Cruise Report
RRS Discovery DY158
22 December 2022 – 29 January 2023

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Cover photo by Povl Abrahamsen

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1. Introduction

Ryan Saunders

Background

Cruise DY158 was merged from three different SMEs, which were originally supposed to be two separate cruises, one with a biological focus, and one physical oceanography (hydrography) cruise. All comprised long-term monitoring, funded through National Capability single- and multi-centre funding streams to the British Antarctic Survey (BAS) and National Oceanography Centre (NOC).

The Polar Ocean Ecosystems Time Series (POETS) Western Core Box (WCB)/Scotia Sea Open-Ocean Biological laboratoriES (SCOOBIES) work focused on monitoring the ocean and ecosystem near South Georgia using acoustic transects, biological netting, and mooring arrays with current meters and profilers, sediment traps, acoustic monitoring devices, and temperature/conductivity recorders. The physical oceanography SMEs comprised the A23 CTD/LADCP section from South Georgia to the northern Weddell Sea, and the long-term Orkney Passage Moorings. These time series formed part of the Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) programme in 2016-2022 and are now part of BIOPOLE and NC-funded long-term monitoring.

The cruise also involved research for a UKRI Future Leaders Fellowship, CUPIDO, and an MSCA Fellowship, ParaKrill. The objectives of these grant funded projects were to examine the role of mircoplastic pollution in Southern Ocean carbon flux and zooplankton physiology (CUPIDO) and investigate how parasites impact the physiology of Antarctic krill (ParaKrill). CUPIDO involved the use of floating sediment traps, moored sediment traps, depth-discrete zooplankton samplers, CTD water sampling and on-board krill and zooplankton experiments. On-board physiology experiments were undertaken for ParaKrill using krill samples collected by RMT8 nets as part of the POETS WCB survey. A CASS project to quantify the levels of methane in the atmosphere and ocean was undertaken on the cruise, which used an ultra-greenhouse gas analyser and underway water samples to measure methane levels in air and water. Additional CTD water samples were collected to quantify methane levels through the water column, and underwater acoustics were used to detect methane seepage flares in the seabed around the bays of South Georgia. A BAS Ecosystems project was also conducted on the cruise to study copepod respiration as a precursor to BIOPOLE. This project conducted on-board experiments on copepods collected by vertical ring net hauls (Bongo nets).

Cruise overview

We were fortunate that the weather was favourable enough to allow most of the planned activities to take place as planned. At the P3 station, the SCOOBIES mooring was recovered and redeployed, and samples and time-series data were recovered for all sediment traps and sensors, except the SonoVault, which appeared not to have switched on after the 2021 deployment. The floating sediment trap was deployed for 24 hours but the collecting devices were lost upon recovery due to a parted wire. An electronic fault with the MOCNESS net motor prevented its usage, but the Mammoth net and bongo nets were deployed to obtain zooplankton samples at P3. A full depth CTD was deployed at P3 and water samples were collected across the water column for various ecosystem monitoring projects.

The Western Core Box acoustic survey for krill was completed apart from 2 (from 8) CTDs and 4 (from 8) oblique RMT8 hauls that were missed due to weather or time constraints. Six RMT8 target hauls were deployed to target fish large krill swarms in the survey region. Successful EK80 and WBAT calibrations were performed in Rosita Harbour and all POETS moorings (WCB and ECB, with accompanying CTDs) were deployed as planned. A small-scale swath survey, with ADCP bottom-tracking, was undertaken to identify the optimum site for the ECB mooring prior to deployment, and 2 acoustic transects (T1 and T2) of the Eastern Core Box were undertaken. Krill and copepod experiments were executed successfully throughout the cruise. Additional krill fishing around the South Orkney Islands was also undertaken for these experiments.

Although we suffered a two-day setback avoiding bad weather, the A23 transect was completed in full, except for one station (A23-38) that was dropped due to time constraints after re-spooling the CTD wire. Stations between A23-52 and A23-44 were sampled from north to south after departing South Georgia, but stations between A23-24 and A23-43 were sampled in a northward direction after our relocation to the southernmost station on the transect. Water samples were collected for calibrations and various other projects throughout the A23 transect, together with further bongo nets for zooplankton experimental work and ecosystems studies. Three Argo floats were also deployed on the A23 transect on behalf of the Met Office.

Our passage to the M2 and M3 mooring sites was slowed by the weather and, despite two attempts, it was not possible to reach the M3 site due to ice floes in the sector. However, the M2 mooring was recovered and re-deployed successfully after dragging operations were employed to free the mooring when it failed to surface upon release. All six of the Orkney Passage moorings were recovered successfully, giving full time-series of data from the moored sensors. As planned, four (OP1, 2, 3 and 5) of the Orkney Passage moorings were redeployed for a two-year period. Before our transit to Mare Harbour, Falkland Islands, there was sufficient science time for an opportunistic survey of the A76a iceberg (~74 x 14 nmil in size) in the Scotia Sea, where we spent ~24 hours circumnavigating the berg to collect underway seawater samples to examine its physical, biogeochemical and biological impact on the oceanic environment.

Finally, the atmospheric and oceanic methane survey was completed successfully as planned, with underway air and water samples collected throughout the survey accompanied by water samples collected from across the water column at many CTD stations. Acoustic data (EM710 and EK80) and CTDs were collected in Rosita Harbour and Stromness Bay to examine sub-bottom methane flares.

Acknowledgements

Overall, this was a successful cruise, and I would like to thank those involved in planning, funding, and organising the cruise, at NERC HQ, NMF, and BAS. This cruise contributed important data to our long time-series, provided essential maintenance for important ocean-sensing infra-structure, and

generated innovative data for studying ocean ecosystem function and ocean-atmosphere dynamics in the Southern Ocean. I would especially like to thank all on board, crew and science party, for their dedication and efforts to completing the science objectives. The successful outcomes of this cruise are a result of everyone's enthusiasm, contributions and hard work.

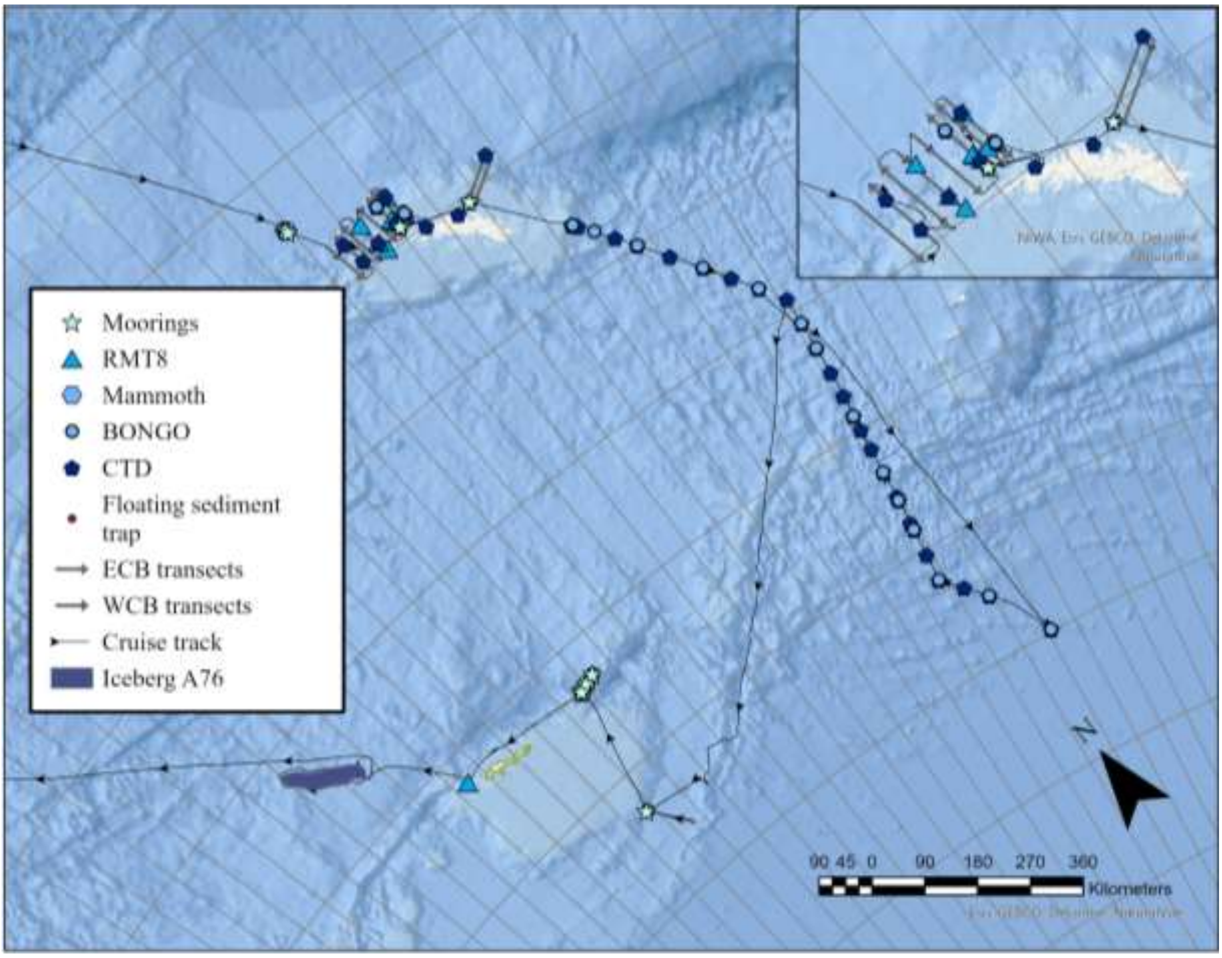

Figure 1. Overview of the cruise track and stations occupied on DY158.

2. Cruise personnel

Science party

Ryan Saunders, PSO (BAS)
Povl Abrahamsen (BAS)
Geraint Tarling (BAS)
Mike Meredith (BAS)
Gabrielle Stowasser (BAS)
Clara Manno (BAS)
Jack Leung (BAS)
Tom Gillum-Webb (BAS)
Emily Rowlands (BAS)
Alison Cleary (BAS)
Angelika Slomska (University Gdansk)
Nadine Johnston (BAS)
Tracey Dornan (BAS)
Sarah Manthorpe (BAS)
Philippa Birchenall (University Hull)
Evelyn Workman (BAS)
Laura Taylor (BAS)
Christopher Auckland (BAS)
Jonathan Rosser (BAS)
Stephen Coreless (NMF)
Andrew Moore (NMF)
Dougal Mountifield (NMF)
Paul Henderson (NMF)
Daniel Phillips (NMF)
Jon Short (NMF)

Figure 2. The DY158 science party in front of A76a. Left to right (back row): Geraint, Sarah, Pip, Gabi, Ryan, Daniel, Laura, Nadine, Tom, Paul, Povl. Left to right (front row): Clara, Emily, Angelika, Jack, Tracey, Evelyn, Chris, Jon, Dougal, Alison and Mike.

Officers and crew

Antonio Gatti, Master
John Ovenden, Chief Officer
Collin Leggett, 2nd Officer
Jordan Greenhow, 3rd Officer
James Bills, Chief Engineer
Christopher Kemp, 2nd Engineer
Marc Smith, 3rd Engineer
Elliot Daper, 3rd Engineer
Benjamin Heer, ETO
Valerija Forbes-Simpson, Purser
James Jewell, Medic
Craig Lapsley, CPOS
Andrew MacClean, CPOD
Marshall MacKinnon, POD
Craig Gilfillan, POS
Gary Crabb, SG1a
Collin McMaster, SG1a
Kevin Riley, SG1a
Glyndor Henry, ERPO
Mark Ashfield, Head Chef
Charlotte Ray, Chef
Ashleigh Lipson, Steward
Anthony Drake, Asst. Steward

3. Cruise narrative

Ryan Saunders

Mon 19 Dec: Majority of science party departed Heathrow for Montevideo via Sao Paulo at 2100 hrs. However, Clara was absent from the main travelling party due to an issue with miscommunication of her BASMU medical clearance, and Alison travelled independently from Tasmania via the USA.
Tue 20 Dec: Flight landed in San Paulo on time (0730), and we had a 10-hr layover at the airport until transferring to Montevideo at 1430. Arrived on Discovery around 2000 and all participants had negative lateral flow tests upon embarkation. Clara departed Heathrow to join the ship via Sao Paulo. A scientist received antibiotics from the ships medical team for a dental issue.
Wed 21 Dec: Safety briefing and mobilisation. Tom went for a medical due to delayed communication of his BASMU status. Scientists from the Uruguay Antarctic Institute visited the Discovery and were given a 2-hr tour of the ship. Clara arrived on Discovery around 2000. Science team evening social in Montevideo.
Thu 22 Dec: Mobilisation and securing for sea continues. Departed Montevideo harbour at 1300 (1600 GMT) heading towards P3.
Fri 23 Dec: Continued steaming towards P3. Lifeboat muster drill at 1030 (0730 GMT). Preparations for CTD, MOCNESS and RMT8 test deployments in Argentine Basin. Science introduction meeting at 1300 (1200 GMT). Cleared EEZ at 1830 (1530 GMT) and underway data collection commenced. Communications issues with MOCNESS.
Sat 24 Dec: Arrived at test station (41° 36.981’S, 54° 44.152’W) at 0830 (1130 GMT). CTD deployed successfully (EV1) to 2000 m at 1210 GMT. Heave compensation test undertaken following ship refit. Bongo net deployed successfully to 200 m at 1256 GMT (EV2), although the cod end release valve was not tight on one net leading to some sample loss. Salps and copepods taken for experimental work. RMT8 deployed to 50 m at 1708 GMT (EV3). Net 2 failed to open. Floating sediment trap release mechanism tested at 1841 GMT (EV4). Unable to test MOCNESS due to an electronic issue with the release motor. Departed for P3 at 1911 GMT. Turned off 150 kHz ADCP to improve EK80 data at 2207 GMT. Christmas carols with a live band (Geraint on accordion, Povl on keys and Jon on guitar) in the bar.
Sun 25 Dec: Continued steaming to P3. Issues with MOCNESS are terminal for this cruise, so the Mammoth net is to be assembled as a backup. Outstanding Christmas dinner on-board, with secret Santa, quiz and games in the evening.
Mon 26 Dec: RMT8 test station (-46.485, -45.876) at 1338 GMT (EV5). Net deployed to 200 m, targeting a scattering layer at ~70 m. RMT8 deployment successful. Continued steaming to P3 at 1452 GMT. Mammoth net and sediment trap set up. BBQ on the aft deck. Many whales around in the distance.
Tue 27 Dec: Continued steaming to P3 at 9-10 knots. Swell and wind prohibited Mammoth net test. Safety drills undertaken at 1300 GMT. Bongo net moved around on deck during the night due to no lashings, but no damage incurred.
Wed 28 Dec: P3 station: Heavy swells prevailed upon arrival at P3 (~1000 GMT). P3 mooring located at ~1300 GMT, hove-two for weather and sea state improvement before mooring release and recovery. P3 mooring (EV6) recovered successfully at 1905 GMT. Data downloaded successfully from the ADCP and Microcats, and sediment trap bottles contained samples on both systems. However, the Sono Vault did not record any data during the previous deployment. Data were obtained from the Sea Guards, but there was an issue with the software which prevented an evaluation of quality. Floating sediment trap deployed at 2116 GMT (EV7). Full depth CTD P3-1 deployed at 2311 GMT (EV8). Bongo net deployed at 0009 GMT (EV9) and 0034 GMT (EV10). CTD P3-2 deployed at 0411 GMT (EV11).
Thu 29 Dec: P3 station: Successful Mammoth net test deployment at 1353 GMT (EV12), but only after much time trying figure out how to deploy it over the side. Floating sediment trap located roughly 5 NM southwest of our position at 1400 GMT. Relocated 4.5 nmil for P3 mooring deployment run-up.

P3 mooring top float deployed at 1730 GMT at ~52° 51.308'S, 40° 05.175'W (EV13), with the anchor released at ~52° 48.322'S, 40° 06.944'W at 2003 GMT. Floating sediment trap located, but the stainless-steel sample collection units were lost upon recovery (due to a parted wire) and only the surface float was recovered (2149 GMT). Mammoth net deployed to 1050 m at 2318 (EV14). Triangulation of P3 mooring at 0223 to 0352 GMT. Departed for WCB 1.1N immediately after triangulation.

Fri 30 Dec: WCB: Arrived at WCB 1.1N at 0803 GMT and started the first acoustic transect (EV15). Weather deteriorated during the afternoon whilst steaming north on transect 1.2, but still we still logged data at ~7 knots albeit with some drop-out. Completed transect 1.2 at ~2000 GMT and relocated to station 1.2N to assess weather conditions for CTD and RMT8 deployment. No RMT8 nets possible. CTD1.2N deployed at 2230 GMT (EV17). CTD1.2S deployed at 0444 GMT (EV18). Repositioned to start point of WCB 2.1S with weather improving.

Sat 31 Dec: WCB: First sight of South Georgia in the distance during the morning. Started WCB 2.1 acoustic transect at 0804 GMT (EV19), steaming at ~9 knots. Started WCB 2.2 transect at 1427 GMT (EV20). Relatively small krill swarms observed at ~200 m along the shelf whilst steaming back inshore. Target fished on a krill swarm at 2008 (EV21), but netting operations required team refinements and the target was missed. Net contained a few icefish and mysids. Oblique RMT8 haul at 2.2S deployed at 2306 GMT (EV22). CTD 2.2S deployed at 0140 (EV23). Ringing of the ships bell and Prosecco at midnight local time to see in the New Year.

Sun 1 Jan: WCB: Deployed RMT8 at 2.2N for oblique haul at 0540 GMT (EV24). Started acoustic transect WCB 3.1 at 0911 GMT heading south (EV25). Large ~2 km krill swarm and whale blows observed on-shelf during approach to WCB mooring location. Acoustic transect WCB 3.2 started at 1509 GMT (EV26). CTD 3.2N deployed at 2111 GMT (EV27), with bongo nets deployed at 2125 (EV28) and 2150 GMT (EV29). Relocated shoreward towards the start of transect 3.2 to search for krill swarms.

Mon 2 Jan: WCB: RMT8 was deployed at 0123 GMT (EV30) to target fish a large krill swarm in the surface layer. Around 11 kg of krill was caught, and the on-board experimental work got underway. A neighbouring krill layer was also successfully fished at 0222 GMT (EV31), with catch of around 15 kg. We relocated to station 4.2S and the CTD was deployed at 0508 GMT (EV 32), with the weather deteriorating rapidly. Acoustic transect 4.1 commenced at 0805 (EV33) with reduced transit speed and regular drop out in the acoustics in the morning sections due to the weather. Acoustic transect 4.2 started at 1450 GMT (EV34). RMT8 lost communications during deck test, but later fixed by a re-termination of the fibre optics. WCB acoustic transects completed at 1918 GMT. CTD deployed at 4.2N at 2345 (EV35). Scientist sustained a cut on the shin after tripping whilst passing through the door seal to the deck lab. Scientist was OK after the cut was cleaned and glued.

Tue 3 Jan: WCB: Oblique RMT8 deployed at 4.2N (EV36) at 0138 GMT. Relocated to 3.2S for a CTD at 0602 (EV37). Remained on site for the biological team to switch watches for daytime netting operations. ADCP line survey started at 1139 GMT (EV38). Issue with the aft-starboard crane prevented bongo net deployments at 3.2S. Oblique RMT8 net (EV39) deployed at 1710 GMT and recovered successfully with live krill for experiments. Relocated east steaming along the 100-300 m depth contour across to assess marked positions of krill swarms for target fishing (towards end of 4.1 and 4.2 transects). RMT8 deployed at 1901 GMT to catch a large krill swarm (EV40), with krill caught in good condition. Many whales and seals observed in this area, coinciding with the large amount krill in the area. Another successful RMT8 target-haul deployed at 2101 after a short search (1.5 NM) westwards for a new discrete krill swarm (EV41). Final RMT8 target haul deployed at 2224 (EV42) on a third krill swarm ~2 NM westward of last haul. Successful haul containing live krill. This year seems to be a good krill year. Relocated to station 4.2S for a bongo net now that the aft crane was repaired. Delays to bongo netting due to a winch problem. Bongo net deployed at 4.2S (EV43), but winch problems resulted in abandonment of the deployment.

