Chris
Frame: SS
Requested depth: 3651m
CTD depth at bottom: 3600m
Altimeter: 10m

- AHC ON
- Noisy altimeter with pattern

Cast 041

Date 04/03/2025
Event number: 114
Operator: Liam
Frame: SS
Requested depth: 3127m

CTD depth at bottom: 3064m
Altimeter: 10m

- AHC ON for downcast and OFF for upcast
- Spiked on DO2
- Some spikes on T&C, flour and trans at 20m and 50m
- 25 datapoints on SBE35

Cast 042

Date 04/03/2025
Event number: 115
Operator: Liam
Frame: SS
Requested depth: 1736m
CTD depth at bottom: 1708m
Altimeter: 10m

- AHC ON for downcast and OFF for upcast
- Spiked on DO2
- SBE35 gave garbled output on connection. Disconnect and reconnect solved it.

Cast 043

Date 04/03/2025
Event number: 118
Operator: Chris
Frame: SS
Requested depth: 3407m
CTD depth at bottom: 3371m
Altimeter: 10m

- AHC ON, turned OFF at about 450m on downcast.
- LADCP cables needs cleaning, didn't read voltages. Done after cast.
- Mega tested before and after cast, both fine.

Cast 044

Date 06/03/2025
Event number: 123
Operator: Liam
Frame: SS
Requested depth: 1456m
CTD depth at bottom: 1454m
Altimeter: 10m

- AHC ON for downcast and OFF for upcast
- Redid electrical termination before cast.
- Jump on all the sensors at the bottom, recovered after 50m up.

Cast 045

Date 07/03/2025
Event number: 127
Operator: Liam
Frame: SS
Requested depth: 3399m
CTD depth at bottom: 3357m
Altimeter: 10m

- AHC ON
- Small spiked on DO2
- Altimeter noisy

Cast 046

Date 07/03/2025
Event number: 128
Operator: Liam
Frame: SS
Requested depth: 100m
CTD depth at bottom: 100m
Altimeter: N/A

- AHC ON

Cast 047

Date 08/03/2025
Event number: 141
Operator: Chris
Frame: SS
Requested depth: N/A
CTD depth at bottom: N/A
Altimeter: N/A

- Temp 2, salinity 2, cond 2 were all dead, cast cancelled.

Cast 048

Date 08/03/2025
Event number: 142
Operator: Chris/Liam
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1000m
Altimeter: N/A

- Milli-Q was frozen in sensor 2 line, ice removed, both lines flushed with sea water before cast and cast started again.
- Line 1 frozen this time. Only water needed from this cast so continued.
- Defrosted at about 500m.
- AHC OFF
- Altimeter noisy
- Niskin 7 didn’t fire

Cast 049

Date 10/03/2025
Event number: 149
Operator: Liam
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1000m
Altimeter: N/A

- AHC ON for downcast and OFF for downcast
- Cond 2 reading 0 on surface, came back when it went into the water.

Cast 050

Date 10/03/2025
Event number: 152
Operator: Chris
Frame: SS
Requested depth: 2003m
CTD depth at bottom: 1964m
Altimeter: 10m

- AHC ON
- Microkats on frame
- Niskin 7 didn't fire, mechanism disengaged but pin didn't release. Ring removed, inspected and screw tightened.

Cast 051

Date 11/03/2025
Event number: 159
Operator: Chris
Frame: SS
Requested depth: 3090m
CTD depth at bottom: 3038m
Altimeter: 10m

- AHC ON
- Microkats on frame
- Cond 2 was 0 at start but came on after some time in water
- Spike in DO2 @ 1000m down
- LADCP cable issue

Cast 052

Date 11/03/2025
Event number: 160
Operator: Chris
Frame: SS
Requested depth: 10m
CTD depth at bottom: 12m
Altimeter: N/A

- Media cast
- Microkats on frame
- Fired bottles 1-5, 13-16, 18, 19, 23, 24
- Reset bottles once on deck and went straight into next cast.

Cast 053

Date 11/03/2025
Event number: 161
Operator: Chris
Frame: SS
Requested depth: 758m
CTD depth at bottom: 750m
Altimeter: N/A

- AHC ON
- Microkats on frame

- DO2: Small spike at 300m, BIG spike at 450m and big spike at 575m and 625m down
- LADCP cable issue

Cast 054

Date 13/03/2025
Event number: 162
Operator: Chris
Frame: SS
Requested depth: 10m
CTD depth at bottom: 12m
Altimeter: N/A

- Media Cast

Cast 055

Date 13/03/2025
Event number: 163
Operator: Liam
Frame: SS
Requested depth: 4542m
CTD depth at bottom: 4507.6m
Altimeter: 10.5m

- Spikes in DO2 at 500m and 2000m
- Stopped CTD on downcast at 3303m due to iceberg very close to cable
- Emptied MilliQ at 2333 local time as hangar was sub-freezing

Cast 056

Date 14/03/2025
Event number: 167
Operator: Liam
Frame: SS
Requested depth: 105m
CTD depth at bottom: 107m
Altimeter: N/A

- Issues with freezing: rosette needed defrosting before cast
- CTD secondary sensors seemed a little frozen before entering water
- CTD primary sensors were frozen: had to defrost at ~40m depth for 30mins before starting cast
- DO sensors seemed to have larger than normal variation

Cast 057

Date 16/03/2025
Event number: 178
Operator: Liam
Frame: SS
Requested depth: 100m
CTD depth at bottom: 99.2m
Altimeter: N/A

- AHC ON
- Larger delta in conductivity than before freezing.
- SOMETHING scientists happy to keep sensors on.