Wed 4 Jan: Rosita Harbour calibration

Bongo nets deployed successfully at 4.2S at 0136 and 020 GMT (EV44 and EV45, respectively) after crane repair. Steamed towards Rosita Harbour for acoustic calibration and methane flares investigations. Sub-surface gas flare observed on passage with EK80 at ~0514 GMT (53° 52.5700'S, 37° 25.53'W, 200 m depth). Whilst on DP at the entrance to Rosita Harbour, marine mammal observations were undertaken on the bridge from 0700 to 0800 GMT prior to the EM710 methane survey. Fur seals observed fairly regularly, which is common for the area during summer, but no cetaceans were seen. EM710 therefore switched on in low power mode at 0800 GMT and we commenced into Rosita Harbour logging data for detecting methane flares. Three potential flares observed on the 18 kHz EK80. A CTD was deployed 0955 GMT (EV46) and the EK80 calibration occurred between 1122 and 2057 GMT (EV47). Conditions were perfect for calibration and good results were obtained for all frequencies, except the 333 kHz which was not attempted. Beautiful day and scenery in Rosita Harbour. Calibration of WBAT 1 commenced at 2136 GMT (EV48).

Thu 5 Jan: WCB mooring and Stromness methane survey

Calibration of WBAT 2 commenced at 0139 GMT (EV49). Remained on station in Rosita Harbour for the night, departing at 0800 GMT back to the WCB region. WCB mooring successfully deployed at 1302 GMT (-53.792, -37.394; EV50). CTD deployed at 1347 GMT (EV51). Bongo nets deployed at 1514 GMT (EV52) and 1532 (EV53). Relocated to Stromness Bay for the CASS acoustic methane survey. Entered Stromness Bay around 2100 GMT. Very few flare-like targets observed in either Stromness Bay or Husvik Bay. CTD deployed on the most plausible of the detected candidates at 2330 (EV55). Departed Stromness at 0100 GMT to undertake a swath survey of the proposed ECB mooring site.

Fri 6 Jan: ECB mooring and acoustic transects

EM710 swath survey (with concurrent ADCP bottom-tracking) of the proposed ECB mooring site occurred between 0243 and 0745 GMT (EV56). A suitable site in the ECB survey region (~ 1 NM east of the start point of acoustic transect 1) was determined for the mooring in ~274 m water depth. The ECB was deployed at 0927 GMT at -54.1034, -36.2467 (EV57). We then relocated to undertake acoustic transect E1.1 (EV58) at 0948, with a CTD station at the end of transect E1.1N (EV59; 1443 GMT). No bongo nets were deployed due to high winds. Acoustic transect E1.2 (EV60) commenced at 1658 GMT, The ECB mooring CTD was deployed at 2311 GMT (EV61), before steaming further east to the A23 transect, as a port call at KEP was not possible due to an outbreak of a virus on the base.

Sat 7 Jan: A23 transect

Arrived at the start of the A23 transect and CTD A23-52 (EV62) deployed at 0951 GMT. CTD A23-51A (EV63) deployed at 1144 GMT, with bongo nets at 1153 GMT (EV64) and 1220 (EV65) GMT. A humpback whale was observed close to the ship during this deployment. CTD A23-51 deployed at 1411 GMT (EV66) and CTD A23-50A (EV67) deployed shortly after at 1626 GMT. CTD A23-50 at 2025 GMT (EV68), with a bongo net (EV69 at 2158). During the night, CTD A23-49 at 0114 GMT (EV70).

Sun 8 Jan: A23 transect

CTD A23-48 (EV71) 0726 GMT, with bongo nets at 0919 GMT (EV72) and 0946 GMT (EV73). We are now roughly at the halfway point in terms of science time and still on schedule, although poor weather is forecast for the 10-11th Jan. M3 mooring still seems to be covered by ice at this stage. CTD A23-47 (EV74) deployed at 1336 GMT and CTD A23-46 (EV75) at 2008 GMT. A bongo net was deployed at 2205 GMT (EV76).

Mon 9 Jan: A23 transect

Two more CTDs were deployed before breaking off to avoid incoming weather: CTD A23-45 (EV77) at 0152 GMT and CTD A23-44 (EV78) at 0802 GMT. A bongo net was deployed at the latter station at 0905 GMT (EV79), but a second deployment was cancelled to reduce the chances of net loss with wind speeds increasing. We broke off from the A23 transect to steam (~396 NM: 1.8 days) south to the southernmost CTD station (A23-24) at 1121 GMT, the strategy being to sample the A23 transect from south to north to avoid bad weather which was forecast for the 10th and 11th Jan (10 m swells, +40 knot winds predicted). We expect to lose around 2 days of science time, but our schedule can currently accommodate this.

Tues 10 Jan: A23 transect

Steaming to CTD station A23-24 and making good progress at ~9-10 knots. Weather conditions presently good. Pub quiz night in the bar.

Wed 11 Jan: A23 transect

Arrived on station at 0600 GMT and CTD A23-24 deployed at 0606 GMT (EV80), with a bongo net at 0906 GMT (EV81). Weather conditions remain good. Argo float deployed at -63.964206, -28.876089 at 1039 GMT (EV82). Steamed north and deployed the CTD at A23-25 (EV83; 1520 GMT) and A23-26 (EV84; 2154 GMT), with a bongo net at A23-26 (EV85; 2245 GMT). Issues with ADCP bottom track apparent.

Thu 12 Jan: A23 transect

Further CTDs were deployed at A23-27 (EV86; 0411 GMT), A23-28 (EV87; 1103 GMT, with bongo nets EV88 and EV89), and A23-29 (EV90; 1753 GMT). Samples of appendicularians were collected from the bong nets at A23-28 for experimental work.

Fri 13 Jan: A23 transect

CTD deployed at A23-30 (EV91; 0050 GMT), with one bongo net (EV92; 0109 GMT) and an Argo float deployed during departure (EV93; 0333 GMT). A23-31 CTD deployed at 0448 GMT (EV94). A23-32 CTD deployed at 1034 GMT (EV95), with two bongo nets at this station (EV96 and EV97 deployed at 1105 and 1127, respectively). A23-33 CTD deployed at 1448 GMT (EV98) and A23-34 CTD at 2026 GMT (EV99). Bongo net at A23-34 (EV100; 2109 GMT).

Sat 14 Jan: A23 transect

A23-35 CTD deployed at 0121 GMT (EV101), A23-36 CTD at 0632 (EV102), and A23-37 CTD at 1130 GMT (EV103). Winds too high for bongo nets. Amazing scenes of 5 humpbacks circling within a few meters of the ship for ~3 hrs during the CTD deployment at A23-37. A few chinstraps also contributed to the spectacle. However, our progress delayed at A23-37, as re-spooling of the CTD wire on the winch drum was necessary upon CTD recovery (1717 GMT). Winds dropped sufficiently for 2 bongo net deployments during this operation (EV104 at 1726 GMT and EV105 at 1750 GMT). Due to the time loss, CTD station A23-38 was skipped, and we steamed directly to A23-39 where the CTD was deployed at 2315 GMT (EV106), along with a bongo net (EV107; 0004 GMT).

Sun 15 Jan: A23 transect

Last day of the A23 transect. CTD deployed at A23-40 at 0525 GMT (EV108). CTD deployed at A23-41 at 1144 GMT (EV109), with 2 bongo nets (EV110 and EV111 at 1159 and 1225 GMT, respectively). The final Argo float was deployed upon departure from A23-41 (EV112; 1510 GMT). CTD A23-42 deployed 1802 GMT (EV113), with a bongo net (EV114; 2035 GMT). A23 transect completed at A23-43, where the CTD was deployed at 0009 GMT (EV115). M3 site is now ice free and there is a slight strategic advantage to moving to the M3 and M2 moorings to avoid upcoming weather conditions at the Orkney Passage site. We therefore departed back south towards the M3 mooring site at 0335 GMT (estimated 2 day passage time) with the weather freshening for our passage.

Mon 16 Jan: transit to M3 and M2

Our progress slowed during the morning due to swell and winds, but our speed increased from late afternoon as conditions improved. Arrival at M3 is estimated to be Wednesday evening at best. Today we had a meeting to discuss the mooring operations and a general science meeting in the evening. Movie night viewing of The Thing in the main lab.

Tue 17 Jan: transit to M3 and M2

Still transiting and making good progress now that the weather conditions have improved. Arrival at M3 is estimated Wednesday lunchtime at best. There were lots of icebergs and bits of sea ice around for pleasant viewing. Security safety drill held.

Wed 18 Jan: M3 and M2 moorings

Slow progress on approach to M3 mooring site due to relatively high sea ice in the sector. We diverted to the M2 site at 1204 GMT (~41 NM from M3 site) as ice concentrations were too dense for the Discovery’s on passage to M3. We arrived at M2 with sufficient time for recovery. The mooring releases communicated with the on-board deck box, and when triggered, they signaled that the release mechanism had operated. However, the mooring was not released (no decrease in range detected). A decision was made to steam back towards the M3 mooring to assess the possibility of a track through the ice from the northwest for its recovery (departure at 2205 GMT).

Thu 19 Jan: M3 and M2 moorings

Again, a passage to the M3 mooring was impossible for the Discovery, so we returned back to M2 (broke off back to M2 at ~0330 GMT) and prepared the dragging gear to try to recover M2 mooring. Dragging gear set up by ~1300 GMT after an early start (0645 GMT) and dragging commenced shortly after at 1404 GMT (EV116). M2 mooring successfully recovered at 2326 GMT.

Fri 20 Jan: M3 and M2 moorings

Overnight CTD at M2 (EV117; 0123 GMT), with 2 bongo nets deployed (EV118 at 0138 GMT and EV 119 at 0202 GMT). M2 mooring redeployed successfully at 1047 GMT (EV120,) followed by trilateration and ranging before steaming to Orkney Passage (OP1).

Sat 21 Jan: Orkney Passage moorings

Arrived at OP1 station at 0123 GMT and the CTD was deployed (EV121) immediately, followed by 2 bongo nets (0139 GMT; EV122 and 0204 GMT; EV123). We relocated to OP3 and deployed the CTD at 0528 GMT (EV124). The OP1 mooring was released successfully at 0818 GMT and was recovered at 1052 GMT (EV125). We then relocated to OP2 and released the mooring at 1142 GMT (EV126), which was successfully recovered at 1352 GMT. Relocated to OP4 where the mooring was released and successfully recovered at 1741 GMT (EV127). We then moved to OP6 and released and recovered the mooring at 2010 GMT (EV128). We stayed overnight at OP6 to undertake CTDs and bongo nets. There was an issue with CTD mounted ADCP caused by water ingress, so it was removed for repair at this station. The CTD was deployed at 2149 GMT (EV129), with bongo nets at 2210 GMT (EV130) and 2231 GMT (EV131)

Sun 22 Jan: Orkney Passage moorings

Relocated to OP4 where the CTD was deployed at 0106 GMT (EV132). CTD was then deployed at OP5 (EV133) at 0459 GMT. OP5 mooring was released and recovered successfully at 1229 GMT (EV134). We then successfully recovered the OP3 mooring (EV135) at 1500 GMT and deployed a replacement at 1738 GMT (EV136). A make-shift version of the floating sediment trap was deployed upon arrival at OP2 (EV137) at 1904 GMT. CTD (EV138; 1927 GMT) and bongo nets (EV139 and EV140; 1938 and 1958, respectively deployed at OP2. Many of the science team volunteered for biofouling maintenance duties and glass sphere inspections today to help turn around the moorings. In the evening we relocated to a station between OPCTD 8 and 9 and deployed the CTD at 2303 GMT (EV141).

Mon 23 Jan: Orkney Passage moorings

We moved to a station between OPCTD 11 and 12 and then deployed the CTD (EV142; 0228 GMT). Although the weather had picked up (30 kt winds), the OP1 mooring was redeployed successfully at 1131 GMT (EV143). The OP2 mooring was redeployed 1427 GMT (EV144), followed by the OP5 mooring at 1706 GMT (EV145) after relocating. Weather conditions improved in the afternoon and the floating sediment trap was located at -60.61, -42.00 (1744 GMT) and subsequently recovered, but the collection bottles were again lost. Trilateration of the OP occurred between 1825 and 2204 GMT. The CTD was deployed at station OPCTD4 (EV147, 2228 GMT), with 2 bongo nets (EV148 and EV149) to complete the scheduled cruise program. We subsequently departed for the South Orkney region to search for krill for target fishing.

Tue 24 Jan: South Orkney krill fishing

We steamed west along the shelf break of the South Orkneys searching for krill for RMT8 netting. At 1110 GMT, several fishing vessels (Saga Sea, Antarctic Sea, Antarctic Endeavour and Antarctic Endurance) were observed krill fishing in the region around 60° 25.15'S, 45° 10.08'W where large krill swarms were observed consistently between 65 and 120 m depth. We stopped briefly in the region with the intention to fish, but we had to move on to avoid overlap with the fishing vessels, particularly given the relatively poor visibility. After steaming further to the northwest of Coronation Island, we targeted a krill swarm at -60.440, -46.545 (~30 m depth in a canyon) and caught sufficient live krill for experimental work (EV150; 1626 GMT). Three krill fishing boats were operating in our proximity (two Chinese registered). Departed to A76a iceberg at 1731 GMT to undertake a survey.

Wed 25 Jan: A76a survey

We arrived at A76a at ~0300 GMT and commenced collecting underway seawater samples. Amazing views of A76a in the morning once the fog lifted temporarily. Due to prevailing north-easterly winds, we circumnavigated A76a entirely in a clockwise direction starting from the bottom southeast tip. The circumnavigation was completed in approximately 24 hours steaming at a distance of around 400 m from the berg and at speeds between 5 and 10 knots. A traditional Burn's night supper was served with the ode to the haggis performed by Craig against a backdrop of bagpipe music.

Thu 26 Jan: Transit to Mare Harbour

The DY158 science programme was completed around 0300 GMT and we departed for Mare Harbour. Transit and start of demobilisation of lab and work areas.

Fri 27 Jan: Transit to Mare Harbour

Continued steaming to Mare Harbour and packing. End of krill experiment work. On-board post cruise safety meeting/debrief. Tour of the Engine room and Discovery themed quiz night. Report to hazcom after ADCP battery fell from a shelf and bruised a scientist's leg.

Sat 28 Jan: Transit to Mare Harbour

Approaching Falkland Islands at good speed. Sample packing and storage. At anchor around Lively Island. Lifeboat and small boat launches for safety compliance testing.

Sun 29 Jan: Arrive Mare Harbour

Pilot pickup at ~1200 GMT to enter Mare Harbour and tie up alongside. Final container packing and lab cleaning. End of DY158.

4. AME Mechanical Cruise Report – Science Equipment

Tom Gillum-Web, Jack Leung

RMT8

Setup

RMT8 was already assembled from the previous cruise. Hardware was checked and tightened / secured where necessary. Overall, in good, usable condition.

Cross stand was braced with threaded bar as it was starting to become unstable.

Stations

8 deployments, 8 successful. Full information of deployment techniques and data collected is found in the Macrozooplankton section.

Post-cruise tasks

- Cross stands needs rejuvenating if not replaced with new wood sides.
- Locate cod end safety pins which are less likely to catch on net, this caused a fair amount of hassle when recovering the nets on deck

DWNM

Setup

System was already set up from previous cruise DY159.
The current fibre splice on the fish end had expired and was re-spliced.

Out of the 3 times the deep tow cable had to be re-routed through the block (for mooring work), twice the splice broke. Once as it was going over the block it got snagged, 2nd time a crewmember removed the protective hose by accident while trying to reach the termination.
Each time a new splice was required.

Post-cruise tasks

We found the most success with repeatable splicing with no water ingress to the OFJB was to mount the box to the cross and attach the deep tow cable. Guide the inner core through the ribs of the cross and install the core through the cable gland and tighten. Only then did we splice the fibre. Doing it this way prevents the cable twisting within the gland, destroying the seal and potentially severing the splice.

MOCNESS

Setup

MOCNESS was assembled on deck with nets and sensors. The pigtail from the termination (from previous cruise) was not long enough to reach from the towing bridles to the MOCNESS fish / sensors. Discussion with crew to re-terminate the wire with enough reach to allow MOCNESS fishing revealed it would take up to 24hr, which would impact the planned RMT 8 fishing. The decision was made to retire MOCNESS to prevent time loss for RMT 8. The Mammoth was used in lieu.

Post-cruise tasks

During testing, the modified fish for MOCNESS would not fire the MOCNESS motor. A test cable was made up to control the MOCNESS using pins 1 & 2 (usually reserved for RMT) successfully. To be investigated by electronic engineers.

Bongo

Setup

Opening / closing bongo was already assembled. This was modified to have standard bongo cod-end holder instead.
During deployments one of the taps on cod-end was drilled and retapped as the handle was slipping, making it hard to visually tell if the valve was closed ready for deployment.

5. SCOOBIES and POETS moorings

Clara Manno, Gabriele Stowasser, Tracey Dornan, Jack Leung and Jennifer Jackson

The SCOOBIES (SCotia sea Open-Ocean BIological laboratoriES) are situated in the northern Scotia Sea to investigate the biological and biogeochemical influence of the largest persistent phytoplankton bloom in the Southern Ocean. SCOOBIES primary purpose is to consider the flux of carbon to deep ocean layers as well as monitoring ocean chemistry parameters, particular in relation to ocean acidification. Relative to its size, the Southern Ocean sequesters a disproportionate amount of anthropogenic carbon to the deep ocean. Moorings are equipped to measure the amount of carbon reaching the deep ocean. This is the end-point to a long chain of events which starts with carbon entering the surface layers and being fixed by photosynthetic plankton. These organisms die or are eaten and some of the carbon they contain eventually sinks into the deeper layers, leading to its removal from the biosphere. The P3 mooring site has been occupied since 2006 with a buoy situated at 200m below sea level and a variety of sensors and sediment traps. CTD, water and net sampling are also completed to compliment the year-round observations.

The POETS (Polar Ocean Ecosystem Time Series South Georgia Krill Observatory) moorings comprises the Western Core Box (WCB) mooring and the Eastern Core Box (ECB) mooring that are deployed to the northwest and northeast of South Georgia, respectively, to collect acoustic and environmental data to monitor within-year variation of krill abundance. These moorings support the long-term POETS WCB program that uses ship-based acoustics surveys to monitor local krill biomass and ecosystem variation at South Georgia. The WCB mooring program has been ongoing since 2002. The ECB mooring was deployed for the first time during DY158.

Mooring deployment and recovery

P3 mooring

P3 mooring was recovered on 28/12/2022. It responded quickly to the acoustic release pings, and surfaced above its as deployed location. It was found that the VHF Combo beacon installed did not have a pressure activated switch, so it had depleted its battery likely within a week or 2 of deployment. No spares were available, so it was deployed without a VHF / Strobe.

The SAMI-PH sensor was successfully recovered, and no sign of corrosion or damage were observed. Data acquisition ran through the whole year. All the bottles were successfully recovered in sediment traps (1000 m and 2000 m). Bottles were packed into vermiculate boxes for storage at +4°C for analysis in Cambridge. The pH of the solution in each bottle was measured and was ranging between 8.00-8.01. This pH value in the sediment collected from the traps confirmed that the buffer solution was working well, and the samples will be suitable for further Ocean Acidification study. Only the deep sediment trap was redeployed. Bottles in the Deep sediment trap were programmed to rotate each 15-30 days as for the previous year. No data were collected from the SonoVault. The instrument appeared not to have switched on during the previous set-up/deployment and all memory cards were blank.