Cast 058

Date 16/03/2025
Event number: 179
Operator: Liam
Frame: SS
Requested depth: 1967m
CTD depth at bottom: 1953.5m
Altimeter: 10.2m

- AHC ON
- Spikes on DO2 sensor
- Microkat on frame.
- Boom got stuck outboard, CTD wouldn't lock into place.

Cast 058

Date 16/03/2025
Event number: 179
Operator: Liam
Frame: SS
Requested depth: 1967m
CTD depth at bottom: 1953.5m
Altimeter: 10.2m

- AHC ON
- Spikes on DO2 sensor
- Microkat on frame.
- Boom got stuck outboard, CTD wouldn't lock into place.

Cast 059

Date 16/03/2025
Event number: 183
Operator: Chris/Liam
Frame: SS
Requested depth: 1763m
CTD depth at bottom: 1734.7m
Altimeter: 10.2m

- AHC ON
- Spikes on DO2 sensor at about 500m
- Altimeter noisy
- Bottle #7 didn't fire.

Cast 060

Date 17/03/2025
Event number: 187
Operator: Chris/Liam
Frame: SS
Requested depth: 3170m
CTD depth at bottom: 3133.7m
Altimeter: 10.5m

- AHC ON
- CTD left in water after stability check, left at 1.7m to stabilise
- Lead formed so CTD ended up 19m from seabed, paid out for niskin 3 and 4

- Altimeter noisy at set intervals.
- Boom got stuck outboard, new winch operator didn't press engage on belly box for both winch and boom.

Cast 061

Date 18/03/2025
Event number: 189
Operator: Liam
Frame: SS
Requested depth: 3587m
CTD depth at bottom: 3603m
Altimeter: 10.2m

- AHC ON
- Altimeter noisy at set intervals.
- SBE35 had no data, sample count = 0. Downloaded data points 1 – 24

Cast 062

Date 18/03/2025
Event number: 191
Operator: Chris
Frame: SS
Requested depth: 3406m
CTD depth at bottom: 3360m
Altimeter: 10m

- AHC ON

Cast 063

Date 18/03/2025
Event number: 194
Operator: Liam
Frame: SS
Requested depth: 105m
CTD depth at bottom: 104.8m
Altimeter: N/A

- AHC ON

Cast 064

Date 19/03/2025
Event number: 197
Operator: Chris
Frame: SS
Requested depth: 2113m
CTD depth at bottom: 2096m
Altimeter: 9.9m

- AHC ON
- DO2 spike at 700m on the downcast
- Temp, DO2 and conductivity graphs on the upcast changed a lot compared to the downcast between 375m – 200m but then came back in line.

Cast 065

Date 23/03/2025

Event number: 205
Operator: Liam
Frame: SS
Requested depth: 3769m
CTD depth at bottom: 3741m
Altimeter: 10m

- AHC ON
- Issue deploying CTD – out on boom for about 10 minutes

Cast 066

Date 23/03/2025
Event number: 207
Operator: Liam
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1008m
Altimeter: N/A

- AHC ON for downcast, OFF for upcast
- Delay in deployment – ship DP issue – held out on boom then recovered to deck. Restarted acquisition.
- CTD stuck out on boom during recovery – operator error.

Cast 067

Date 23/03/2025
Event number: 208
Operator: Chris
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1004m
Altimeter: N/A

- AHC OFF
- LADCP comms needed to be restarted before cast.
- Fluorescence and beam attenuation, very low – this was correct.

Cast 068

Date 23/03/2025
Event number: 211
Operator: Chris
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1006m
Altimeter: N/A

- AHC ON

Cast 069

Date 23/03/2025
Event number: 212
Operator: Liam
Frame: SS
Requested depth: 1020m
CTD depth at bottom: 1007m

Altimeter: N/A

- AHC ON

Cast 070

Date 24/03/2025
Event number: 213
Operator: Chris
Frame: SS
Requested depth: 200m
CTD depth at bottom: 213.8m
Altimeter: 10.1m

- AHC ON
- Niskin 19 leaking, changed bottom O-ring

Cast 071

Date 24/03/2025
Event number: 216
Operator: Chris
Frame: SS
Requested depth: 205m
CTD depth at bottom: 211.5m
Altimeter: 2m

- AHC ON for downcast, OFF from 20m above seabed, back ON for upcast from 11m above seabed
- Scientist requested as close as possible to the seabed
- LADCP cable button on cable wasn't push in.

Information about CTD configuration(s)

Notes About Gravity Meter

On 06/02/2025, turned on once outside of Argentinean waters. Turned OFF, on 27/03/2025.