P3 was re-deployed on 29/12/2022 in accordance with the attached schematic, minus the VHF strobe and PH sensor, which is being sent to the manufacturer for maintenance and calibration. 1 of the 2 moored sediment traps recovered was not re-deployed. (Deep trap, 2000 deployed). OPIC (Ocean Plastic Incubator Chamber) was deployed for the first time (see CUPIDO project section for details)

Deployed Location: 52° 51.3' S 40° 05.2' W

Work Carried Out on redeployed instruments:

Acoustic Releases: 93 + 2060

- □ New Batteries
- □ Tested
- □ New Dropping Bar
- □ Clean and lubricate O-rings
- □ Installed new design linking bars

Iridium Beacon: IMEI: 300434060651120, Serial no: M015U5

- □ New Batteries
- □ Clean and lubricate O-rings
- □ Turn on before deployment

Argos Beacon: SN 280, ID: 60210

- □ New Batteries
- □ Clean and lubricate O-rings
- □ Tested
- □ Turn on before deployment

ADCP Serial Number: 15548, WHS 300-I-UG164

- □ Download Data:
- □ L:\scientific_work_areas\Mooring Work\P3\data
- □ New Batteries
- □ Check and lubricate O-rings
- □ Set Up instrument for redeployment
- □ Erase Data
- □ Start WinSC for set-up of instrument
- □ Set up instrument:
- ⍰ Number of bins:25(1-128)
- ⍰ Bin Size (m) :8 (0.2-16)
- ⍰ Pings per ensemble: 10
- ⍰ Interval: 15 min
- ⍰ Duration: 550 days
- ⍰ Transducer depth: 200 m
- ⍰ Save deployment settings
- ⍰ Start Time: xx.xx.xx. 00.00.00 – Start after deployment
- ⍰ Set up ADCP real time clock to PC clock
- ⍰ Don't verify the compass
- ⍰ Run pre-deployment test to check instrument

CTD on main buoy SN: 37-11807

- □ Download Data: L:\scientific_work_areas\Mooring Work\P3\data
- □ New Batteries
- □ Clean and lubricate O-rings
- □ Set up instrument for re-deployment
- □ Set real time clock to PC clock (p.28)
- □ Check instrument is ok and is set up properly by using "DS" command (p.27)
- □ Set up instrument for "autonomous sampling" following instructions on page 24. Started

CTD 37 SMP 43742: 4548 below lower Trimsyn buoys

- □ Download Data: L:\scientific_work_areas\Mooring Work\P3\data
- □ New Batteries
- □ Clean and lubricate O-rings
- □ Set up instrument for re-deployment
- □ Set real time clock to PC clock (p.28)

□ Check instrument is ok and is set up properly by using “DS” command (p.27)
□ Set up instrument for “autonomous sampling” following instructions on page 24. Started Seaguard Current meter with O2 sensor: 1309, Deep
□ SN: 1309
□ Number of records: 4462
□ Session ended 21.59.10
□ Current meter sensor: 851
□ Optode: 1561
□ The Seaguard current meter with O2 sensor does not output a setup file.
□ Deployment settings:
The sampling interval was set to 2 hrs, as this resulted in a deployment time of 560 days. All other settings were left at the manufacture’s settings. It was checked that the current meter was set in burst mode (optimal for long term battery use).
o Data downloaded, file: L:\cruise_science_work\Mooring P3\SeaGuard 1309
□ New batteries
□ Check and lubricate O-rings
Sediment Trap Parflux
□ New Batteries
□ Do NOT remove both batteries at the same time.
□ always disconnect the cable on the sediment trap first, before unplugging the computer end
□ Set up sediment trap with sample tubes and formalin
□ Download data
□ Clean and lubricate O-rings
□ Check rope and shackles
Work To be Carried out on Mooring and Hardware
□ Checked and/or changed all shackles
□ Checked and/or changed all chain
□ Trimsyn Buoys
□ Chain on Buoy
□ Checked and/or changed all rope
□ Checked titanium swivel
□ Changed ALL stainless steel shackels
□ Done a onceover on all parts of mooring buoy
□ Replaced screws on clamps

OPIC was deployed for the first time, so refer to OPIC user manual for set-up instructions and deployment directions.

P3 sediment trap-Deployment schedule for 2023-2024:

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

WCB Mooring

Following a premature recovery in 2022, the WCB mooring was deployed on 05/01/2023, as shown in the attached schematic without issue. No strobe / VHF was installed as they were again the type without the pressure switch. The SonoVault was supplied with pre-installed SD cards, properly formatted. All that was done onboard was installing batteries and turning on the device, which was verified by the blinking LED pattern. Refer to SonoVault section below for further information.

Deployed Location: 53° 47.5' S, 37° 23.6' W (-53.798212, -37.934813; ~300 m water depth)

Argos Beacon: Serial number 251, ID 35520
Iridium: IMEI: 300234060553503O
Acoustic Release: 21020005 & 21020004
ADCP: serial number 7522
CTD: serial number 4852

CTD set up parameters:

- Sample interval = 900 s

ADCP setup parameters:

- Number of bins:25(1-128)
- Bin Size (m) :8 (0.2-16)
- Pings per ensemble: 10
- Interval: 15 min
- Duration: 550 days
- Transducer depth: 200 m

WCB sediment trap-Deployment schedule for 2023-2024:

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

ECB Mooring

A detailed swath bathymetry survey was undertaken during the cruise to find an optimal deployment site for the ECB mooring towards the shelf-break off Cumberland Bay at the start of ECB acoustic survey transects 1.1 (Figure 1, main cruise track). A site with approximately 275 m water depth was selected and the mooring was deployed on the 06/01/2023. The configuration of the mooring array is illustrated in Figure 5.

Deployment location: -54.103402, -36.246799 (~275 m water depth)

Acoustic Releases: 22060086 & 22060087
Argos Beacon: S/N 783, ID: 152636
Iridium: S/N Mo169H IMEI: 300434060655100

ADCP: serial number 17273
CTD: serial number 4855

CTD set up parameters:

- Sample interval = 900 s

ADCP setup parameters:

- Number of bins:25(1-128)
- Bin Size (m): 8 (0.2-16)
- Pings per ensamble: 10
- Interval: 15 min
- Duration: 550 days
- Transducer depth: 200 m

Further details on ECB mooring and the WBAT set up is found in section 6.

Details of the SonoVault deployment are given below.

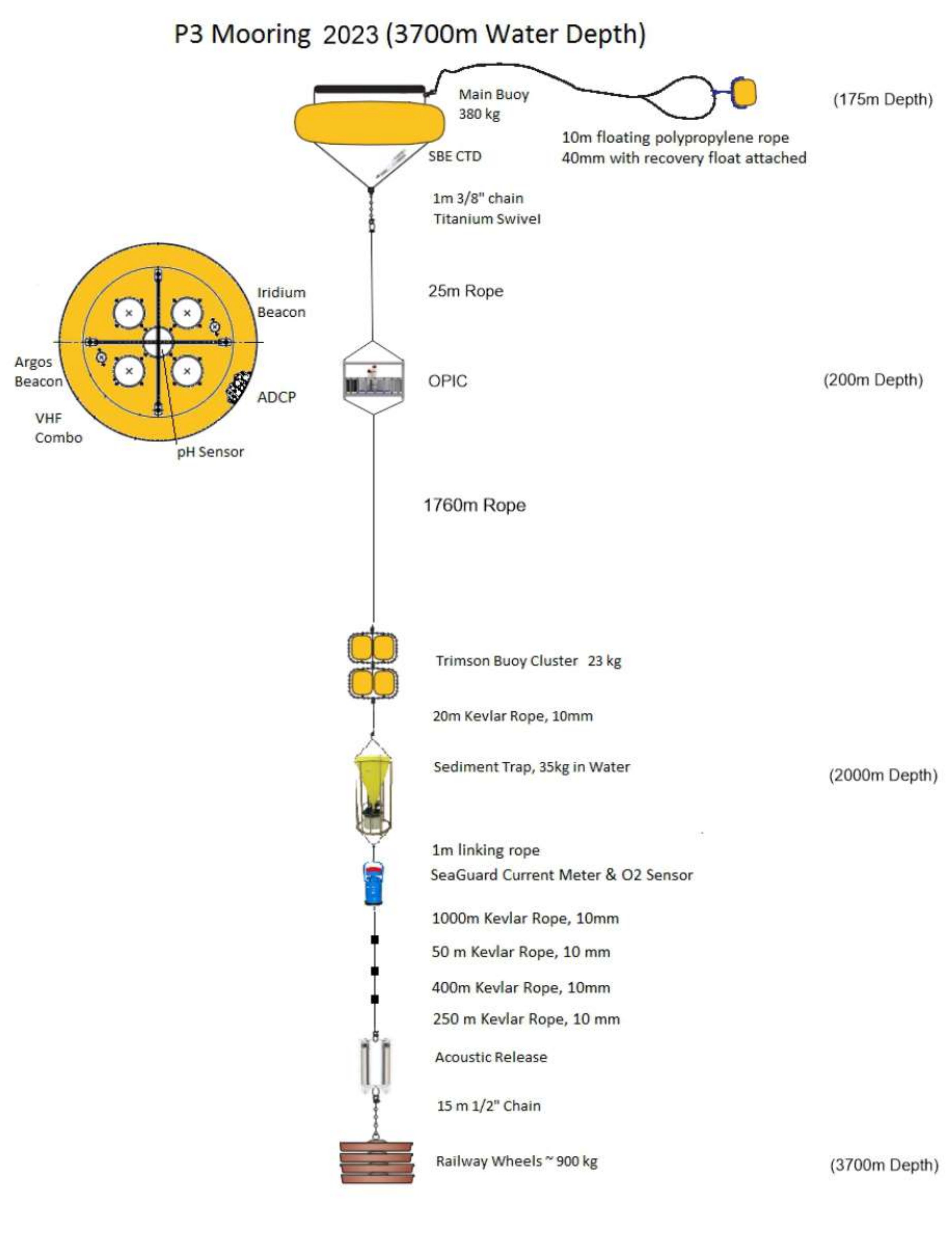

Figure 3. Configuration of the P3 mooring array deployed during DY158.

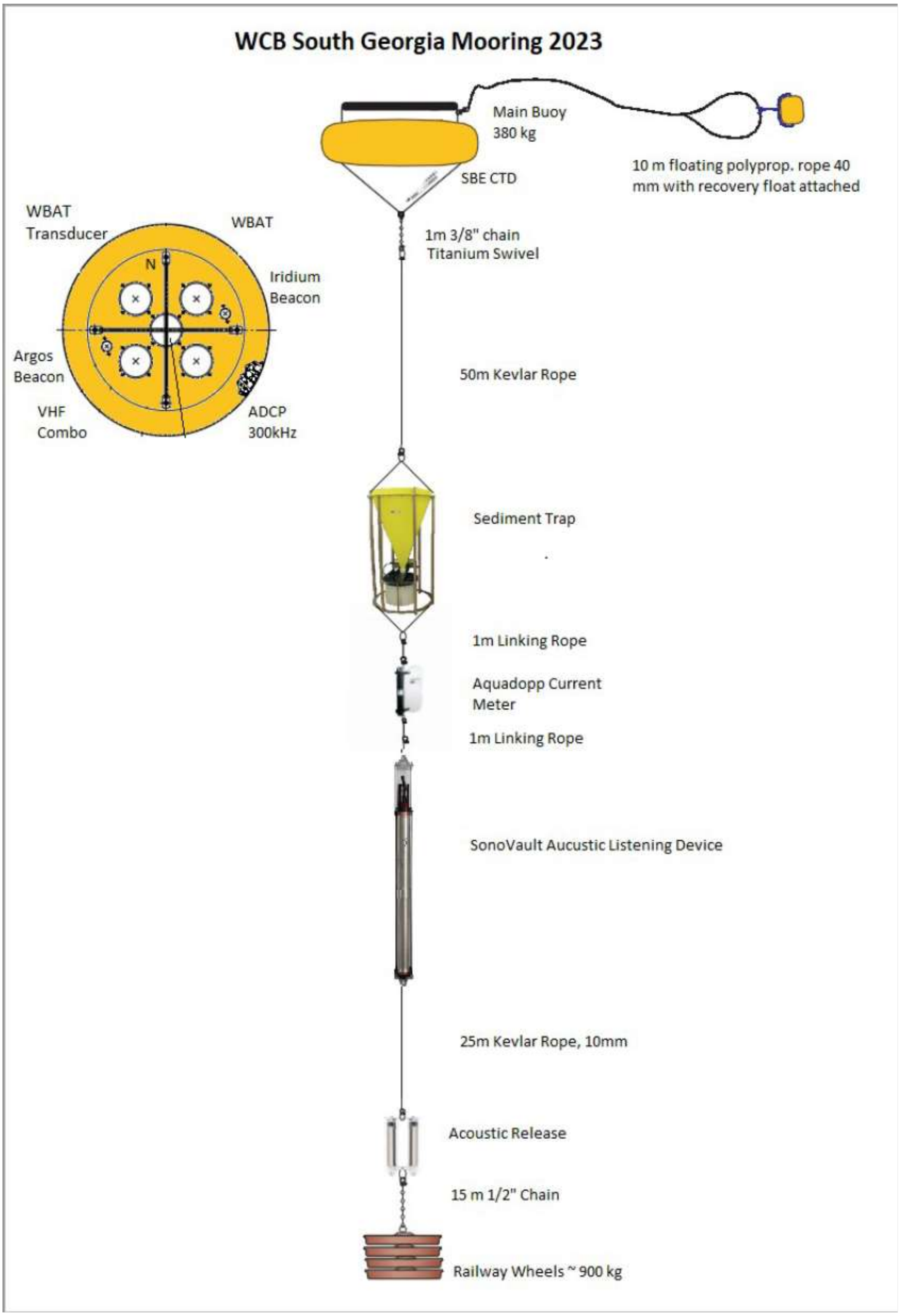

Figure 4. Configuration of the Western Core Box (WCB) mooring array deployed during DY158.

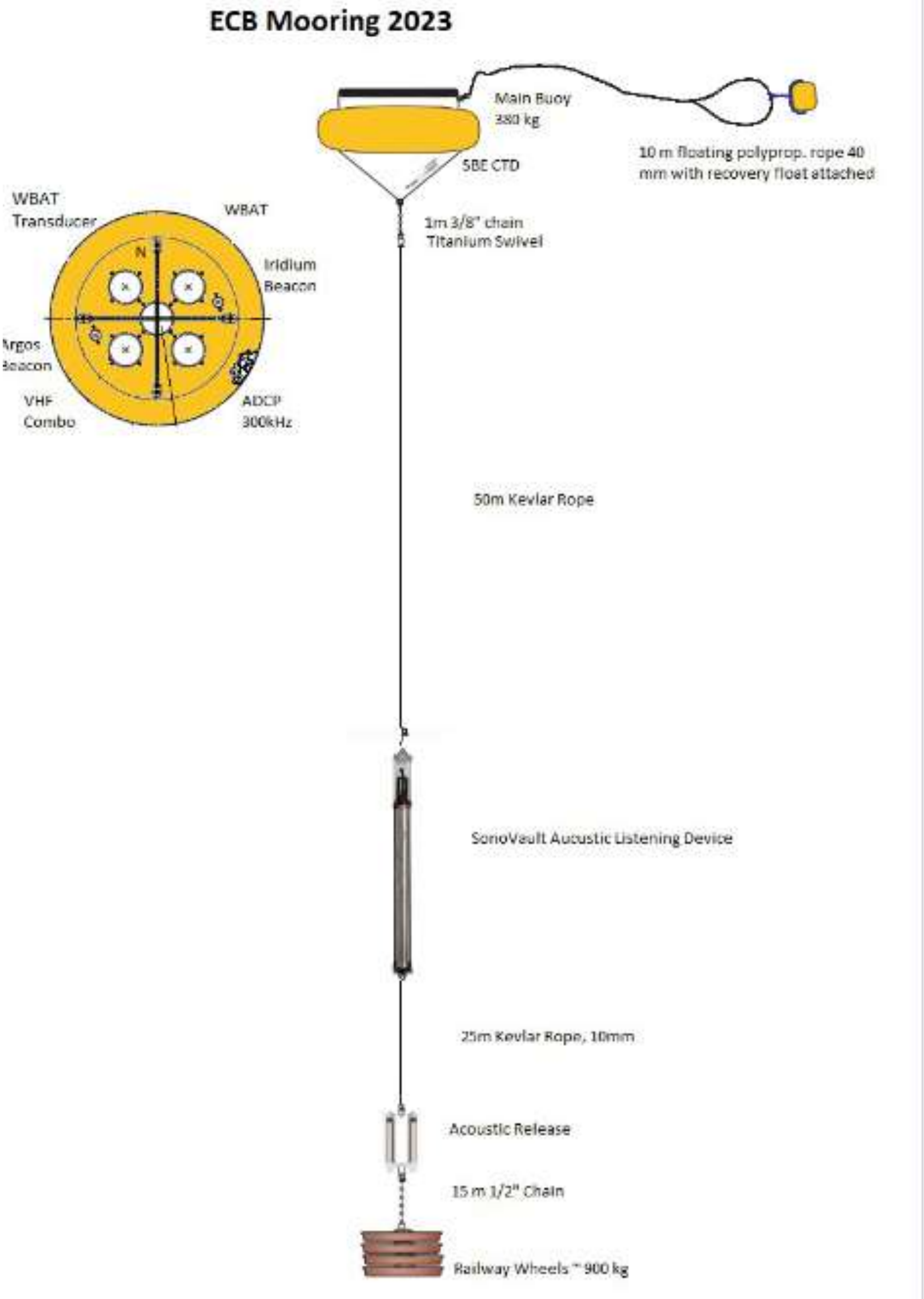

Figure 5. Configuration of the Eastern Core Box (ECB) mooring array deployed during DY158.

SONOVAULTS

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 DY158 on the Western Core Box Mooring (Instrument number: S/N 25161) and the Eastern Core Box Mooring (Instrument number: 25228) respectively. Both instruments had been programmed and SD cards formatted and installed at BAS prior to shipping.

QUICK GUIDE: SONOVAULT DEPLOYMENT AND RETRIEVAL

1. Battery filling and replacement (p2)
2. Switching the system on and off (p2)
3. Retrieving and installing SD cards (p4)

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.

Figure 6. Develogic Sonovault in housing, installed in a mooring frame.

Figure 7. 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 8) and its top lid with 3 screws will become visible. Remove the three screws with an Allen key (Fig 9). 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 10). 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.

Figure 8. Battery container within sonovault.

Figure 9. Top view onto battery container.

Figure 10. Installing batteries into a battery container.

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 (Figure 11). This plug includes a bi-colour LED which signals a switching operation.

Figure 11. 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 (Figure 12a). The South Pole of the magnet is marked red and is used to turn the switch off. To turn the Smart Power Switch on (Figure 12b) and off (Figure 12c), the magnet has to touch the Magnet Starter plug for > 3 seconds.

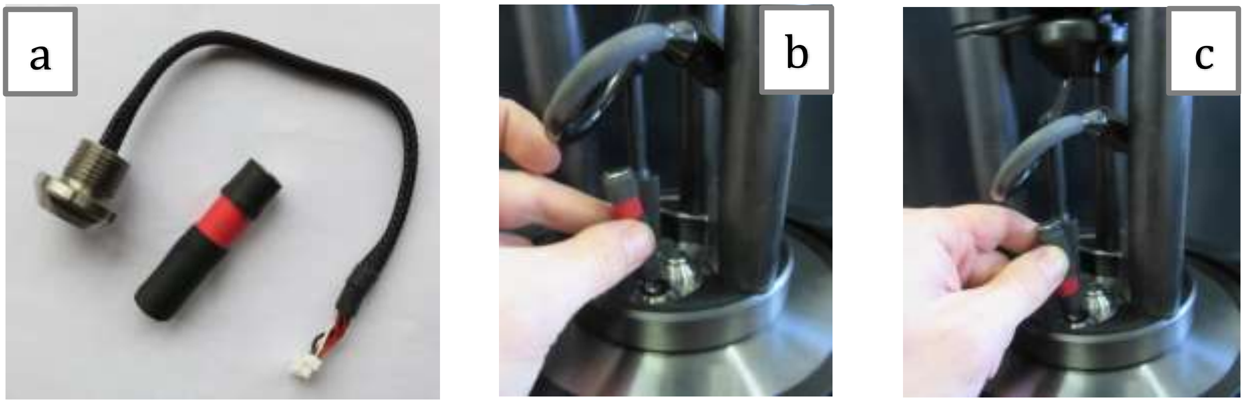

Figure 12. a) Magnet starter plug and included magnet. b) Switching ON the sonovault using the magnet starter plug (black North pole). c) Switching OFF the sonovault using the magnet start plug (red South pole).

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 = 30.2 V

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.

Retrieving / installing SD cards

SD cards are located in stacked storage modules beneath the hydrophone (Figure 13).