On 16/03/2025, PC turned off for some reason, it was turned back ON and the system was running again.

Notes about Goniometer

The scientists used the Goniometer for one of the mooring recoveries and it all worked fine.

Additional work completed on cruise

A lock was put on drill drawer and keys put inside key safe.

Figure 29: Lock on drill drawer

PML Systems

pCO2 Flux

There were a number of issues with this system but it was run for the vast majority of the cruise.

On 06/02/2025, we ran through SOP and turned ON system. The SOP should included setting the UPS to output power. PML was not getting connection to the CR800 and asked to swap out the battery in the instrument. Could not find their spares, PML should order more, pulled old battery out and tested with the multimeter. Still at 3.6V and could see the comm port on Device Manager. After some fault finding the plug the CR800 was plugged into on the socket was found to be broken, the power supply cables were extended and was plugged into the bulkhead socket.

Figure 30: CR800 plugged into bulkhead

On 07/03/2025, a burning smell reported coming from the system. Found it to be coming from the pump cabinet. Turned system off and opened the cabinet, motor was still at 50C+ after 45 minutes. The Gast Vacuum pump was inspected and was found to have failed. Initially it overheated but blew the 5A fuse when trying to start it from cool. Opened to investigate rear bearing is seized so must have caused motor to overheat. Mains flex had melted/charred and was copper exposed. Reading 3 ohm across L/N. Changed mains cable but still reading same impedance and blows fuse when turned on.

Figure 31: Temperature on the outside of the enclosure (left) and the gast pump (right) after 45 minutes

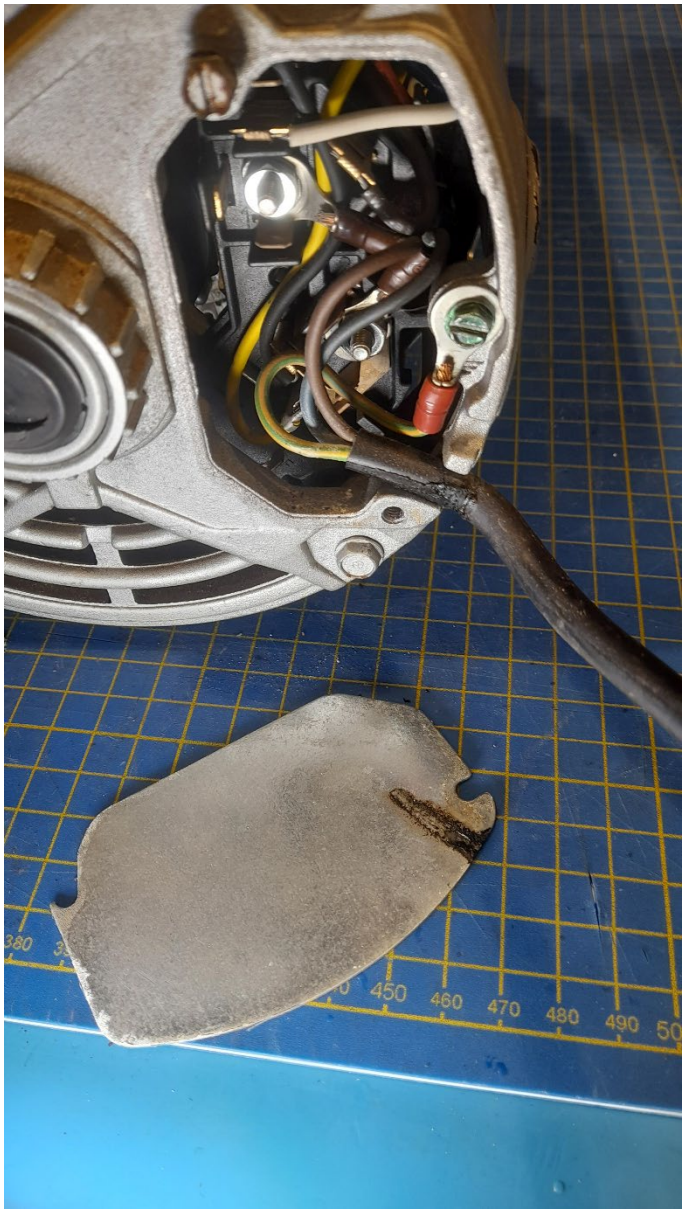

Figure 32: Melted mains flex cable on pump

The pump was replaced with the spare but we had to heat up the old motor end to get the pipe fitting out and then had to file thread with thread file to fix thread. We also made rubber mounts to replace wood chocks in cabinet and reduce vibration. Opened the cable gland at top and temporarily added a fan to keep the temperature down. The enclosure was >60°C when measured beforehand and once fans had been running for a while it was <30°C. N.B. it would be easy to fit a fan on the inside of the cabinet, at the recess where the cable gland sits.

Figure 33: Fan temporarily fitted to top cable gland of pump cabinet

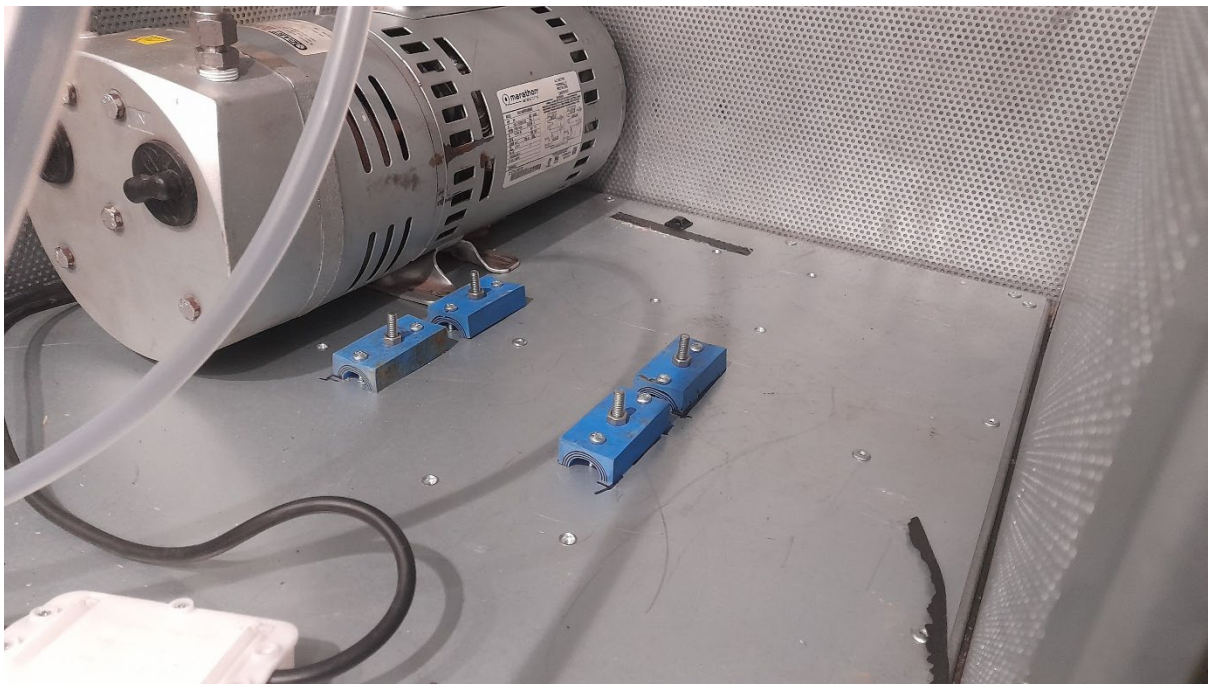

Figure 34: Rubber mounts made for vacuum pump

On 11/03/2025, we replaced the fan in the Picarro warm box.

The system was turned OFF on 27/03/2025.

pCO2 Underway

On 06/02/2025, we ran through SOP and turned ON system. The next days we had to adjust the console side gas valves. On 27/03/2025 the system was flushed with fresh water, gas supply turned OFF, PC shutdown and solenoids cleaned. We were able to remove the bio fowling from the solenoids but there was quite a bit of rust inside them.