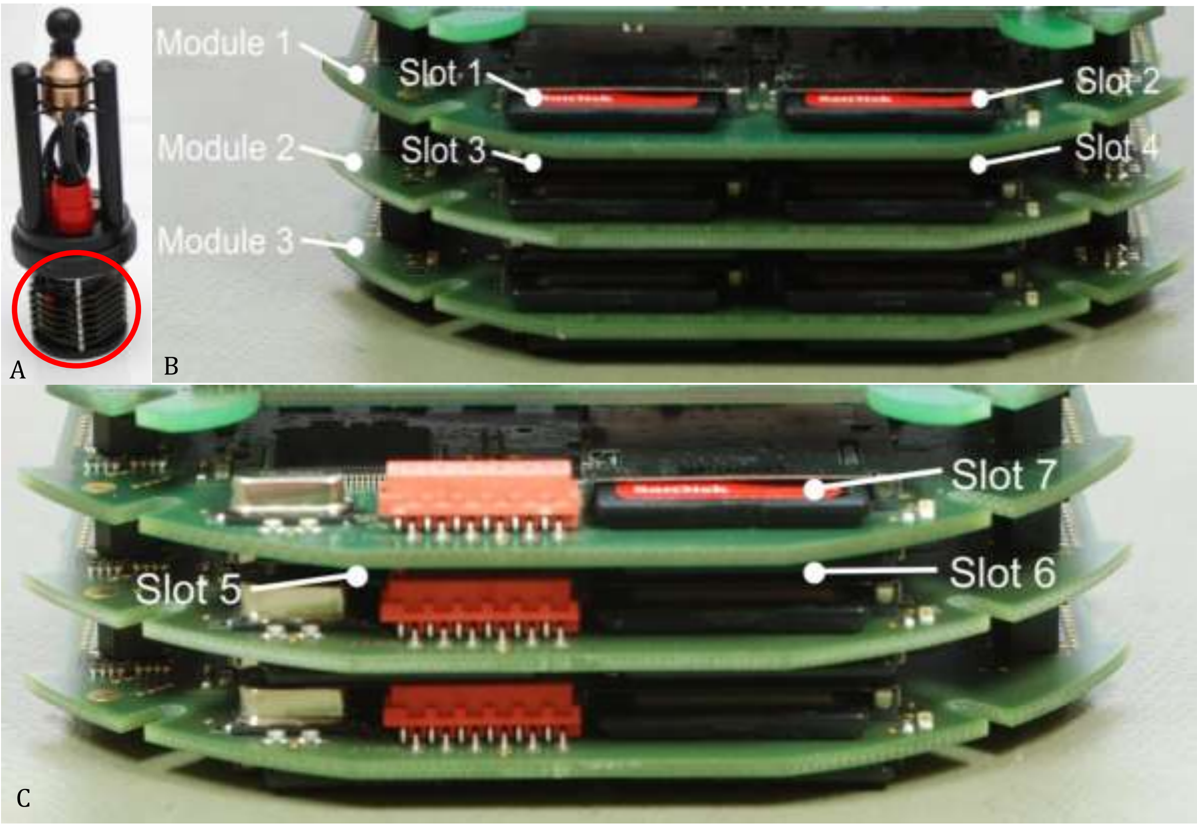

Figure 13. A. Top of sonovault (left), showing location of storage modules (red circle) beneath hydrophone. B & C Detail of storage modules, showing positioning of SD cards within modules: (B) from the front; (C) from the back.

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 old sonovault

One sonovault (Instrument number S/N 25168) was recovered from the WCB Mooring deployed on JC211 in 2021. The instrument was cleaned, the batteries removed and SD cards removed. Unfortunately, no data was recorded during this deployment and the instrument will be sent off for servicing.

6. Western Core Box Summary

Tracey Dornan

Since 1981 BAS have undertaken cruises to determine krill biomass as part of the ongoing assessment of the status of the marine ecosystem in the region of South Georgia. This unique time series, known as the Western Core Box (WCB), is part of the Ecosystems Programme contribution to BAS national capability. It comprises an acoustic grid survey of 8 transects each of 80 km in length, together with associated net and oceanographic sampling and the calibration of acoustic instrumentation. During DY158 two additional acoustic transects were carried out in the Eastern Core Box (ECB), a focus of the Winter Antarctic krill fishery (Figure 14). In addition to the core box acoustic surveys, which cover a wide area but have limited temporal coverage, two moorings were deployed in the WCB and ECB, to provide seasonal trends in krill abundance and distribution.

Fisheries Acoustics

The RRS Discovery is equipped with a six frequency Simrad EK80 split-beam echosounder, operating at 18, 38, 70, 120, 200 and 333 kHz, with transducers mounted on a drop keel. The EK80 was run throughout DY158 to collect information on the horizontal and vertical distribution of krill and to derive estimates of krill biomass in the South Georgia WCB and ECB surveys (Figure 14). Data was also collected in international waters during all transits to South Georgia, during A23, and passage from South Orkneys to the Falkland Islands.

WCB acoustic data is accompanied by CTD data and RMT8 net tows, which are essential to characterise the environment, community composition and convert acoustic signal to krill biomass (69, 229).

Method and system specification

Transducers are mounted to the ship's drop keel, with a draft of 6.51 m recorded prior to departure from Uruguay. The drop keel was retained in the raised position, flush to the hull, for all transits and surveys. The 38, 70, 120 and 200 kHz transducers are connected to EK80 Wide Band Transceivers (WBT), which can be operated in both continuous wave (CW; narrowband) or frequency modulated (FM; wideband chirp) transmission modes. The 18 and 333 kHz transducers are connected to older EK60 General Purpose Transceivers (GPT) which operate in CW only. All frequencies were run in CW mode throughout the cruise and calibration.

Simrad EK80 software (version 21.15) was used to control the echosounder. All raw data were collected to 1100 m, except during the calibration. The EK80 was operated in default settings from a previous calibration during DY159 in St. Helena (**Error! Reference source not found.**), although the environmental settings were updated at the start of the cruise to a temperature of 3°C and salinity of 33.7 PSU. See Table 1 for settings applied.

Variable	18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
Mode	Active	Active	Active	Active	Active	Active
Pulse duration (ms)	1.024	1.024	1.024	1.024	1.024	0.256 / 1.024
Transmit power (W)	1600	2000	750	250	150	50
Pulse type	CW	CW	CW	CW	CW	CW
Range (m)	1100	1100	1100	1100	1100	1100
Ping interval (ms)	2000	2000	2000	2000	2000	2000
Ramping	na	Fast	Fast	Fast	Fast	na
Transceiver	GPT	WBT	WBT	WBT	WBT	GPT

Table 1. EK80 settings used during acoustic surveys.

The EK80 was controlled through the K-Sync along with the ADCP (75 kHz), with the EK80 set as *Master*. Six active ping groups were set up with the EK80 firing in all groups on a 2 s ping interval and the 75 kHz ADCP firing every other group i.e. 4 s ping interval. As it was not possible to K-Sync the EA640 (10 kHz single beam depth sounder) it was run as a stand-alone unit on a 10 s ping interval during surveys. EA640 ping interval varied at other times depending on ship requirements.

EK80 Calibration

The EK80 was calibrated on 4/01/2023 in Rosita Harbour, South Georgia. The ship was balanced on DP. All echosounders were stopped, and the EK80 was self-triggered at a rate of 1 ping per second. Each transducer was calibrated in turn, although all transducers were operating at the time. Standard calibration procedures were used and all frequencies, except the 333 kHz, were calibrated using a 38.1 mm tungsten carbide sphere. The 333 kHz was not calibrated, as previous attempts using a 20 mm sphere were unsuccessful due to the depths the sphere is at on Discovery versus the usable range.

Line lengths and depths for calibration are contained within the guidelines for calibrating RRS Discovery (Andrew Moore, NMF documentation, 201).

A CTD (Event 46) was undertaken prior to the calibration. Temperature and salinity were averaged from the surface to 50 m (depth of the calibration sphere) and were 1.8 °C and 33.80 PSU. Calibrated settings are given in **Error! Reference source not found.**.

All calibrations were successful and uploaded to the transducers on completion with the exception of the 200 kHz transducer which had an RMS of 0.4, and the 333 kHz transducer which remains un-calibrated. The 200 kHz was reprocessed with a 1dB target window on target strength, resulting in an RMS of 0.2, which was accepted and uploaded to the system on 7/1/2023 12:21:25.

Variable	18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
Transducer type	ES18-11	ES38-7	ES70-7C	ES120-7C	ES200-7C	ES333-7C
Transducer Serial No.	2111	350	258	2250 (890*)	533	135
Transducer depth (m)	6.5	6.5	6.5	6.5	6.5	6.5
Transceiver Type	GPT	WBT	WBT	WBT	WBT	GPT
Transceiver Serial No.	00907206dc83	767751	400250	400256	998652	00907206d0a4
Transducer power (W)	1600	2000	750	250	150	50
Temperature (°C)	1.8 (3.0)	1.8 (3.0)	1.8 (3.0)	1.8 (3.0)	1.8 (3.0)	1.8 (3.0)
Salinity	33.80 (33.70)	33.80 (33.70)	33.80 (33.70)	33.80 (33.70)	33.80 (33.70)	33.80 (33.70)
Pulse length (us)	1024	1024	1024	1024	1024	256 (1024)*
2-way beam angle (dB)	-17.0	-20.	-20.7	-20.7	-20.7	-20.7
Transducer gain (dB)	22.99 (22.08)	26.91 (26.18)	27.83 (27.36)	26.15 (26.23)	26.66 (26.67)	25.0
Sa correction (dB)	-0.68 (-0.66)	-0.11 (-0.01)	0.01 (-0.09)	-0.16 (-0.08)	-0.15 (-0.16)	0

3dB beam along (°)	10.09	6.68	6.55	6.65	6.58	7
3dB beam athwart (°)	10.18	6.68	6.50	6.74	6.60	7
Along offset (°)	-0.22	0	0.03	-0.07	-0.34	0
Athwart offset (°)	-0.18	-0.02	-0.02	-0.05	0.11	0
RMS Error (dB) [Calibration]	0.06	0.07	0.08	0.15	0.20	N/A
Calibration Applied (Time/Date)	04-01-23 20:25	04-01-23 17:34	04-01-23 19:47	04-01-23 19:11	07-01-23^ 12:21	N/A

Table 2. EK80 calibration settings. ES333-7C not calibrated, grey cell values are from EK80 software defaults for this transducer type. ^ As RMS was higher than acceptable, the 200 kHz calibration was applied several days later following recalibration via replays and suspension of out of bounds TS hits.

EK80 Data Coverage

Acoustic transects WCB and ECB

The WCB was run in a west to east direction starting at the northern end of WCB 1.1. Two legs were completed per day during daylight hours, with the aim to complete 2 CTDs, 2 oblique hauls and additional targeted RMT8 net hauls overnight. Poor weather meant it was not possible to complete all planned RMT8 hauls and CTDs.

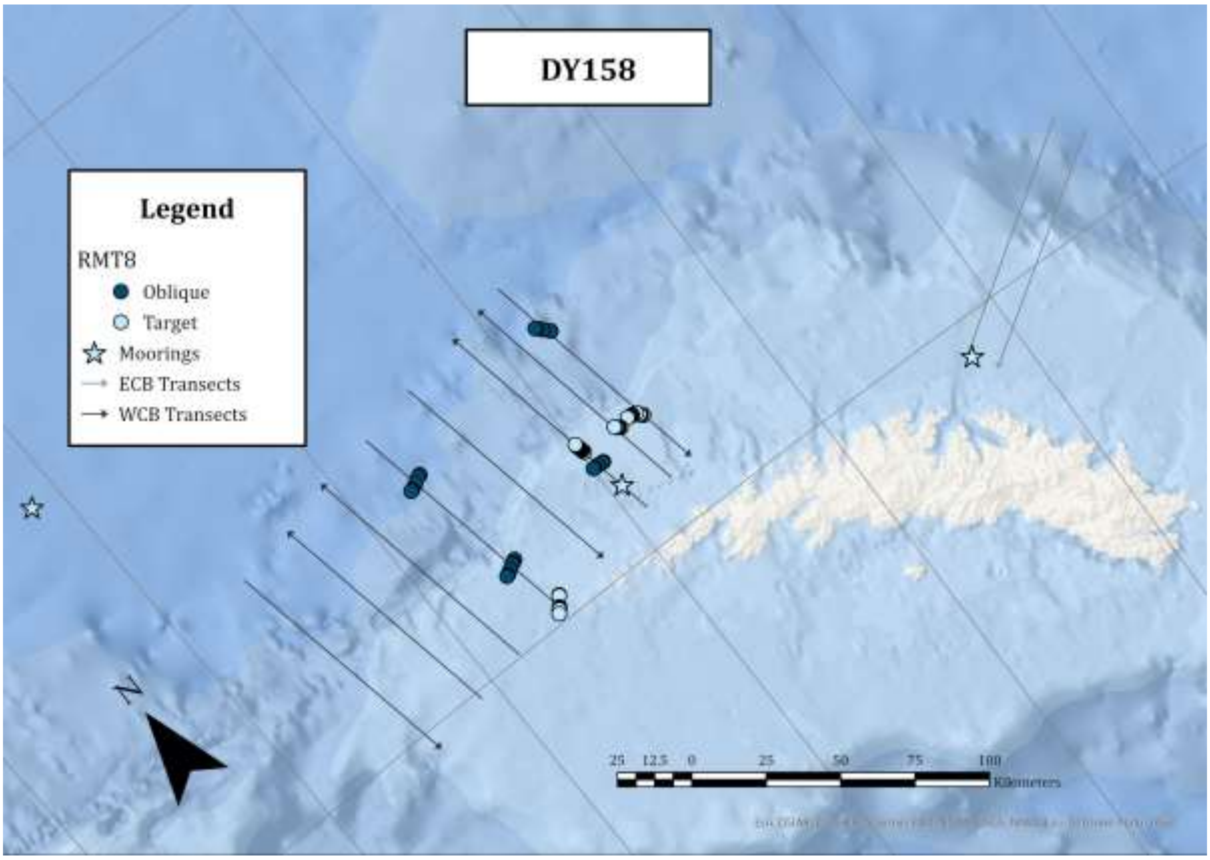

Figure 14. Map of WCB and ECB acoustic transects, along with RMT8 nets and WCB mooring.

Following WCB survey transects the EK80 system was calibrated in Rosita Harbour. ADCP bottom tracking occurred after this and prior to the 2 ECB transects, which affected EK80 data quality on transit to ECB. Two lines of the ECB were run on 06/01/2023, no RMT8 fishing was conducted during the ECB.

DateTime	Event	Comment	Latitude	Longitude
23/12/2022 20:10		EK80 pinging on 2 s intervals and logging	-37.9859	-52.6602
23/12/2022 20:15		EK80 - Skipper log turned off – 200 Khz noise on EK80	-38.0014	-52.6491
23/12/2022 22:40		EK80 - Switched from WBT to GPT for ES200 - 7C noise investigation	-38.3929	-52.3467
23/12/2022 23:24		EK80 - Pinging/logging overnight - monitor 200 KHz noise	-38.5137	-52.2526
24/12/2022 11:40		EK80 - ADCPs switched on - passive noise in 200 Hz EK	-40.6782	-50.6167
24/12/2022 12:39		EK80 OFF - Return 200 KHz to WBT config	-40.6891	-50.6294
24/12/2022 12:41		EK80 ON - Logging 200 KHz WBT (previous noise not present)	-40.6896	-50.6301
24/12/2022 12:46		EK80 - Noise (ADCPs turned on 1240) - noise on 120 KHz	-40.6916	-50.6328
28/12/2022 00:00		EK80 Recording OFF - on P3 station	-51.2338	-41.5159
28/12/2022 13:45		EK80 frequencies set to passive (for P3 acoustic release comm.)	-52.8070	-40.1074
30/12/2022 03:46		EK80 Back ON - Active	-52.7852	-40.0916
30/12/2022 08:02	15	Commenced W1.1 EK80 survey	-53.3451	-39.6036
30/12/2022 12:47	15	Finish transect W1.1	-54.0600	-39.3900
30/12/2022 14:07	16	Commence EK80 W1.2 survey line	-54.0251	-39.0888
30/12/2022 19:57	16	End of line W1.2	-53.3158	-39.3030
31/12/2022 08:04	19	Commenced survey line W2.1	-53.9942	-38.8185
31/12/2022 13:06	19	Finish survey line W2.1	-53.2724	-39.0421
31/12/2022 14:37	20	Commenced survey transect W2.2	-53.2563	-38.7512
31/12/2022 19:26	20	Finish survey transect W2.2	-53.9626	-38.5267
01/01/2023 09:11	25	Commence EK80 transect W3.1	-53.2211	-38.4506
01/01/2023 13:52	25	Finish EK80 transect W3.1	-53.9275	-38.2195
01/01/2023 15:09	26	Commence transect W3.2 south-north	-53.8913	-37.9072
01/01/2023 19:42	26	Transect W3.2 complete	-53.1852	-38.1404
02/01/2023 08:05	33	Commenced EK80 transect W4.1	-53.8689	-37.7287
02/01/2023 14:07	33	Finish EK80 W4.1 transect	-53.1657	-37.9647
02/01/2023 14:50	34	Start EK80 transect W4.2 north-south	-53.1533	-37.8314
02/01/2023 19:18	34	End of transect W4.2	-53.8536	-37.5942
04/01/2023 11:22	47	Start of Rosita Bay calibration	-54.0167	-37.4292
04/01/2023 20:27	47	EK80 calibration complete	-54.0170	-37.4268
06/01/2023 09:48	58	Commenced EK80 survey E1.1	-54.0968	-36.2618
06/01/2023 09:53		333 kHz pulse length set to 1.024ms (previously 0.256 ms)	-54.0895	-36.2449
06/01/2023 14:14	58	Finish survey line E1.1 - heading to ECB1.1N	-53.6925	-35.2559
06/01/2023 16:58	60	Start EK80 survey north to south	-53.7697	-35.1626
06/01/2023 22:19	60	EK80 survey E1.2 complete	-54.1733	-36.1744

Table 3. Summary of WCB, ECB transects and calibration locations, plus EK80 outbound transit issues - see problems encountered for further details.

Transit data

The transit data recorded on the outbound transit between 23/01/2022 20:10 until 30/12/2022 03:46 (prior to the WCB survey) was regularly paused or interrupted to try and resolve EK80 noise issues and to conduct test stations and P3 activities, and so data is disjointed, with noise issues in the earlier sections of the transit.

The EK80 was also able to collect transit data during A23 and Orkney Passage (OP) mooring recoveries. These transits were interrupted by the CTD and mooring stations but still provide good coverage.

Transit data from the South Orkneys to Falkland Islands included a circumnavigation of the A76 iceberg. This transit was broken for a CTD-bongo net station and a final RMT8 target net north-west of the South Orkneys. Data is generally of good quality though there is some interference from the non-k-sync'd EA640 particularly on the 200 kHz and some weather and ice related drop out on the iceberg circumnavigation.

EK80 Problems encountered

Noise on 200 kHz and resolution

The EK80 was first switched on in international waters 23.12.2022 at 20:10 GMT. Electrical noise was visible on the 200 kHz frequency (no ADCP's running). To investigate the noise, we tried the following:

- Skipper log (Simrad 200 kHz) and the EA640 were switched off.
- EK80 200kHz was switched to passive.
- All frequencies switched to passive.
- All frequencies except 200 kHz powered down.

However, noise was still present (Figure 15).

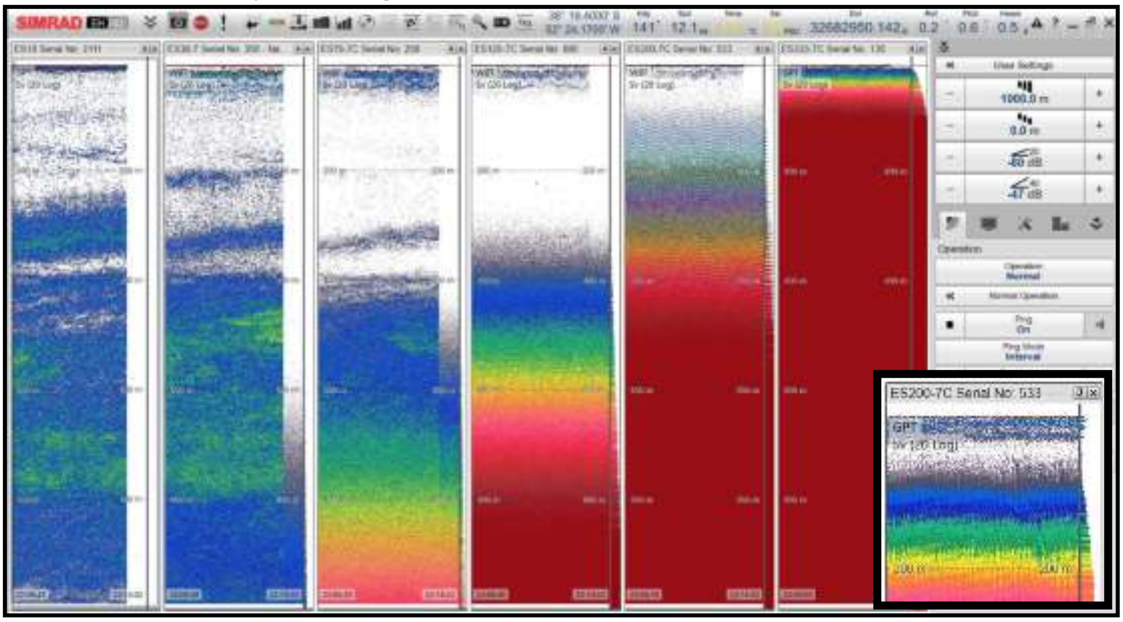

Figure 15. Main: Screen shot of EK80 (D20221223-T221436) showing noise on 200k Hz (WBT) with echosounders on 'active' then switched to 'passive' at 22:13. Inset: Noise present while 200kHz transducer on GPT (D20221223-T230959).