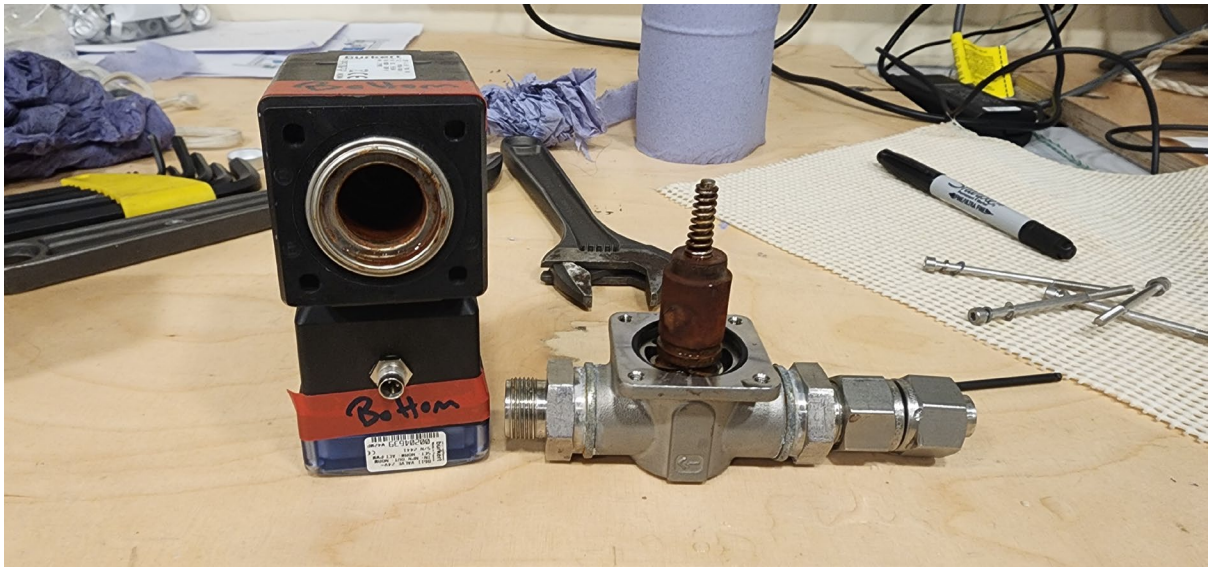

Figure 35: Bottom PCO2 solenoid before cleaning

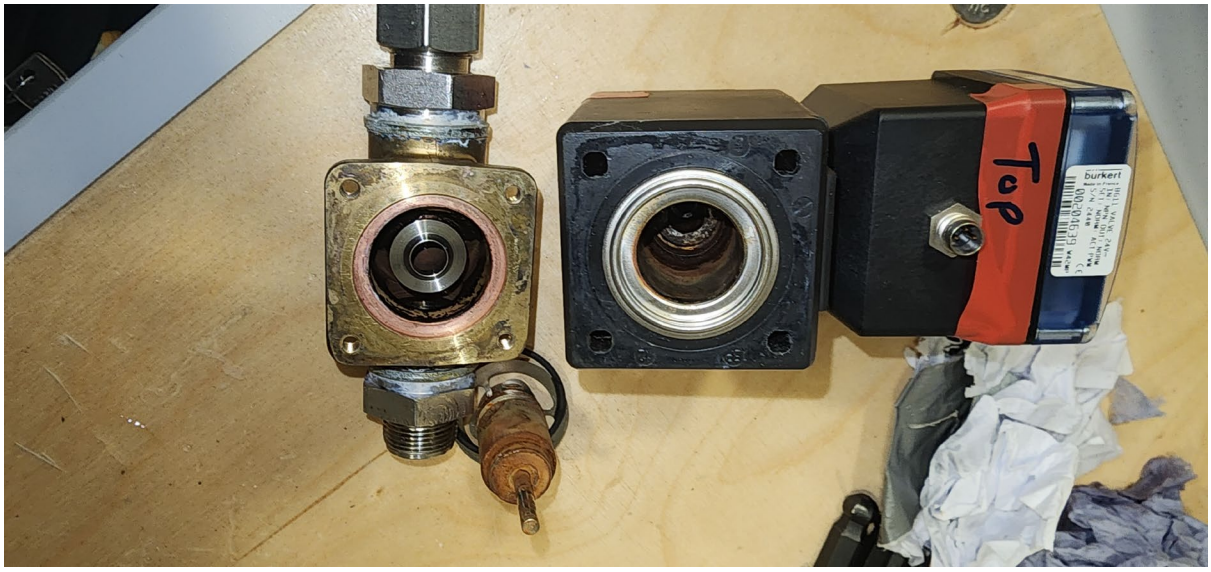

Figure 36: Top PCO2 solenoid after cleaning

POPS

On 05/02/2025 and 06/02/2025 the POPS was investigated for low sensor readings. Cleaned internal tube with air. All comms went down on 06/02/2025 at 16:30.

On 09/02/2025, we debugged the lack of comms. There was no response over network so the system was rebooted. IT could then SSH into unit, but seems hard drive is mounting then dismounting at start up. Could hear audible click of hard drive starting to spin, but then failing.

On 10/02/2025 we tried a different USB3 cable but no improvement. We arranged with IT to clone current hard drive to an SSD and will attempt to replace it. We the changed out to SSD but no immediate update on Grafana.

Some changes were made remotely by Jonathon Witherstone and the system was up and running again.

Moorings

We helped with some minor issues on the moorings throughout the cruise such as overhauling LADCP units for mooring replacement and installing batteries on mooring equipment. Looked at an issue with the TT801 acoustic release deck unit which was giving clicking noise and no signal on audio output. Possibly battery issue, plugging in charger resolved this. Think it would be worth replacing lead acid batteries in unit. Also built 3x replacement connectors for the PPS filters for P3 mooring, as barbed hose connectors were damaged during instrument set up. Used UCSW parts.