We plugged the 200 kHz transducer from the WBT to the older EK60 GPT. While the GPT output was of lower resolution (Figure 15 inset), the noise was still present. We plugged the 200 kHz back to the WBT as it was hoped that finer resolution on the WBT would make it easier to clean the noise. However, plugging back to the WBT (24.12.2022 12:40 GMT) solved the noise problem. We assume that either the connections were cleaned by physically plugging the transducer from one unit to another or that transceiver cabling was moved during the exploration process eliminating the noise.

K-Sync issues – EK80, ADCP and EA640

We attempted to K-Sync the EK80 with hull-mounted ADCPs (75 and 150 kHz) and depth range EA640. However, in spite of troubleshooting and replacement of communication cables we found it impossible to K-Sync all equipment. As a compromise we operated the EK80 and 75 kHz ADCP via K-Sync with the EK80 as Master. The EK80 was triggered on a 2 s ping interval and 75 kHz ADCP every second ping cycle i.e. 4s ping interval. We did not run the 150 kHz ADCP with EK80 beyond initial trials because it created too much noise on the 120 kHz data even when run through K-Sync. The EA640 would not fire when triggered by the K-Sync and seemed to be unable to be controlled by K-Sync so it was set to run on a 10 s ping interval to try to reduce interference with the EK80 during transits and krill surveys. EA640 power and pulse length settings were adjusted throughout to try and minimise interference when transiting on and off shelf.

Change in 333 kHz pulse duration

The transmit pulse duration of all frequencies was initially set to 1.024 ms. However, the 333 kHz frequency defaulted to a pulse duration of 0.256 ms when the EK80 software was powered down to troubleshoot noise on transit to the WCB survey. This was reverted to 1.024 ms just after the start of the first ECB transect (06/01/2023 09:53). While consistent pulse settings are required for biomass estimates and long-term monitoring, the 333 kHz frequency is not currently calibrated or used in biomass estimates.

WBAT – WCB and ECB moorings

The Simrad Wide Band Autonomous Transceiver (WBAT) is a low-power, scientific echosounder that can be used to observe distributions of zooplankton and micronekton. It operates in continuous wave (CW), or frequency modulated (FM) wideband modes. Using a transducer centred at 120 kHz, CW echoes are received at 120 kHz, or echoes from FM transmitted pulses are received from over a frequency band (90-170 kHz). To complement the spatial WCB acoustic survey, two WBATs with 120 kHz transducers were deployed on WCB and ECB mooring buoys (Figure 16). With the buoys deployed at an approx. depth of 200 m (Figure 16), the upwards facing transducers can be used to monitor temporal changes in krill vertical distribution and relative abundance in epipelagic waters.

Figure 16. WBAT (top left) and upwards facing 120 kHz transducer (top right) installed into WCB mooring buoy.

WBAT Calibration

Both WBATs were calibrated in Rosita Harbour (04-05/01/2023) using standard sphere techniques (Demer et al. 2015), while connected to the transducer it was deployed with. Each WBAT transducer pair was mounted in a custom built calibration frame with the transducer facing downward (Figure 17). The frame was suspended from a crane over the starboard side of the vessel, with the transducer held approx. 0.5-1 m below the sea surface (half the frame submerged), to eliminate risk of the transducer pinging in open air. All other echosounders were switched off during calibration.

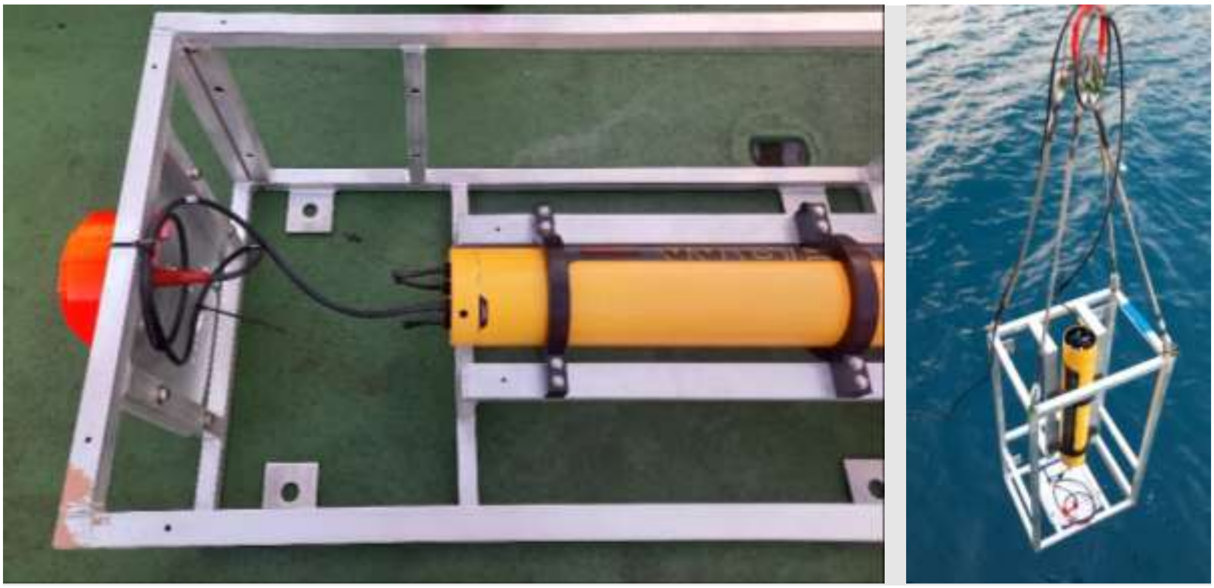

Figure 17. Simrad WBAT (yellow) and 120 kHz transducer (orange) mounted in calibration frame DY158. Right: WBAT being deployed for calibration, serial cable connection at top of WBAT allowed direct communication to WBAT via a laptop on deck.

A 22 mm tungsten carbide sphere was suspended on monofilament line from a telescopic pole, and sphere manoeuvred under the transducer from the ships aft deck. Calibration was controlled directly using EK Mission Planner software (version 3.3.0) operated from a laptop on deck via communications via a 30 m serial cable. The WBAT serial connection was above water at all times (Figure 17). The serial cable enabled us to monitor the position of the sphere in the transducer beam in real time.

WBATs were calibrated first in CW and then FM modes using separate calibration mission plans. CTD values obtained during EK80 calibration provided a mean temperature and salinity between 2-11 m of 1.865°C and 33.8075 respectively. See Table 4 for calibration settings.

	WCB	ECB
WBAT S.N.	279949	253128
Transducer S.N.	147	166
Transducer type	ES120-7CD	ES120-7CD
Transmit mode	Active	Active
Transmit Power (W)	200	200
FM start-end frequency (kHz)	90-170	90-170
Ping rate (s)	1	1
Pulse duration (ms)	1.024	1.024
Ramping	Fast	Fast
Range CW/FM (m)	10/15	10/15
Calibration date	05/01/2023	04/01/2023
Temperature CW/FM (°C)	1.9/1.8	1.9/1.8
Salinity	34	34
Acidity	8.0	8.0

Table 4. Calibration settings and results for WCB and ECB WBATs.

WBAT calibration results and issues

Calibration raw files were loaded into EK80 software. CW data was processed using a 6dB window to limit the dB range of acceptable 'hits'. No hits were suspended in either WCB or ECB CW calibrations as observation of the calibration target field and layer indicated that only single targets were being detected, with noise regions visible on the echogram being automatically removed by the software. Sphere coverage on CW calibrations was generally good (Figure 18). FM data was processed using a 10dB window to provide sufficient hits. Both FM calibrations had some poorly covered quadrants. Calibration results were saved as .xml files.

During calibration it seemed that the rectangular frame was potentially limiting transducer coverage as the frame profile and off-centre transducer mount plate made it difficult to cover all quadrants. A frame with a circular profile and central transducer plate may help if calibrations need to be conducted from ships deck. Good coverage may have been easier to achieve from a smaller support vessel. Alternatively, it may be possible to bring the frame on deck, rotate the transducer through 120° and redeploy to collect more data but this may be difficult if a) time is short, b) the frame is not exactly vertical on each deployment or c) there are strong currents. It should also be noted that the EK mission planner software does not indicate when sufficient hits have been recorded, so it is only when data is downloaded and processed in the EK80 software that the calibration quality is known.

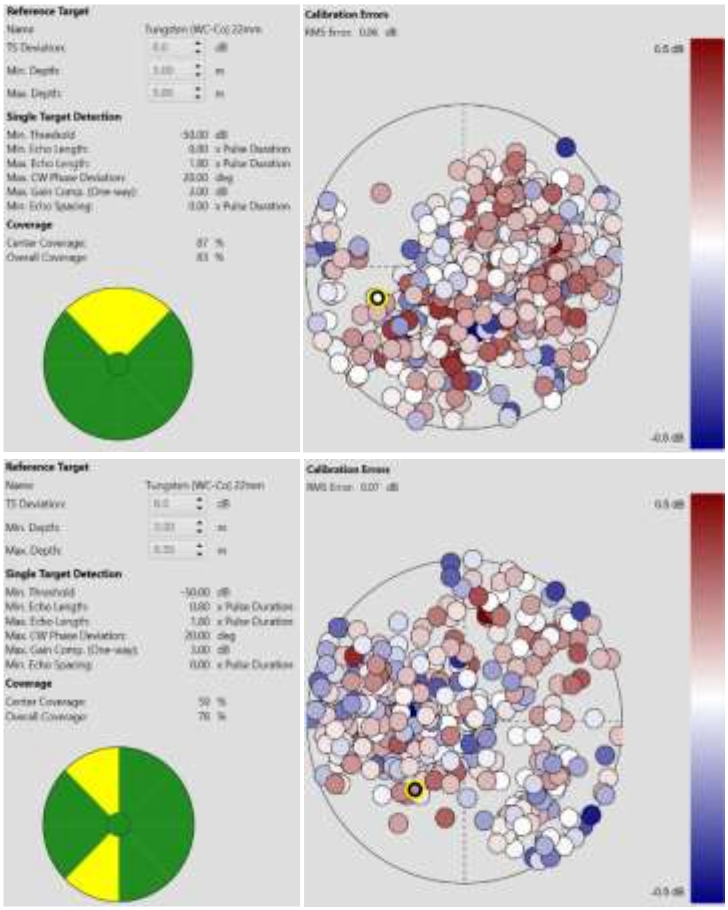

Figure 18. Distribution of targets measured during calibration for Transducer SN147 (top) and SN166 (bottom) in CW mode.

	WCB SN:279949 / SN:147	ECB SN:253128 / SN:166
Resulting gain (dB)	26.76	27.05
Gain adjust (dB)	1.76	2.05
Beamwidth (along, deg)	7.29	7.15
Beamwidth (athwart, deg)	7.23	7.11
Offset (along, deg)	0.04	-0.04
Offset (athwart, deg)	0.07	-0.02
Sa correction	0.07	0.07
RMS Error	0.06	0.07

Table 5. Summary of calibration coefficients for CW mode for each WBAT/transducer pair.

WBAT set up

Both missions for WCB and ECB WBATs were sent and activated immediately post calibration in Rosita Harbour as they were due to be deployed shortly afterwards. Set up process:

- USB drive checked to ensure previous data was downloaded/removed
- New Lithium Batteries inserted
- All o-rings checked and greased as appropriate
- Electromagnetic ring checked and changed as appropriate
- Calibration in Rosita Harbour (see WBAT Calibration)
- Save calibration data from USB to laptop

- Send mission plan to WBAT to start after deployment
    - Ping ensembles including CW/FM pings (15 of each) and 3 passive pings
    - Event start interval (1 hour)
    - Range 250 m
    - Temp: 3°C
    - Salinity: 34
    - Acidity (pH) = 8

WCB mooring WBAT

Simrad WBT Serial number: 279949 and 120 kHz ES120-7CD Transducer Serial Number: 147
O-rings checked and re-greased, all in good condition, none replaced.
Mission plan
Start time – End time (to not ping in water) (07/01/2023 01:00 – 01/02/2024 01:00)
Message centre:

Storage Controller FW v3.3.0-138
Storage Controller Driver v3.3.0
Storage Controller OS v2.6.33-arm1-WBAT2.1

Mission Controller FW v3.3.0-C.1
Mission Controller FPGA v10

Echo Sounder FW v0.19
Echo Sounder FPGA TX v0
Echo Sounder FPGA RX v3

Serial number: 279949

Battery voltage: 13.943509 v

ECB mooring WBAT

Simrad WBT Serial number: 253128 and 120 kHz ES120-7CD Transducer Serial Number: 166
O-rings checked and re-greased. Electromagnetic o-ring replaced (not greased).
Mission plan
Start time – End time (to not ping in water) (07/01/2023 01:00 – 01/02/2024 01:00)
Message centre:

Storage Controller FW v3.3.0-138
Storage Controller Driver v3.3.0
Storage Controller OS v2.6.33-arm1-WBAT2.1

Mission Controller FW v3.3.0-C.1
Mission Controller FPGA v10

Echo Sounder FW v0.18
Echo Sounder FPGA TX v0
Echo Sounder FPGA RX v3

Serial number: 253128

Battery voltage: 13.892359 v

Future tasks

- Reconsider WBAT calibration frame to enable full quadrant coverage
- Make up load tested deployment strops
- Purchase electromagnetic o-rings
- Purchase 'kim wipes' for cleaning
- Purchase lightweight calibration pole for operation from aft deck of ship

References

Demer, D. A., L. Berger, M. Bernasconi, E. Bethke, K. Boswell, D. D. Chu, Reka, A. Dunford, S. Fässler, S. Gauthier, L. T. Hufnagle, J. M. Jech, N. Bouffant, A. Lebourges-Dhaussy, X. Lurton, G. J. Macaulay, Y. Perrot, T. Ryan, S. Parker-Stetter, S. Stienessen, T. Weber and N. Williamson (2015). Calibration of acoustic instruments. ICES Cooperative Research Report. E. D. Anderson. Copenhagen, Denmark, International Council for the Exploration of the Sea. **326**: 133.

6. Bongo netting

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A Bongo net containing a spring-tensioned motion compensation unit was deployed regularly throughout cruise DY158. The net contained 2 x 61 cm diameter rings, with one 200 µm mesh and one 100 µm mesh. The cod-ends contained taps through which samples were collected at the end of the deployment.

Deployments were carried out off the starboard aft side using a Lebus 8 mm scroll winch with a 2500 m non-conducting wire. The wire went through a standard block which was suspended from a Sormec telescopic knuckle boom crane situated on the aft quarter.
Between deployments, the Bongo rested on a ~1 m high fence on the aft quarter, tied down with a ratchet strap. It was lifted through a combination of the tension being taken up by the winch and the crane lifting the block. Once vertical, the Bongo was moved to outboard by the crane, with two deck operators stabilising the net until it was sufficiently outboard.

Descent and ascent of the net was carried out at a speed of ~0. 2 m/s, which was measured by a gauge integrated within the Lebus winch. This gauge became non-operational towards the end of the cruise, at which point the winch operator had to estimate speed and depth. In this instance, it was possible to determine maximum depth through marks made on the wire at 100 m and 200 m.

The usual protocol was for the first deployment to be made to 200 m. This catch was to be preserved complete. However, when the weather was rough, this was sometimes the only deployment, so it was necessary to extract specimens from the catch for live incubation work. A record was kept of all specimens extracted from the catch and placed on the sample label within the catch. Preservation was in 4% formaldehyde. Where conditions allowed, the second deployment was carried out for the specific purpose of picking live specimens after which it was discarded. The second deployment depth was either 100 m or 200 m.

An important aspect of the deployments was that they were possible to perform while CTD operations were taking place. It was necessary to wait until the CTD reached a depth of 100 m before deploying the Bongo. The capacity to deploy both instruments at the same time allowed many more Bongo deployments to be made than originally scheduled since they added no extra wire time to cruise operations.

In total, 40 deployments were made during DY158 (Table 6).

Time	Event	Comment	Latitude	Longitude	Single Beam Depth (m)	Water Fluorescence (volt)	Starboard Total Irradiance (volt x 10-5)	Port Total Irradiance (volt x 10-5)	Water Salinity (PSU)	Water Temperature (°C)
23/12/2022 18:39		log started	-37.7583	-52.8374	3732.53	0.0665	88	1047.1	0.106	18.8401
24/12/2022 12:53	2	Bongo nets deployed	-40.6944	-50.6366	5476.4	NaN	548.2	624.7	33.0381	20.3702
24/12/2022 13:07	2	Bongo nets at 200 m commence recovery	-40.6986	-50.6421	5478.78	0.0787	NaN	NaN	32.9583	20.3528
24/12/2022 13:24	2	Bongo nets recovered to deck; 200 m down; preserved	-40.7033	-50.6483	5479.78	0.0787	543.2	619.7	32.8941	20.4576
29/12/2022 00:09	9	Bongo nets deployed	-52.8079	-40.1138	3801.82	0.2583	-0.2	-1.4	33.9907	4.9022
29/12/2022 00:34	9	Bongo nets recovered to deck; preserved	-52.8079	-40.1139	3800.27	0.2397	0.2	0.5	33.9885	4.9076
29/12/2022 00:34	10	Bongo nets deployed	-52.8079	-40.1139	3802.41	0.2527	0.3	0.5	33.991	4.9082
29/12/2022 00:46	10	Bongo nets at 200 m start recovery	-52.8079	-40.1139	3800.8	NaN	0.9	0.3	33.9903	4.9063
29/12/2022 00:59	10	Bongo nets recovered to deck; picked and discarded	-52.8079	-40.1139	3801.51	NaN	NaN	NaN	33.9897	4.9094
01/01/2023 21:25	28	Bongo nets deployed	-53.3616	-38.0822	2665.12	0.5991	15.4	17.9	33.9676	4.2368

01/01/2023 21:49	28	Bongo nets recovered; 200 m down; preserved	-53.3615	-38.0822	2665.05	0.5667	17.2	20.9	33.9629	4.2885
01/01/2023 21:50	29	Bongo nets deployed	-53.3615	-38.0822	2665.17	0.5811	18.9	22.3	33.9597	4.3014
01/01/2023 22:02	29	Bongo nets recovered; 100 m down; picked and discarded	-53.3615	-38.0823	2665.09	0.5643	NaN	NaN	33.9592	4.3271
03/01/2023 23:50	43	On DP for bongo deployment (WC84.2CTDS)	-53.6785	-37.6524	130.63	0.6281	0.2	0.3	33.8802	4.2899
03/01/2023 23:55	43	Bongo nets deployed	-53.6782	-37.6527	128.34	0.6041	0.8	0.2	33.8828	4.0638
03/01/2023 23:58	43	Bongo aborted	-53.6781	-37.6527	128.25	0.5965	1.7	0.3	33.885	4.0822
04/01/2023 01:36	44	Bongo nets deployed	-53.678	-37.6527	127.48	0.5975	-0.5	0.5	33.8857	4.1244
04/01/2023 01:48	44	Bongo nets max wire out 200 m, start recovery	-53.678	-37.6527	127.69	0.5659	0.5	0.3	33.8877	4.1279
04/01/2023 02:01	44	Bongo nets recovered to deck; preserved	-53.678	-37.6527	127.72	NaN	0.3	0.3	33.8867	4.1508
04/01/2023 02:03	45	Bongo nets deployed	-53.678	-37.6527	127.61	0.5835	0.6	0.3	33.8856	4.1455
04/01/2023 02:08	45	Bongo nets max wire out 100 m, start recovery	-53.678	-37.6527	127.7	0.5621	0.2	0.5	33.8867	4.1228
04/01/2023 02:15	45	Bongo nets recovered to deck; 100 m	-53.678	-37.6527	127.67	0.5792	1.1	0.5	33.8866	4.1476

		down; picked and discarded								
05/01/2023 15:14	52	Bongo nets deployed	-53.799	-37.939	310.04	NaN	960.8	1152.2	33.9292	4.1052
05/01/2023 15:31	52	Bongo nets recovered; 150 m down; preserved	-53.799	-37.939	310.59	0.2271	1015.8	1207.3	33.9235	4.2289
05/01/2023 15:32	53	Bongo nets deployed	-53.799	-37.939	310.18	0.2425	1071	1271.5	33.9261	4.3422
05/01/2023 15:45	53	Bongo nets recovered; 100 m down; picked and discarded	-53.799	-37.939	309.55	0.1826	734.4	905.9	33.9237	4.3927
07/01/2023 11:53	64	Bongo nets deployed	-55.2302	-34.49	1012.54	0.0763	NaN	NaN	33.9587	3.2094
07/01/2023 12:05	64	Bongo nets max wire out 200 m	-55.2302	-34.49	1012.04	0.0772	456.5	534.4	33.9587	3.2122
07/01/2023 12:18	64	Bongo nets recovered to deck; preserved	-55.2302	-34.49	1010.99	0.0809	313.4	368	33.9578	3.2201
07/01/2023 12:20	65	Bongo nets deployed	-55.2302	-34.49	1011.07	0.0812	297.9	349.3	33.9581	3.2332
07/01/2023 12:24	65	Bongo nets max wire out 100 m	-55.2302	-34.49	1010.86	0.081	245.7	287.8	33.9578	3.2282
07/01/2023 12:31	65	Bongo nets recovered to deck; picked and discarded	-55.2302	-34.49	1010.67	0.088	249	292.1	33.9569	3.2208
07/01/2023 21:58	69	Bongo nets deployed	-55.4846	-34.133	2488.96	0.121	NaN	NaN	34.0225	2.971
07/01/2023 22:08	69	Bongo nets recovered	-55.4845	-34.133	2489.58	0.123	NaN	NaN	34.0229	2.9296

08/01/2023 09:19	72	Bongo nets deployed	-55.9902	-33.4192	3027.86	0.1599	NaN	NaN	34.2342	2.0225
08/01/2023 09:31	72	Bongo nets max wire out 200 m	-55.9902	-33.4192	3072.66	0.1317	127.4	147.7	34.2359	2.0362
08/01/2023 09:43	72	Bongo nets recovered; preserved	-55.9902	-33.4192	3044.24	0.1292	144.8	169.5	34.2364	2.037
08/01/2023 09:46	73	Bongo nets deployed	-55.9902	-33.4192	3051.05	0.1334	168.2	197	34.2363	2.0427
08/01/2023 09:59	73	Bongo nets recovered; 100 m; picked and discarded	-55.9902	-33.4192	3005.21	0.1106	269.6	315.4	34.2359	2.0394
08/01/2023 22:05	76	Bongo nets deployed	-56.7755	-32.3037	3272.67	0.1434	32.3	38	34.2511	2.6618
08/01/2023 22:11	76	Bongo nets max wire out 100 m	-56.7755	-32.3038	3272.59	0.1407	29	32.8	34.2516	2.6607
08/01/2023 22:19	76	Bongo nets recovered; picked and discarded	-56.7755	-32.3038	3272.04	0.1442	21.4	24.7	34.2526	2.6605
09/01/2023 09:05	79	Bongo nets deployed	-57.4583	-31.3272	3788.8	0.1881	344.1	403.4	34.2508	1.8936
09/01/2023 09:15	79	Bongo nets max wire out 200 m	-57.4583	-31.3272	3789.99	0.226	229.8	270.8	34.2517	1.8852
09/01/2023 09:28	79	Bongo nets recovered; picked and preserved	-57.4582	-31.3272	3789.32	0.2393	159.3	186.2	34.2513	1.883
11/01/2023 09:06	81	Bongo nets deployed	-63.9646	-28.874	4827.95	0.1534	228	268.9	33.7193	-0.7557
11/01/2023 09:17	81	Bongo nets max wire out 200 m	-63.9645	-28.874	4826.69	0.1486	339.5	423.4	33.7158	-0.753
11/01/2023 09:28	81	Bongo nets recovered; picked	-63.9645	-28.874	4826.06	0.1505	289.9	340.6	33.7033	-0.7514

		and remnants preserved								
11/01/2023 22:45	85	Bongo nets deployed	-63.0726	-30.1153	4916.62	0.7172	9.8	8.7	33.9373	-0.0761
11/01/2023 22:51	85	Bongo nets max wire out 100 m	-63.0726	-30.1153	4916.66	0.7169	4.7	7.5	33.9396	-0.0796
11/01/2023 22:57	85	Bongo nets recovered to deck; picked and discarded	-63.0726	-30.1153	4916.74	0.7126	7.2	7.3	33.9386	-0.077
12/01/2023 11:30	88	Bongo nets deployed	-62.491	-31.2605	4793.32	NaN	388	458.1	33.8316	-0.0977
12/01/2023 11:48	88	Bongo nets max wire out 200 m	-62.491	-31.2605	4796.04	0.3882	NaN	NaN	33.8324	-0.0807
12/01/2023 11:59	88	Bongo nets recovered to deck; preserved	-62.491	-31.2605	4793.58	0.396	366.8	431.8	33.8323	-0.0802
12/01/2023 12:01	89	Bongo nets deployed	-62.491	-31.2605	4793.95	0.3716	328.1	386.5	33.8325	-0.0793
12/01/2023 12:07	89	Bongo nets max wire out 100 m	-62.491	-31.2605	4794.11	0.334	307.6	361.9	33.8337	-0.084
12/01/2023 12:14	89	Bongo nets recovered to deck; picked and discarded	-62.491	-31.2605	4793.48	0.4576	320.4	377.5	33.8348	-0.1022
13/01/2023 01:09	92	Bongo nets deployed	-61.6603	-31.1092	3386.83	0.7439	1.7	0.8	33.8982	0.0496
13/01/2023 01:13	92	Bongo nets max wire 100 m	-61.6603	-31.1092	3386.46	0.7578	3.1	0.9	33.8978	0.0266
13/01/2023 01:20	92	Bongo nets recovered to deck; picked and discarded	-61.6603	-31.1092	3386.96	0.7639	1.2	0.9	33.8965	0.0514

13/01/2023 11:05	96	Bongo nets deployed	-61.1707	-31.046	3499.24	0.4404	241.1	289.5	33.9285	-0.0273
13/01/2023 11:14	96	Bongo nets max wire out 200 m	-61.1707	-31.046	3499.45	0.4262	357.1	422.4	33.9287	-0.0161
13/01/2023 11:26	96	Bongo nets recovered to deck; preserved	-61.1707	-31.046	3502.16	0.4083	327.1	388.3	33.9283	-0.0177
13/01/2023 11:27	97	Bongo nets deployed	-61.1707	-31.046	3499.92	0.3796	NaN	NaN	33.9282	-0.0233
13/01/2023 11:27	97	Bongo nets recovered to deck; picked and discarded	-61.1707	-31.046	3499.71	0.4175	305	363.8	33.9285	-0.0217
13/01/2023 11:32	97	Bongo nets max wire out 100 m	-61.1707	-31.046	3499.49	0.3233	377.7	455	33.9287	-0.0183
13/01/2023 21:09	100	Bongo nets deployed	-60.6997	-31.0096	1593.54	NaN	78.1	92.5	33.9128	-0.1111
13/01/2023 21:13	100	Bongo nets max wire out 100 m	-60.6997	-31.0095	1595.84	0.6175	74.2	86.2	33.9128	-0.1089
13/01/2023 21:20	100	Bongo nets recovered; picked and discarded	-60.6997	-31.0096	1594.86	0.6247	51	58.4	33.9099	-0.1113
14/01/2023 17:26	104	Bongo nets deployed	-59.7666	-30.9071	3844.7	0.177	322.7	379.9	33.9537	-0.1681
14/01/2023 17:32	104	Bongo nets max wire out 200 m	-59.7666	-30.9071	3844.51	0.1685	NaN	NaN	33.9546	-0.1558
14/01/2023 17:48	104	Bongo nets recovered; preserved	-59.7666	-30.9071	3844.62	0.1727	222.3	261.7	33.9531	-0.1577
14/01/2023 17:50	105	Bongo nets deployed	-59.7666	-30.9071	3844.79	NaN	211.8	246.9	33.9542	-0.1611
14/01/2023 17:55	105	Bongo nets max wire out 100 m	-59.7666	-30.9072	3844.83	0.1689	221.9	257.6	33.9541	-0.1594

14/01/2023 18:02	105	Bongo nets recovered; discarded	-59.7666	-30.9072	3844.65	NaN	242.6	285.5	33.9544	-0.1573
15/01/2023 11:59	110	Bongo nets deployed	-58.6346	-30.8241	3539.98	0.1772	458.1	546.1	34.061	0.4284
15/01/2023 12:12	110	Bongo nets max wire out 200 m	-58.6346	-30.8241	3539.12	0.1582	505.8	596.6	34.0569	0.4579
15/01/2023 12:23	110	Bongo nets recovered; picked and remnants preserved	-58.6346	-30.824	3542.54	0.1414	510.3	603.9	34.0512	0.4516
15/01/2023 12:25	111	Bongo nets deployed	-58.6346	-30.8241	3533.72	0.1447	608.5	722.8	34.0589	0.4563
15/01/2023 12:31	111	Bongo nets max wire out 100 m	-58.6345	-30.8241	3543.81	0.1341	611.7	727.2	34.0601	0.4666
15/01/2023 12:39	111	Bongo nets recovered; discarded	-58.6345	-30.8241	3539.75	NaN	451	543.5	34.0587	0.4545
15/01/2023 20:35	114	Bongo nets deployed	-58.2128	-30.821	4032.73	0.1408	93.2	109.1	34.21	1.2274
15/01/2023 20:41	114	Bongo nets wire out 100 m	-58.2128	-30.821	4020.73	0.1413	82.4	95.4	34.21	1.2209
15/01/2023 20:48	114	Bongo nets recovered; picked and discarded	-58.2128	-30.821	4031.85	0.1318	82.9	97.2	34.2099	1.2289
20/01/2023 01:38	118	Bongo nets deployed	-62.615	-43.2439	3094.3	NaN	0.3	0.6	33.589	-0.4595
20/01/2023 01:50	118	Bongo nets max wire out 200 m	-62.6151	-43.2439	3094.17	1.2679	1.4	0.5	33.5862	-0.4647
20/01/2023 02:00	118	Bongo nets recovered; 200 m; picked and discarded	-62.6151	-43.2439	3100.03	1.2503	1.1	0.6	33.5902	-0.4488

20/01/2023 02:02	119	Bongo nets deployed	-62.6151	-43.2439	3094.22	1.2773	0.9	0.5	33.5856	-0.4479
20/01/2023 02:11	119	Bongo nets max wire 100 m	-62.6151	-43.2439	3094.15	1.3098	NaN	0.6	33.5825	-0.4208
20/01/2023 02:25	119	Bongo nets recovered; preserved	-62.6151	-43.2439	3094.2	NaN	0.9	0.6	33.5788	-0.44
21/01/2023 01:39	122	Bongo nets deployed	-60.6311	-42.0874	3706.72	0.1884	NaN	-0.5	34.0435	0.0784
21/01/2023 01:50	122	Bongo nets max wire out 200 m	-60.6312	-42.0875	3705.76	0.1851	-0.3	-0.5	34.0443	0.0726
21/01/2023 02:02	122	Bongo nets recovered; preserved	-60.6312	-42.0875	3702.08	0.1842	-0.3	-0.5	34.0429	0.0558
21/01/2023 02:04	123	Bongo nets deployed	-60.6312	-42.0875	3701.55	0.1852	-0.5	-0.8	34.0426	0.0482
21/01/2023 02:15	123	Bongo nets max wire out 200 m	-60.6312	-42.0875	3702.3	0.1869	NaN	-0.6	34.0467	0.0639
21/01/2023 02:26	123	Bongo nets recovered; picked and discarded	-60.6312	-42.0875	3701.88	0.1846	-0.3	-0.6	34.0401	0.0538
21/01/2023 22:10	130	Bongo nets deployed	-60.5626	-41.6326	2357.5	0.1868	34.6	40.9	34.0988	0.7551
21/01/2023 22:20	130	Bongo nets max wire 200 m	-60.5626	-41.6326	2356.36	0.1938	21.7	25.5	34.096	0.7422
21/01/2023 22:29	130	Bongo nets recovered; preserved	-60.5626	-41.6325	2356.63	0.1921	13.4	15.4	34.0931	0.7188
21/01/2023 22:31	131	Bongo nets deployed	-60.5626	-41.6325	2356.66	0.1901	14.8	17.1	34.0938	0.7238
21/01/2023 22:40	131	Bongo nets max wire out 200 m	-60.5626	-41.6326	2357.79	0.1926	14.5	16.6	34.0939	0.7097

21/01/2023 22:50	131	Bongo nets recovered; picked and discarded	-60.5626	-41.6326	2356.79	0.1909	8.1	9.6	34.0876	0.684
22/01/2023 19:38	139	Bongo nets deployed	-60.6413	-42.1692	3125.16	0.1932	133.7	157.9	34.053	-0.0216
22/01/2023 19:47	139	Bongo nets max wire out 200 m	-60.6413	-42.1692	3179.04	0.2289	95.8	112.9	34.0521	-0.0262
22/01/2023 19:57	139	Bongo nets recovered; preserved	-60.6413	-42.1692	3229.91	0.2237	115.2	135.2	34.0514	-0.0172
22/01/2023 19:58	140	Bongo nets deployed	-60.6413	-42.1692	3200.87	0.2058	114.1	134.1	34.0502	-0.0171
22/01/2023 20:07	140	Bongo nets max wire out 200 m	-60.6413	-42.1692	3119.31	0.1994	88.8	104.4	34.0511	-0.0147
22/01/2023 20:17	140	Bongo nets recovered; picked and discarded	-60.6413	-42.1692	2974.56	0.2246	92.5	107.9	34.051	-0.0295
23/01/2023 22:47	148	Bongo nets deployed	-60.6653	-42.256	1538.61	0.2684	11.6	14.5	34.0135	-0.0189
23/01/2023 22:55	148	Bongo nets max wire 200 m	-60.6653	-42.256	1538.79	0.265	10.5	12.7	34.015	-0.018
23/01/2023 23:04	148	Bongo nets recovered; preserved	-60.6653	-42.256	1538.65	0.2824	10.2	11.6	34.0163	-0.0267
23/01/2023 23:07	149	Bongo nets deployed	-60.6653	-42.256	1538.45	0.2774	8.7	10.8	34.017	-0.0318
23/01/2023 23:16	149	Bongo nets max wire out 200 m	-60.6653	-42.256	1545.36	0.2661	6.4	7.6	34.0158	-0.0308
23/01/2023 23:25	149	Bongo nets recovered; picked and discarded	-60.6653	-42.256	1538.68	0.2634	4.4	5.2	34.0169	-0.0301

Table 6. Summary of Bongo deployments.

7. Mammoth netting

Geraint Tarling, British Antarctic Survey

SCOOBIES carries out regular depth discrete net monitoring at site P3 to accompany mooring activities at this site. The original intention was to deploy the MOCNESS system day and night. However, the MOCNESS system was not operational because of fibre optic cable communication issues. The Hydro-Bios MAMMOTH was used as a backup. After a test deployment to 200 m, it was only possible to deploy this system to full depth (100 m) once because of weather issues. Unlike the MOCNESS, which is a towed system, the MAMMOTH was deployed vertically. Essentially, this type of deployment is effective at capturing mesozooplankton but not the macrozooplankton that is also captured by the MOCNESS.

The MAMMOTH was deployed from the mid-ships P-frame. The trawl warp was fed through the main winch, and two Rexworth winches were used on the side wires. The trawl warp was inboard of the anti-pendulum roller attached to a swivel on the main net, whilst the two side wires for the cod-end carousel are out-board. The anti-pendulum roller is bent inwards to create a gap between the cod-ends and the main net body. Steady lines are used on both the cod-ends and the net frame to control the system going outboard. Once over the side, a third line is used to turn the net around so the safety bar can be disengaged prior to deployment.

Note: Before the net was deployed, the Rexworth winches were attached to the main body and were used to rotate it 90° so that its mouth was facing skywards. The winches were then detached and reattached to the cod-end carousel for the deployment.

Figure 19. Predeployment – Rexworth winches used to rotate main body so the mouth faces upwards. These winches are then detached and attached to the cod-end carousel for deployment.

Figure 20. Rexworth winches are used to manoeuvre the cod end carousel outboard while wait of main body is taken by the trawl warp.

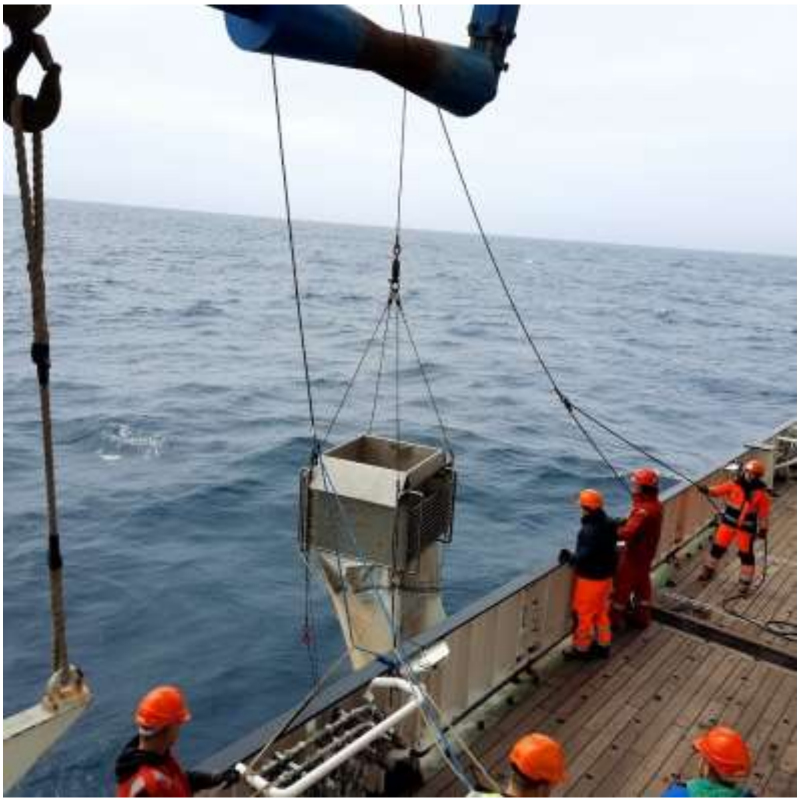


Figure 21. Rexworth winches have now been detached and weight of carousel is now taken by the 4 wires between it and the main body. Retaining ropes (with G links) now hold the carousel deployment wires. Main frame has been rotated 90° sideways to allow an operator to reach and disengage the safety bar before the instrument is lower for deployment.