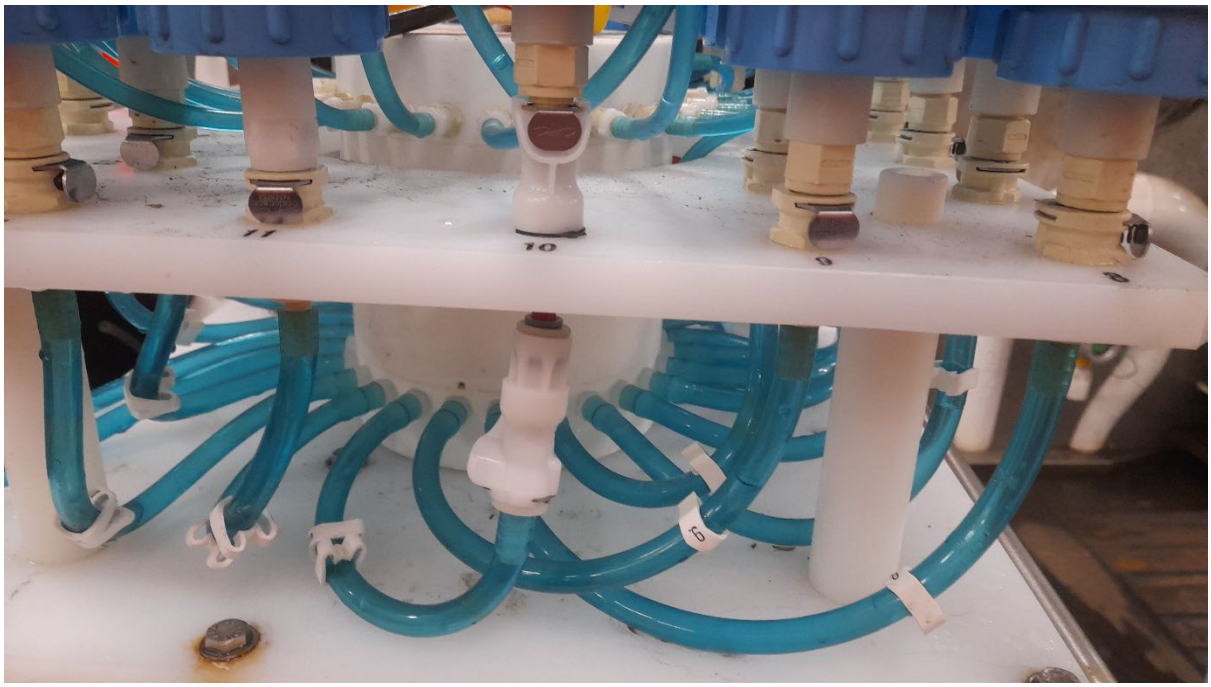

Figure 37: Makeshift PPS filter connector (middle)

Benthic Sled

We helped AME Mech with Benthic Sled camera system wiring.

iDirac

Helped scientists with set up and dismantling of iDirac system on deck 10. Moved Nitrogen bottle to gas bottle store on deck 3 at end of the cruise, and left calibration bottle with lab manager. System was packaged up for cargo flight north, with one Swagelok part (1/8” to 1/16” reducer) being left onboard to give to Rothera Met team to repair their system.

AME Department notes

Stats and Numbers

Question	Answer
How many hours of hand over with previous ships AME Engineer did you have?	N/A
Is the Field Toolkit checked and sealed? (please add items to be ordered to 4.2)	Y

The knife part number RS:132-5282 is missing from the bag

Items to be purchased

- Back end of OJB
- OJB rubber part that goes over inner cable.
- Chocolate blocks
- Molykote 44
- LADCP charging pig tail (male) or new LADCP cables.
    - This is essential as we have had to clean and solder old ones to reuse.
- ¼" barb fittings for UCSW wall. E.g. PLC2200412 from CPCWorldwide.com
- Thin wire we used for CTD SS termination.
    - Could not find ours that used to be in toolbox.
- Cable ties
    - RS233-424
- DC/DC converters – e.g. Traco
    - This is not essential but could be useful on later cruises for equipment repair
- Bolts for top of SS bullet head.
    - M8x12mm, 5mm allen key
- 5V, 1.4A USB charger for USBL wand
- Knife
    - RS132-5282
- PML should order
    - Batteries for CR800
    - 4 plug extension cable
    - 12V 0.1A 40mm fan

Department Future To-Do List

Additional notes

End of cruise Notes

SD046 Poems

Sea Fever

John Masefield

I must go down to the seas again, to the lonely sea and the sky,
And all I ask is a tall ship and a star to steer her by;
And the wheel's kick and the wind's song and the white sail's shaking,
And a grey mist on the sea's face, and a grey dawn breaking.

I must go down to the seas again, for the call of the running tide
Is a wild call and a clear call that may not be denied;
And all I ask is a windy day with the white clouds flying,
And the flung spray and the blown spume, and the sea-gulls crying.

I must go down to the seas again, to the vagrant gypsy life,
To the gull's way and the whale's way where the wind's like a whetted knife;
And all I ask is a merry yarn from a laughing fellow-rover,
And quiet sleep and a sweet dream when the long trick's over.

Road not taken

Robert Frost

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

Song for a Lonely Mooring

Guillaum Boutin

Among the waves a glow,
Alone in Neptune's flow,
Waiting to be found,
But there's no one around,
Just a research boat,
By some chance still afloat,
Why are they waiting?
Are they even looking?

If

Rudyard Kipling

If you can keep your head when all about you
  Are losing theirs and blaming it on you,
If you can trust yourself when all men doubt you,
  But make allowance for their doubting too;
If you can wait and not be tired by waiting,
  Or being lied about, don't deal in lies,
Or being hated, don't give way to hating,
  And yet don't look too good, nor talk too wise:

If you can dream—and not make dreams your master;
  If you can think—and not make thoughts your aim;
If you can meet with Triumph and Disaster
  And treat those two impostors just the same;
If you can bear to hear the truth you've spoken
  Twisted by knaves to make a trap for fools,
Or watch the things you gave your life to, broken,
  And stoop and build 'em up with worn-out tools:

If you can make one heap of all your winnings
  And risk it on one turn of pitch-and-toss,
And lose, and start again at your beginnings
  And never breathe a word about your loss;
If you can force your heart and nerve and sinew
  To serve your turn long after they are gone,
And so hold on when there is nothing in you
  Except the Will which says to them: 'Hold on!'