Two deployments were made at station P3. The first was a test deployment to 200 m. The second was to 1000 m. Both deployments were successful although note 1: the depth programme of the test deployment meant that the top 20 m were not sampled and 2: buckets 4 and 6 disengaged from the carousel and spilled some sample – a qualitative sample was retained and preserved for both buckets 4 and 6. All samples for test deployment and 1000 m deployment were preserved in 4% formaldehyde. No twisting was evident in the nets so it can be assumed that all samples (with the exception of buckets 4 and 6 of 1000 m deployment) were quantitative. The Mammoth system makes an internal digital record of flow rates and environmental variables to an internal disk that can be download via the Oceanlab system. The two Oceanlab files for the above deployments are as follows:
MPS XL_2615_2022-12-29_14-51-43.hbl (test deployment)
MPS XL_2615_2022-12-30_00-20-38.hbl (1000 m deployment)

These can be viewed in Oceanlab and exported as a text file. At time of writing, both the deployment files and exported text files were placed in the following cruise drive directory:
\\DYNAS1.discovery.local\Public\DY158\Geraint\Mammoth\Mammoth deployment data

Time	Event	Comment	Latitude	Longitude	Ground Speed (knot)	Water Fluorescence (volt)	Single Beam Depth (m)	Starboard Total Irradiance (volt x 10-5)	Port Total Irradiance (volt x 10-5)	Surface Water Salinity (PSU)	Surface Water Temperature (°C)
29/12/2022 13:59	12	Mammoth test to 200 m	-52.8074	-40.114	0.4	0.1462	3791.82	610.4	717.8	33.9919	4.8972
29/12/2022 14:34	12	Net 1 open at 200 m	-52.8074	-40.1142	0.3	0.1312	3791.87	623.9	734.6	33.9903	4.9295
29/12/2022 14:35	12	Net 2 open at 180 m	-52.8074	-40.1142	0.6	0.1204	3791.82	636	745.2	33.9929	4.9276
29/12/2022 14:37	12	Net 3 open at 160 m	-52.8074	-40.1141	1.1	0.1239	NaN	750.7	882.7	33.9936	4.9298
29/12/2022 14:39	12	Net 4 open at 140 m	-52.8074	-40.1141	0.4	NaN	3791.75	726.9	850.2	33.9925	4.9238
29/12/2022 14:40	12	Net 5 open at 120 m	-52.8074	-40.1142	0.4	0.1225	3798.77	732	862.7	33.9933	4.9322
29/12/2022 14:42	12	Net 6 open at 100 m	-52.8074	-40.1142	0.5	0.1083	3799.54	731.4	866.1	33.9928	4.9313
29/12/2022 14:44	12	Net 7 open @80 m	-52.8074	-40.1142	0.2	0.1146	3802.64	841.1	987.2	33.9925	4.9323
29/12/2022 14:46	12	Net 8 open @60 m	-52.8074	-40.1142	0.3	0.105	NaN	886.5	1044.8	33.993	4.9194
29/12/2022 14:47	12	Net 9 open @40 m	-52.8074	-40.1142	0.1	NaN	3791.82	912.5	1070.9	33.9925	4.9169
29/12/2022 14:49	12	Net 9 closed @20 m	-52.8074	-40.1141	0.4	0.1076	3791.88	979.5	1139.8	33.9924	4.932
29/12/2022 15:01	12	Recovered on deck	-52.8074	-40.1142	0.1	0.1076	3802.96	645.6	756.7	33.993	4.9251
29/12/2022 16:00		log started	-52.8211	-40.0963	1.2	NaN	NaN	402.4	470.9	33.994	4.9359

29/12/2022 23:18	14	P3 Mammoth net (deep) deployed	-52.8353	-40.0839	0.7	0.2617	NaN	1.2	1.1	33.9931	4.9284
30/12/2022 00:22	14	Net 1 open @1000 m	-52.8353	-40.0839	0.4	0.2649	3795.61	NaN	NaN	33.9909	4.92
30/12/2022 00:32	14	Net 2 open @875 m	-52.8353	-40.0839	0.3	0.2637	3795.29	1.5	0.8	33.9887	4.9139
30/12/2022 00:43	14	Net 3 open @750 m	-52.8353	-40.0837	0.5	0.2519	3795.54	0.9	0.9	33.9913	4.9119
30/12/2022 00:53	14	Net 4 open @625 m (note - some sample spilled)	-52.8353	-40.0837	0.1	0.2588	3798.08	NaN	NaN	33.9906	4.9137
30/12/2022 01:04	14	Net 5 open @500 m	-52.8353	-40.0837	0.7	0.2551	3797.85	0.8	1.4	33.991	4.9067
30/12/2022 01:14	14	Net 6 open @375 m (note - some sample spilled)	-52.8353	-40.0837	0.4	0.2585	3795.27	0.2	1.7	33.9897	4.9087
30/12/2022 01:25	14	Net 7 open @250 m	-52.8352	-40.0836	0.5	0.2499	3795.31	1.4	2	33.9901	4.8996
30/12/2022 01:38	14	Net 8 open @125 m	-52.8352	-40.0836	0.5	0.247	3795.32	0.9	1.7	33.9907	4.8884
30/12/2022 01:42	14	Net 9 open @50 m	-52.8352	-40.0836	0.4	0.2635	3798	0.3	1.8	33.9907	4.8907
30/12/2022 01:44	14	Net 9 closed @5 m	-52.8352	-40.0836	0.5	0.2518	3795.41	0.5	1.7	33.9897	4.8915
30/12/2022 01:49	14	Net on deck	-52.8352	-40.0836	0.4	0.2538	3795.39	1.1	1.7	33.9907	4.8909

Table 7. Bongo net deployments during DY158.

8. Macrozooplankton

Gabriele Stowasser, Tracey Dornan, Philippa Birchenall, Alison Cleary, Thomas Gillum-Webb Nadine Johnston, Jack Leung, Clara Manno, Sarah Manthorpe, Emily Rowlands, Angelika Slomska, Ryan Saunders, Laura Taylor, Geraint Tarling.

Gear

The RMT8 was used to characterise the macrozooplankton community in the Western Corebox (WCB) in 200 m oblique trawls and target trawls. A target haul was also carried out close to the South Orkney Islands. Target trawls were undertaken on krill swarms identified from the EK80. In oblique trawls net 1 was opened near the surface (10-20 m) and the net deployed to 200 m (where water depth was sufficient) before closing and net 2 opened at 200 m depth and closed near the surface (10-20 m). 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 Alison Cleary (BAS) with krill for incubation experiments (project ParaKrill). Krill, fish and squid were furthermore sampled for micro- and nano-plastic incubation experiments (krill; Emily Rowlands, British Antarctic Survey) as well as for a study on the transfer of microplastics across the Southern Ocean food web (fish and squid, University of Coimbra, Portugal). Oblique trawls within the Western Core Box were only undertaken at the CTD positions. All RMT8 hauls are listed in Table 8.

Deployment and recovery procedures

Deployments were made over the aft with four harnessed operatives in the red deployment zone, two controlling the on-deck auxiliary winches (port and starboard) and a trawl wire operative in the winch room. The operation was controlled by a further on-deck operative who communicated between the bridge, winch room and other deck operatives. The main trawl wire was the 14.5 mm deep tow wire which passed through a standard block on the top centre of the stern gantry; the auxiliary winches were North Sea winches (non-scrolling) which went through blocks part way up each side of the stern gantry. During deployment, tension was first taken on the trawl wire to lift the control unit (or “cross”) from its stand. Tension was then taken on the port and starboard auxiliary winches to lift the weight bar off the deck and then the stern gantry is paid out until the net is over the aft. The auxiliary winches are lowered until the entire weight of the net is taken by the trawl wire, at which point the auxiliary winch wires go slack and can be disconnected and linked to retaining ropes on the control unit (using G-clamps). Recovery is the reverse of deployment.

Figure 22. Recovery of RMT 8 net. Auxiliary wires yet to be connected to the weight bridles.

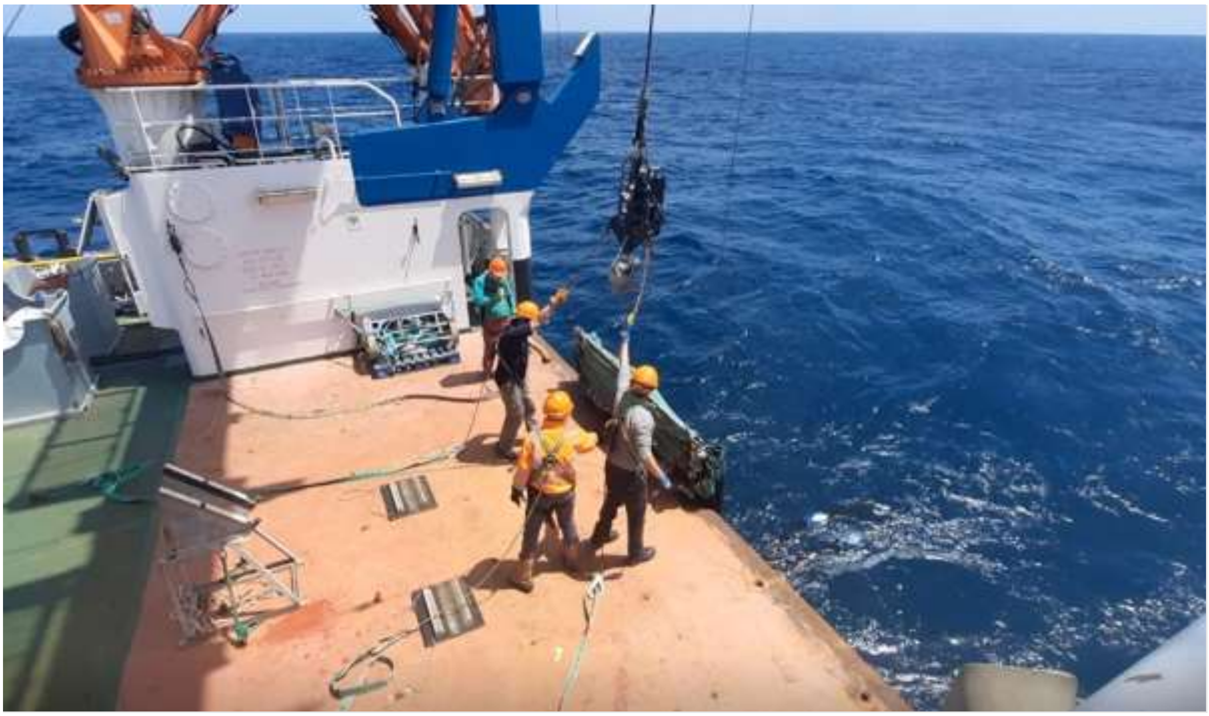


Figure 23. Recovery of RMT8 net. Auxiliary wires connected and weight bar in the process of being hauled on deck by auxiliary winches in tandem with the trawl winch.

Catch sorting and processing

Oblique hauls WCB

For the oblique hauls the total catch of net 2 (200 m – 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 at the British Antarctic Survey. All material collected in net 1 (surface – 200 m) was preserved in 4% formalin. All data were recorded in an Excel database.

Targeted hauls

The catch of targeted hauls was sorted and quantified. Where live *E. superba* were caught samples were taken for incubation experiments. In hauls, where sufficient numbers of *E. superba* were caught, length-frequency data was collected. 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).

Event No	Time and Date (GMT)	Latitude	Longitude	Net depth (m)	Action	Haul type
21	31/12/2022 20:56	-53.9585	-38.5279	119	N1_Open	Target
21	31/12/2022 21:01	-53.9608	-38.5311	109	N1_Close	Target
21	31/12/2022 21:06	-53.9630	-38.5342	73	N2_Open	Target
21	31/12/2022 21:11	-53.9650	-38.5370	65	N2_Close	Target
22	31/12/2022 23:32	-53.7832	-38.5777	23	N1_Open	Oblique WCB 2.2S
22	01/01/2023 00:05	-53.7913	-38.6006	177	N1_Close	Oblique WCB 2.2S
22	01/01/2023 00:05	-53.7913	-38.6007	177	N2_Open	Oblique WCB 2.2S
22	01/01/2023 00:33	-53.7987	-38.6213	20	N2_Close	Oblique WCB 2.2S
24	01/01/2023 05:55	-53.4281	-38.6677	20	N1_Open	Oblique WCB 2.2N
24	01/01/2023 06:26	-53.4374	-38.6957	196	N1_Close	Oblique WCB 2.2N
24	01/01/2023 06:26	-53.4375	-38.6959	196	N2_Open	Oblique WCB 2.2N
24	01/01/2023 06:56	-53.4447	-38.7237	24	N2_Close	Oblique WCB 2.2N
30	02/01/2023 01:34	-53.6538	-37.9849	42	N1_Open	Target
30	02/01/2023 01:38	-53.6509	-37.9860	14	N1_Close	Target
30	02/01/2023 01:40	-53.6498	-37.9866	36	N2_Open	Target
30	02/01/2023 01:44	-53.6480	-37.9876	17	N2_Close	Target
31	02/01/2023 02:32	-53.6375	-37.9916	52	N1_Open	Target
31	02/01/2023 02:37	-53.6350	-37.9922	15	N1_Close	Target
31	02/01/2023 02:40	-53.6335	-37.9925	33	N2_Open	Target
31	02/01/2023 02:43	-53.6321	-37.9929	29	N2_Close	Target
36	03/01/2023 01:41	-53.3347	-37.7588	19	N1_Open	Oblique WCB 4.2N
36	03/01/2023 02:14	-53.3194	-37.7811	196	N1_Close	Oblique WCB 4.2N
36	03/01/2023 02:14	-53.3193	-37.7812	198	N2_Open	Oblique WCB 4.2N

36	03/01/2023 02:44	-53.3071 Target	-37.8016	16	N2_Close	Oblique WCB 4.2N
39	03/01/2023 15:47	-53.7152	-37.9444	20	N1_Open	Oblique WCB 4.2S
39	03/01/2023 16:15	-53.7139	-37.9690	115	N1_Close	Oblique WCB 4.2S
39	03/01/2023 16:15	-53.7139	-37.9693	115	N2_Open	Oblique WCB 4.2S
39	03/01/2023 16:42	-53.7137	-37.9888	18	N2_Close	Oblique WCB 4.2S
40	03/01/2023 19:11	-53.6762	-37.6615	90	N1_Open	Target
40	03/01/2023 19:13	-53.6750	-37.6630	78	N1_Close	Target
40	03/01/2023 19:16	-53.6732	-37.6648	92	N2_Open	Target
40	03/01/2023 19:17	-53.6722	-37.6659	75	N2_Close	Target
41	03/01/2023 21:07	-53.6610	-37.7015	111	N1_Open	Target
41	03/01/2023 21:09	-53.6609	-37.7037	93	N1_Close	Target
41	03/01/2023 21:14	-53.6605	-37.7091	63	N2_Open	Target
41	03/01/2023 21:18	-53.6603	-37.7134	32	N2_Close	Target
42	03/01/2023 22:31	-53.6661	-37.7810	109	N1_Open	Target
42	03/01/2023 22:33	-53.6652	-37.7830	92	N1_Close	Target
42	03/01/2023 22:38	-53.6629	-37.7875	61	N2_Open	Target
42	03/01/2023 22:42	-53.6611	-37.7911	27	N2_Close	Target
150	24/01/2023 16:57	-60.4378	-46.5295	41	N1_Open	Target

Table 8. Successful RMT8 hauls carried out in the Western Core Box (WCB) on cruise DY158.

Catch composition and krill length-frequency

From the RMT8 station hauls, the overall zooplankton community was predominantly comprised of small euphausiids (*Thysanoessa spp.*, *Euphausia frigida* and *E. triacantha*), amphipods (*Themisto gaudichaudii*) and large copepods (*Rhincalanus gigas*). Few salps and fish were observed.

Antarctic krill was relatively abundant in the study region and samples collected by targeted RMT8 hauls were between 33 and 65 mm in size, with cohort modes at ~44 and ~52 mm (Figure below). Multiple stages of maturity were observed within single hauls, with the population structure varying substantially between targeted swarms. However, immature and juvenile specimens were most abundant in most hauls.

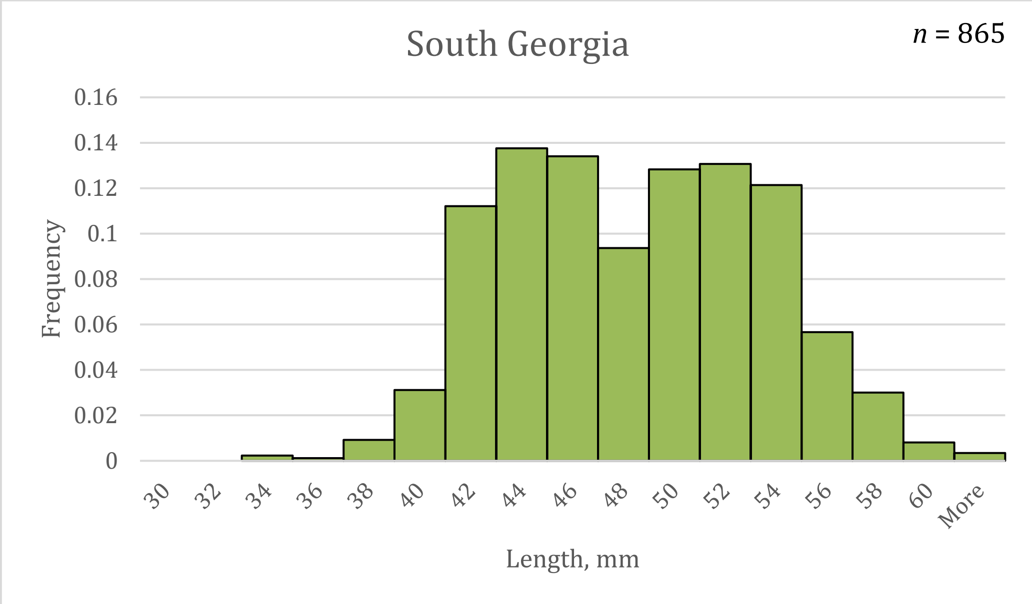


Figure 24. Length-frequency of Antarctic krill in the WCB region from targeted RM8 hauls.

Stable isotope analysis

In order to establish an isotopic baseline for POM across the Scotia Sea particulate organic matter (POM) was collected in the Western Core Box, along the oceanographic transects A23, Orkney Passage (NCL and BIOPOLE) and along Iceberg A76a. POM samples were obtained through filtering waters collected by Niskin bottles deployed via a CTD rosette (WCB, A23, Orkney Passage) and from the Underway clean seawater system (Iceberg A76a). From the CTD water was taken from various depths at each station (Table 9). All water samples collected were processed on-board. Depending on the density of particles varying volumes of seawater per depth were filtered onto 47 mm GF/F filters and the filters stored frozen at -80°C.

Station	Event	Sample depths
P3	11	10 m, 25 m, 75 m, 125 m, 200 m, 450 m, 750 m (no discernible Chlmax)
WCB 3.2N	27	5m, Chlmax (25 m), 75 m, 125 m, 200 m, 450 m, 750 m, 3042 m
WCB Mooring	51	5 m, Chlmax (17 m), 25 m, 75 m, 125 m, 200 m, 287 m (300 m seabed depth)
ECB Mooring	61	Chlmax (6 m), 25 m, 75 m, 125 m, 200 m, 261 m (280 m seabed depth)
A23-51	66	5 m, Chlmax (60 m), 125 m, 200 m
A23-48	71	5 m, Chlmax (45 m)
A23-46	75	5 m, 25 m, Chlmax (50 m), 75 m, 125 m, 200 m, 450 m, 750 m
A23-44	78	5 m, Chlmax (20 m)
A23-24	80	5 m, Chlmax (20 m)
A23-26	84	5 m, Chlmax (20 m)
A23-28	87	5 m, Chlmax (20 m), 75 m, 125 m, 200 m, 450 m, 750 m
A23-30	91	5 m, Chlmax (15 m)
A23-33	98	5 m, Chlmax (30 m), 75 m, 125 m, 200 m, 450 m, 750 m
A23-35	101	5 m, Chlmax (30 m)
A23-40	108	5 m, Chlmax (20 m)
A23-42	113	5 m, 25 m, Chlmax (35 m), 75 m, 125 m, 200 m, 450 m, 750 m

M2 Mooring	117	5 m, Chlmax (30 m), 125 m, 200 m
OP1	121	5 m, Chlmax (40 m)
OP3	124	5 m, Chlmax (40 m), 75 m, 125 m, 200 m, 450 m, 750 m
OP6	129	5 m, Chlmax (40 m)
Iceberg A76a-U1-12		Underway clean seawater supply (6 m)

Table 9. POM samples collected for δ13C and δ15N stable isotope analysis on DY158.

9. ParaKrill

Alison Cleary and Geraint Tarling

Research Goals:

The overall aims of ParaKrill are to improve our understanding of the assemblages of parasites interacting with Antarctic krill, and the impact of these parasites on key life-history parameters of the krill, in order to place krill-parasite interactions into ecological, fisheries, and biogeochemical contexts. On DY158, my main aims were to collect krill from the region to determine in-situ parasite infection rates, and to measure the respiration rate of krill individuals (which will be later assessed for parasite infection) in order to determine the impacts of parasite infection on respiration, and thus metabolism, of krill individuals.

Methods:

Krill were mainly collected in the RMT8 net, with a few opportunistic samples obtained from Bongo net catches. Krill for in-situ parasite infection rates were preserved immediately (T0), with 40 individuals each in ethanol and frozen (-80) samples. Krill for respiration experiments were transferred gently from catch buckets into either the krill condos (20L buckets with mesh-bottom liners to prevent ingestion of faecal pellets), or the krill hotel. Krill condos were filled with filtered seawater, while the krill hotel contained ambient flowing seawater, so krill which initially were housed in the krill hotel were then placed into a krill condo for at least 12 hours prior to an experiment to evacuate gut contents.