If you can talk with crowds and keep your virtue,
  Or walk with Kings—nor lose the common touch,
If neither foes nor loving friends can hurt you,

If all men count with you, but none too much;
If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the Earth and everything that's in it,
And—which is more—you'll be a Man, my son!

Ar Lan y Môr

Anon

Ar lan y môr mae rhosys cochion,
Ar lan y môr mae lilis gwynion,
Ar lan y môr mae ‘nghariad inne,
Yn cysgu’r nos a chodi’r bore.

Ar lan y môr mae carreg wasted,
Lle bûm yn siarad gair â’m cariad,
O amgylch hon fe dyf y lili,
Ac ambell gangen o rosmari.

Ar lan y môr mae cerrig gleision,
Ar lan y môr mae blodau’r meibion,
Ar lan y môr mae pob rinweddau,
Ar lan y môr mae nghariad innau.

Llawn yw’r môr o swnd a chegryn,
Llawn yw’r wy o wyn a melyn,
Llawn yw’r coed o ddail a blonde,
Llawn o gariad merch wyf inne.

Mor hardd yw’r haul yn codi’r bore,
Mor hardd yw’r enfys aml ei liwie,
Mor hardd yw natur ym Mehefin,
Ond harddach fyth yw wyneb Elin

To a mouse

Robert Burns

Wee, sleeket, cowran, tim'rous beastie,
O, what a panic's in thy breastie!
Thou need na start awa sae hasty,
Wi' bickerin brattle!
I wad be laith to rin an' chase thee
Wi' murd'ring pattle!

I'm truly sorry Man's dominion
Has broken Nature's social union,
An' justifies that ill opinion,
Which makes thee startle,
At me, thy poor, earth-born companion,
An' fellow-mortal!

I doubt na, whyles, but thou may thieve;
What then? poor beastie, thou maun live!
A daimen-icker in a thrave
'S a sma' request:
I'll get a blessin wi' the lave,
An' never miss 't!

Thy wee-bit housie, too, in ruin!
It's silly wa's the win's are strewin!
An' naething, now, to big a new ane,
O' foggage green!
An' bleak December's winds ensuin,
Baith snell an' keen!

Thou saw the fields laid bare an' waste,
An' weary Winter comin fast,

An’ cozie here, beneath the blast,
Thou thought to dwell,
Till crash! the cruel coulter past
Out thro’ thy cell.

That wee-bit heap o’ leaves an’ stibble
Has cost thee monie a weary nibble!
Now thou’s turn’d out, for a’ thy trouble,
But house or hald,
To thole the Winter’s sleety dribble,
An’ cranreuch cauld!

But Mousie, thou art no thy-lane,
In proving foresight may be vain:
The best laid schemes o’ Mice an’ Men
Gang aft agley,
An’ lea’e us nought but grief an’ pain,
For promis’d joy!

Still, thou art blest, compar’d wi’ me!
The present only toucheth thee:
But Och! I backward cast my e’e,
On prospects drear!
An’ forward tho’ I canna see,
I guess an’ fear!

Chunkey

Paul Muldoon

A game about which we've got next to nothing straight,
it seems to have been a mash-up of buzkashi and road bowls.
As I try to anticipate a spear-thrower trying to anticipate
the spot where the chunkey-stone rolls

to a standstill, I hear a ten thousand strong shout
go up over the abandoned chunkey-yard at Cahokia, in support,
maybe, of the idea Cahokia will win out.
Maybe we should accept our understanding must fall short

as a spear falls short of this sandstone disk
some take to represent the sun.
Maybe we should accept our grand ambitions as grandiose

and our aversion to averting risk
merely rash. Maybe we should support the idea that having won
will mean merely 'to have come close.'

My country

Dorothea Mackellar

The love of field and coppice,
Of green and shaded lanes.
Of ordered woods and gardens
Is running in your veins,
Strong love of grey-blue distance
Brown streams and soft dim skies
I know but cannot share it,
My love is otherwise.

I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.
I love her far horizons,
I love her jewel-sea,
Her beauty and her terror -
The wide brown land for me!

A stark white ring-barked forest
All tragic to the moon,
The sapphire-misted mountains,
The hot gold hush of noon.
Green tangle of the brushes,
Where lithe lianas coil,
And orchids deck the tree-tops
And ferns the warm dark soil.

Core of my heart, my country!
Her pitiless blue sky,

When sick at heart, around us,
We see the cattle die -
But then the grey clouds gather,
And we can bless again
The drumming of an army,
The steady, soaking rain.

Core of my heart, my country!
Land of the Rainbow Gold,
For flood and fire and famine,
She pays us back threefold -
Over the thirsty paddocks,
Watch, after many days,
The filmy veil of greenness
That thickens as we gaze.

An opal-hearted country,
A wilful, lavish land -
All you who have not loved her,
You will not understand -
Though earth holds many splendours,
Wherever I may die,
I know to what brown country
My homing thoughts will fly.

The imaginary iceberg

Elizabeth Bishop

We'd rather have the iceberg than the ship,
although it meant the end of travel.
Although it stood stock-still like cloudy rock
and all the sea were moving marble.
We'd rather have the iceberg than the ship;
we'd rather own this breathing plain of snow
though the ship's sails were laid upon the sea
as the snow lies undissolved upon the water.
O solemn, floating field,
are you aware an iceberg takes repose
with you, and when it wakes may pasture on your snows?

This is a scene a sailor'd give his eyes for.
The ship's ignored. The iceberg rises
and sinks again; its glassy pinnacles
correct elliptics in the sky.
This is a scene where he who treads the boards
is artlessly rhetorical. The curtain
is light enough to rise on finest ropes
that airy twists of snow provide.
The wits of these white peaks
spar with the sun. Its weight the iceberg dares
upon a shifting stage and stands and stares.

The iceberg cuts its facets from within.
Like jewelry from a grave
it saves itself perpetually and adorns
only itself, perhaps the snows
which so surprise us lying on the sea.

Good-bye, we say, good-bye, the ship steers off
where waves give in to one another's waves
and clouds run in a warmer sky.
Icebergs behoove the soul
(both being self-made from elements least visible)
to see them so: fleshed, fair, erected indivisible.

Oh, I wish I'd looked after me teeth

Pam Ayres

Oh, I wish I'd looked after me teeth,
And spotted the dangers beneath
All the toffees I chewed,
And the sweet sticky food.
Oh, I wish I'd looked after me teeth.

I wish I'd been that much more willin'
When I had more tooth there than fillin'
To give up gobstoppers,
From respect to me choppers,
And to buy something else with me shillin'.

When I think of the lollies I licked
And the liquorice allsorts I picked,
Sherbet dabs, big and little,
All that hard peanut brittle,
My conscience gets horribly pricked.

My mother, she told me no end,
'If you got a tooth, you got a friend.'
I was young then, and careless,
My toothbrush was hairless,
I never had much time to spend.

Oh I showed them the toothpaste all right,
I flashed it about late at night,
But up-and-down brushin'
And pokin' and fussin'
Didn't seem worth the time – I could bite!

If I'd known I was paving the way
To cavities, caps and decay,
The murder of fillin's,
Injections and drillin's,
I'd have thrown all me sherbet away.

So I lie in the old dentist's chair,
And I gaze up his nose in despair,
And his drill it do whine
In these molars of mine.
'Two amalgam,' he'll say, 'for in there.'

How I laughed at my mother's false teeth,
As they foamed in the waters beneath.
But now comes the reckonin'
It's me they are beckonin'
Oh, I wish I'd looked after me teeth.

Changes of climate

Naomi Replansky

Once I lived in polar night,
Burned summer fat for winter light.

When my store was nearly gone,
There came someone like Tropic sun.

I shed my clothes in so much heat
And the ice-mountains in retreat

Fled downhill over river-banks,
Sweat streaming from their white-skinned flanks.

Now, though all around I see
A fragrant moist community

Of fevered growth and sudden storm
Where insect generations swarm

And flesh is eager to divide
And fruit is roundly multiplied,

I dare not lose my Arctic skill,
My strategies against the chill:

What if the fire quit that face?
What if that sun shifted its place?

What if my clouds obscured its light?
What if I woke to daylong night?

Cold would then constrict this scene
And pinch the bud and bleach the green

And scatter those bright birds, all lost
In one shotgun blast of frost.

The giant tendrils withering,
Flesh shrinking into shivering,

Lichens and one stunted tree
Replacing this dense canopy,

And then, upon their well-worn track,
The ice-monsters lumbering back.

SD046 Song

Words written by Hans Braten (SD046 Deck Engineer)

To be sung to the tune of "The Gambler" written by Don Schlitz and most famously performed by Kenny Rogers

On a ship will with science,

Sails towards the Falklands

Going to Antarctica to study hot and cold

And on the SDA, the excitement kept on growing.

We sampled water, sampled life.

And kept them in the hold.

Chorus

You got to know how to see them,

Know how to treat them,

knowing how to sample from a bottle or a tap.

You never study your samples,

When you're standing at the Bongos

It's much easier to study them,

when you have them in the lab.

When the time is right,

And the nets are in position.

They are launched on wires down

to the ocean deep.

And when they are back on deck

All contents are collected

Sampled in a tray and studied

as they are put to sleep.

Chorus

When you want some water sampled,

you first have to collect it.

Launch the CTD

and put it to the depth you need.

Then you close the bottles

to the collected water samples

Bring them back on board the ship

For the science to proceed.

Chorus

When the work is done

You can head towards the sofas.

Or you can use a bean bag

if there is no more space

Take a drink if you like,

and get out all your gossip

Sharing is important

In every little case.

Chorus

When you are back at Cambridge

Or any other institution.

Sitting by your desk,

And looking at a laptop screen,

remember all the fun

You had on SDA,

With all the perfect colleagues

and with all the nice cuisine.