Respiration was measured for batches of 30-80 krill, as soon as practical after collection. Krill were placed individually in ~250 ml BOD bottles of filtered sea water, and the O2 concentration was measured with a Presence firebox4 probe. Krill were incubated for a variable amount of time, until O2 concentrations were between 70 and 90% saturation. A final time point O2 concentration measurement was then taken, the krill was removed from the BOD bottle, photographed next to a size and colour standard, and preserved in 96% ethanol. O2 consumption was calculated from these measurements in a custom Matlab script.

Sample type	Area	Number of Samples
In situ krill samples (T_o)	South Georgia	10 jars of 20 krill
In situ krill samples (T_o)	South Orkneys	8 jars of 20 krill
Respiration experiment krill	South Georgia	297 individual krill vials
Respiration experiment krill	South Orkneys	354 individual krill vials
Krill moults	Southern Ocean	19 moults in vials
Water filters	Southern Ocean	87 filters in vials

Table 10. Samples & data collected.

Figure 25. Krill Condos

Figure 26. Respiration measurements in the controlled temperature room. Left – Alison measuring oxygen concentration with the probe, Right – Geraint photographing and then preserving the krill.

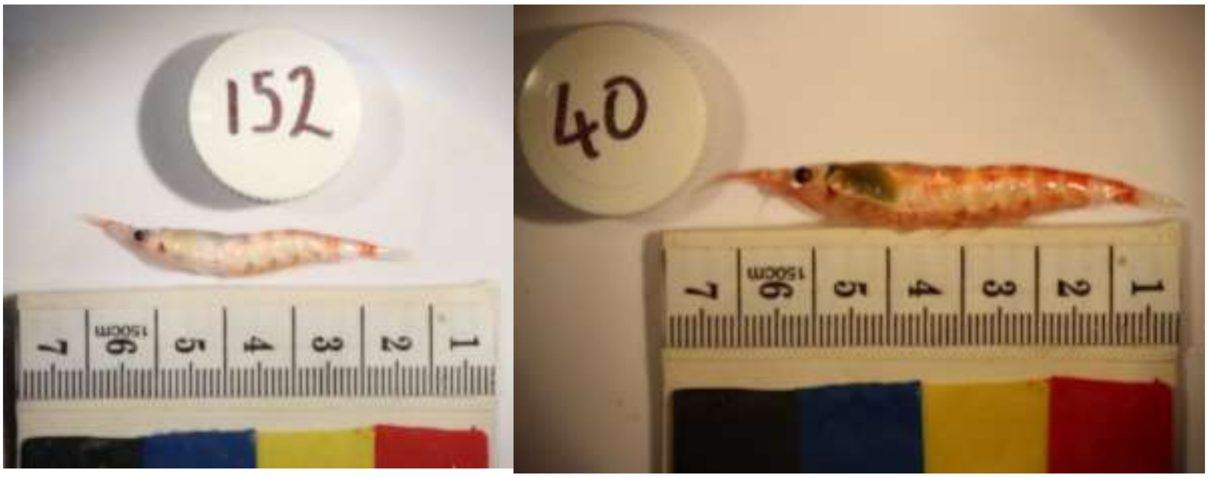


Figure 27. Example krill photograph, note scale and colour standard, and the inclusion of the sample vial cap to identify each photo to the krill individual.

Suggestions for future applications of similar methods:

- There were challenges keeping the controlled temperature room at ambient ocean temperature. The floor was typically 1.5 to 2 degrees warmer than the table top. The temperature was also strongly affected by periods of frequent door openings. In the future it would be good to bring a temperature block/bath (e.g. the beast). It might also be worth thinking about some kind of video doorbell and/or in/out board system – to reduce the number of times the door was opened by people looking for someone (who wasn't in fact in the room).
- Placing the BOD bottles back into the boxes in order after washing/refilling was a bit tricky. If boxes are used again, it would save time/confusion if the bottom of the boxes were labelled with the BOD bottle numbers, so each bottle could be placed back in sequence, regardless of the order they are washed in.
- The krill hotel could have housed more krill if there were more cylinders and jars. Plumbing fittings were borrowed from the ship. Both of these should be checked before it is packed again.
- Krill condos could be improved by adding air stones and a pump with an adjustable air rate. Some compromise lids might also be beneficial – sealed lids are much easier to carry around when the buckets are full, and provide good darkness, but may be reducing the oxygen available to the krill.
- Producing sufficient filtered seawater was fairly time consuming at points (~5 min/10 L, filling all krill condos requires 100 L). Perhaps worth looking into a higher flow rate system, possibly something which could connect directly to ship flow through, instead of an additional pump. An auto-shut-off for the water filter would also be a good addition to improve efficiency and reduce stress.
- Pack more of: non-skid mat (several rolls), black sharpies, small towels to dry BOD bottles before measurements, very small shifters or marlin spikes for assembling/disassembling small shackles on MOCNESS.
- Each of the BOD bottles was more than the nominal volume of 250 ml (closer to 280 ml). They also varied between each other by ±5%. Ensure that exact volumes of each bottle is measured. We achieved this on the ship using a motion compensated balance.
- Leave sufficient time to attach and calibrate each oxyspot in each jar. This took the best part of 4 days to do 120 bottles – we were careful to carry out this calibration at the temperature the experiments were to be carried out at.

10. CUPIDO

Clara Manno, Emily Rowlands, Pip Birchenall and Angelika Slomska

Introduction to CUPIDO (CalcUlating the strength of the Plastic pump In counteracting the Deep export of Oceanic carbon)

The Ocean provides a fundamental ecosystem service to our society by absorbing about 30% of atmospheric CO_2 which helps mitigate the effects of climate change.

Zooplankton play a pivotal role in this process through the so-called Blue Carbon pathway, promoting the transport and storage of large quantities of Carbon to the deep oceanic sediments through the sinking of their faeces, moults and carcasses and through their vertical movement along the water column. Nowadays the zooplankton Blue Carbon pathway is potentially threatened by a global emerging stressor: plastic pollution.

The amount of plastic entering our oceans is increasing worldwide, with global implications for the health of our planet.

Once in the ocean, plastic litter breaks down into millions of small fragments called microplastics (< 1 mm), which can find their way into zooplankton and lower the sinking velocity of their faeces, moults and carcasses.

CUPIDO addresses two main scientific questions:

1. What is the role of zooplankton in promoting the transport of plastic in the ocean?
2. How may this plastic transport interfere with the ability of zooplankton to store carbon in the deep ocean?

The central hypothesis of CUPIDO is that the pathway of plastic from the ocean surface to the depth, when incorporated into zooplankton (named the Zooplankton Plastic Pump), will reduce the capability of the ocean to regulate atmospheric CO_2 emissions.

To address this hypothesis, CUPIDO adopts cutting edge multidisciplinary approaches within an extensive field-based research program, carried out in two contrasting regions with relatively low (Southern Ocean) and high (Mediterranean Sea) level of plastic pollution. Through floating and moored ocean platforms and *in situ* experiments, CUPIDO will generate extensive datasets to feed ecological models to determine the impact of the Zooplankton Plastic Pump on the ecosystem service provided by the oceans in sequestering atmospheric CO_2.

The potential loss in Carbon export and storage by the Ocean corresponds to a change in welfare for our society. Overall, CUPIDO outcomes will assess the potential loss in climate mitigation due to the Zooplankton Plastic Pump and the related economic cost to society.

As part of the DY158 cruise, several kit deployments and laboratory experiments were carried out under the umbrella of CUPIDO including:

1. Deployment of Ocean Plastic Incubator Chamber (OPIC) system **to investigate in situ microplastic degradation over the years.**
2. Deployment of Floating sediment trap to assess the sinking flux of microplastic along the water column.
3. Incubation experiments to expose Krill to microplastic pollution.
4. Collection of water at different depth suing the CTD cast to study the vertical distribution of microplastic along the water column.

Microplastic degradation, OPIC

Overview

Up to now, plastic degradation in seawater has mostly been investigated in controlled laboratory settings and at relatively short-term scales (days or months), mainly testing Ultraviolet (UV)-light, abrasion, and chemical oxidation (reviewed in Sun et al., 2020; Liu et al. 2021). However, laboratory simulations and aging technologies can only mimic some of the multiple environmental factors responsible for the real plastic weathering (Liu et al. 2021). Weathering experiments have suggested that plastic degradation at sea under natural conditions can be accelerated, with significant changes occurring already after 1 year (i.e., Song et al., 2017), also due to the interactions with biological components (Dawson et al., 2018; Roager and Sonnenschein, 2019). For a proper understanding of the mechanisms governing plastic degradation in the deep sea, long-term field-based studies in this remote environment are thus necessary.

To address this knowledge gap, we deployed a novel piece of equipment for the *in situ* monitoring of plastic degradation at sea, the OPIC system, designed and assembled at the British Antarctic Survey. OPIC is designed to be installed alongside mooring line platforms for the deployment in the open ocean at various depth, from surface waters up to 400 m. The customised moored system is equipped with multiple sensors to measure seawater physical and chemical parameters and an automated rotating carousel to expose plastic samples to natural environmental conditions for defined time periods, up to 3 years. For full details see Bergami et al., (2022).

OPIC is designed to test a variety of plastic materials across a wide range of polymers (with both low and high density), sizes (macro- and mesoplastics), shapes (fragments, films, textiles) and aging levels (virgin or weathered materials).

Deployment

OPIC was deployed as part of the P3 mooring, at a depth of 200 m. Nine different polymers were tested in each chamber. The polymer order was varied among chambers (Figure 28).

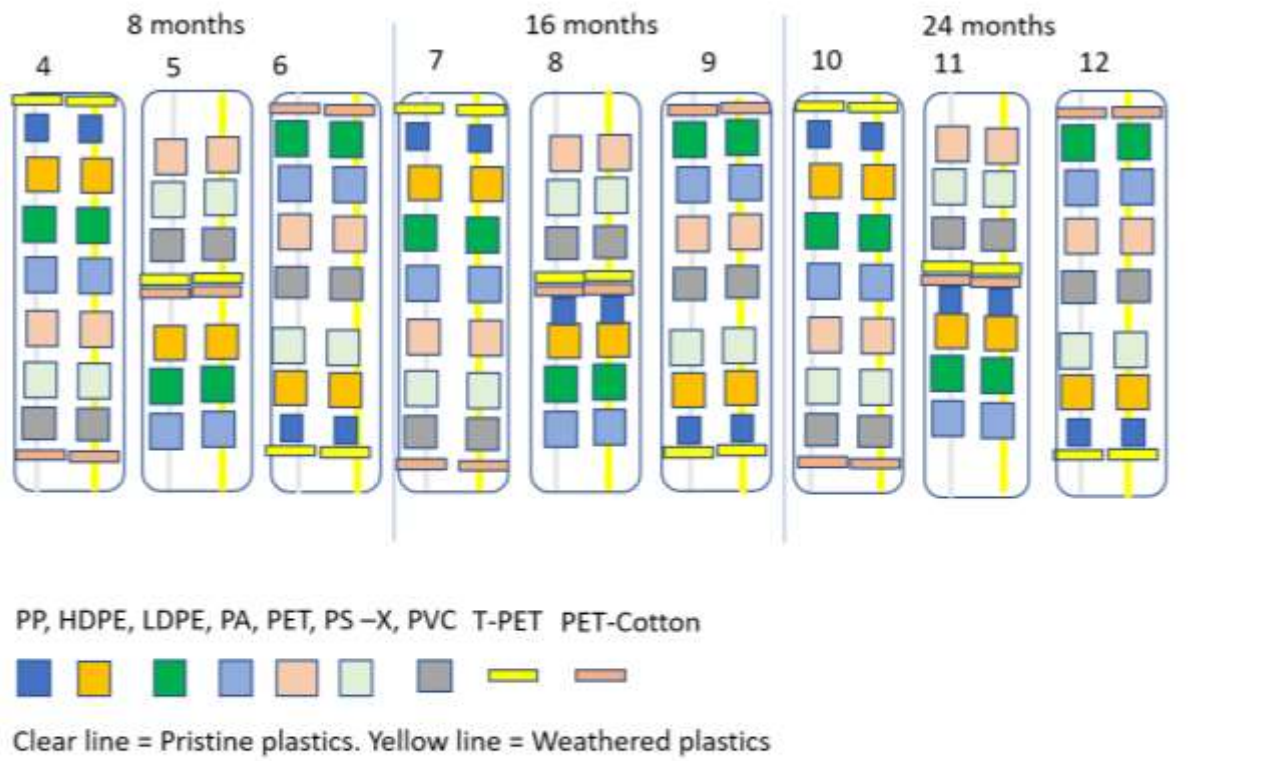


Figure 28. Schematic of polymer order in each chamber.

Figure 29. OPIC chambers prepared for deployment. Programming was carried out to move 3 chambers into the 'garage' after 8, 12 and 24 months. Chamber 5 was loaded into OPIC upside down therefore the polymer order is transposed.

For each polymer type, a pristine sample was pre-weathered under laboratory conditions to produce aged samples. Each chamber during deployment then contained a pristine line of polymers and a weathered line of polymers.

Post recovery

OPIC will be recovered after 2 years. Following OPIC recovery, plastic samples will be collected and replicates split for different analyses, as listed in Table 11. Plastic macroscopic features, such as weight loss and changes in size, colour and opacity can be determined following visual observation and weigh of the specimens. Changes in plastic mechanical properties as polymer density, tensile strength and crystallinity can be determined through sinking experiments, tensile testing and differential scanning calorimetry, respectively. Surface alteration and erosion over time is assessed through SEM, while changes in polymers chemical bond structures are detected using **Fourier-transform infrared (FTIR) spectroscopy.** The hydroxyl, carbonyl, carbon-oxygen indexes resulting from this analysis have been used as indicators of plastic surface oxidation and thus of plastic aging in natural settings (Brandon et al., 2016; ter Halle et al., 2017).

Furthermore, plastics incubated with OPIC will be analysed to evaluate the adsorption of contaminants from the surrounding seawater (Rochman et al., 2014; Chen et al., 2018; Syberg et al., 2020) as well as to determine the composition of the plastisphere that is the biofilm associated to plastics at sea, the presence of invasive species and antibiotic resistance (Laganà et al., 2019; Ibabe et al., 2020).

Plastic feature(s)	Analysis	Marker of plastic degradation
Macroscopic	Visual observation, Weigh	Change in colour and size, weight loss

Mechanical	Sinking, Tensile testing, Differential scanning calorimetry	Change in buoyancy in seawater, tensile strength, crystallinity
Surface roughness	SEM	Embrittlement, Erosion
Chemical composition	**FTIR**	Hydroxyl, carbonyl, carbon-oxygen indexes
Biological colonisation *	**eDNA extraction and sequencing,** Microbial characterization	Plastisphere composition, spread of invasive species, antibiotic resistance
Interaction with contaminants *	Chromatography	Chemicals adsorbed

Table 11. List of the features of plastic samples, (non-) destructive analyses and related outcomes indicative of long-term in situ plastic degradation, which can be determined using OPIC equipment.

Microplastic ingestion: Krill and faecal pellet incubation experiments

Overview

We exposed Antarctic krill to amino (NH_2, cationic) 7 µm polystyrene microparticles over 60-hour short-term exposures. From a carbon sequestration point of view, we investigate how polystyrene spheres impact the sinking rates of faecal pellets, which will in turn impact the transport of carbon to the deep ocean. From an ecotoxicological perspective, we investigate lethal and sub-lethal endpoints. The influence of plastic presence on microbial communities will also be explored.

Methods

Antarctic krill were collected by rectangular midwater trawl (RMT-8) from Event 30 and Event 150. Soon after sampling krill were moved to the cold room in buckets to acclimatise.

After three hours, krill of a similar size that were actively swimming were selected for a short-term in vivo exposure study. Experiments were carried out in the dark, within 3 L Kilner jars filled to a volume of 2 L with.

Four treatment conditions were used including a control of filtered seawater (0.22 µm), a plastic treatment (2.5 µg/mL unlabelled PS-NH_2), an algae treatment and a plastic plus algae treatment. Each treatment contained three replicates, and each jar 3 organisms. Microplastic was vortexed but not sonicated prior to preparing dilutions. The microplastics were purchased from magsphere without antibacterial preservatives known to be toxic e.g., sodium azide. Algal feed was made up according to the concentration used in Dawson et al., (2018b), whereby they used 0.00798 mg (dry weight) per 4 litre jar. With dry weight equating to 8% of wet weight, a large stock was made by weighing the equivalent wet weight:(0.00798/4) * (100/8) = 0.02948 mg/L (wet weight). A 1000* stock solution was made up (294.8 mg/L) and subsequently aliquoted from.

Initially mesh bottoms were added to the kilner jars to prevent krill from interacting with the negatively buoyant faecal pellets. However, it quickly became apparent that the krill were able to navigate around/under the mesh bottoms which were therefore removed to prevent krill from becoming trapped.

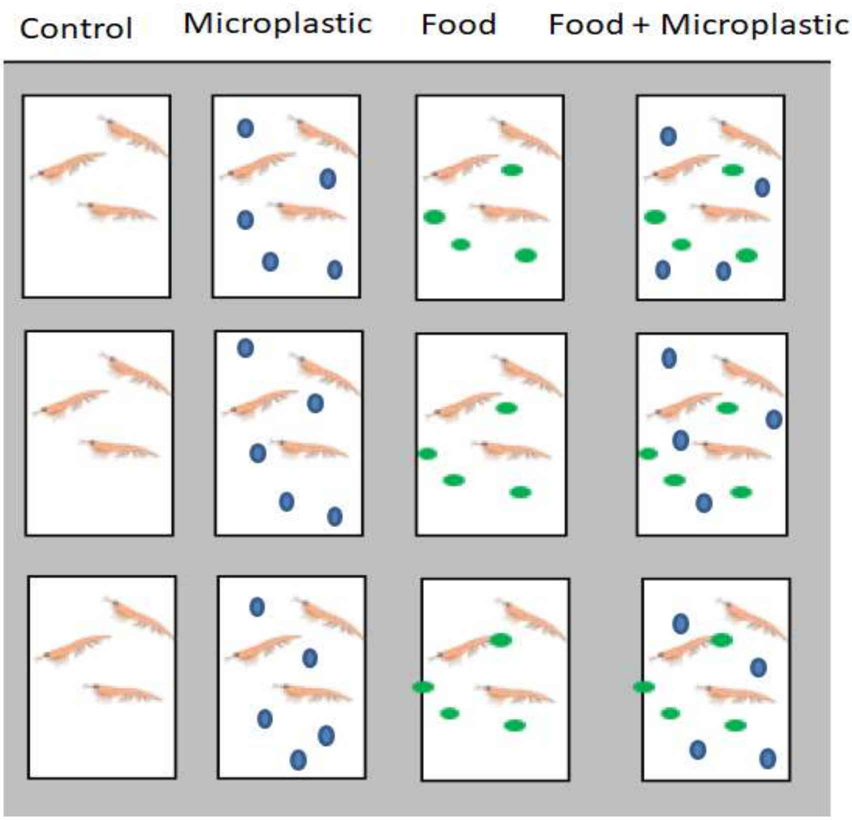


Figure 30. Schematic of the krill incubation experiment including a control 0.20 µm.

Each experiment was carried out for 60 hours, at which point the experiment was terminated. All krill were frozen at -80 °C. A 50 ml water sample from each incubation jar was also frozen at -20 °C. In Cambridge, water samples will be assessed to measure microplastic aggregation, as well as microbial communities. Lipid analyses will be conducted on the krill. The composition of krill faecal pellets, as well as their sinking rate will also be investigated.

Vertical distribution of microplastics within the water column

Plastic pollution has become a global environmental issue, reaching even the most pristine and remote wilderness of our planet. Microplastic concentrations within the Southern Ocean (SO) is an area of data paucity. Previous studies have outlined presence of plastics in the SO, but most of the studies have been focused on sub-surface waters while less attention has been dedicated to studying the vertical distribution of microplastics within the water column.

The aim of this study is to investigate the vertical distribution of microplastic concentration across the Scotia Sea (South-West Atlantic sector of the SO) in specific areas characterized by contrasting environmental regimes (i.e. presence of ice, bloom, open ocean versus shelf region), Figure 31.

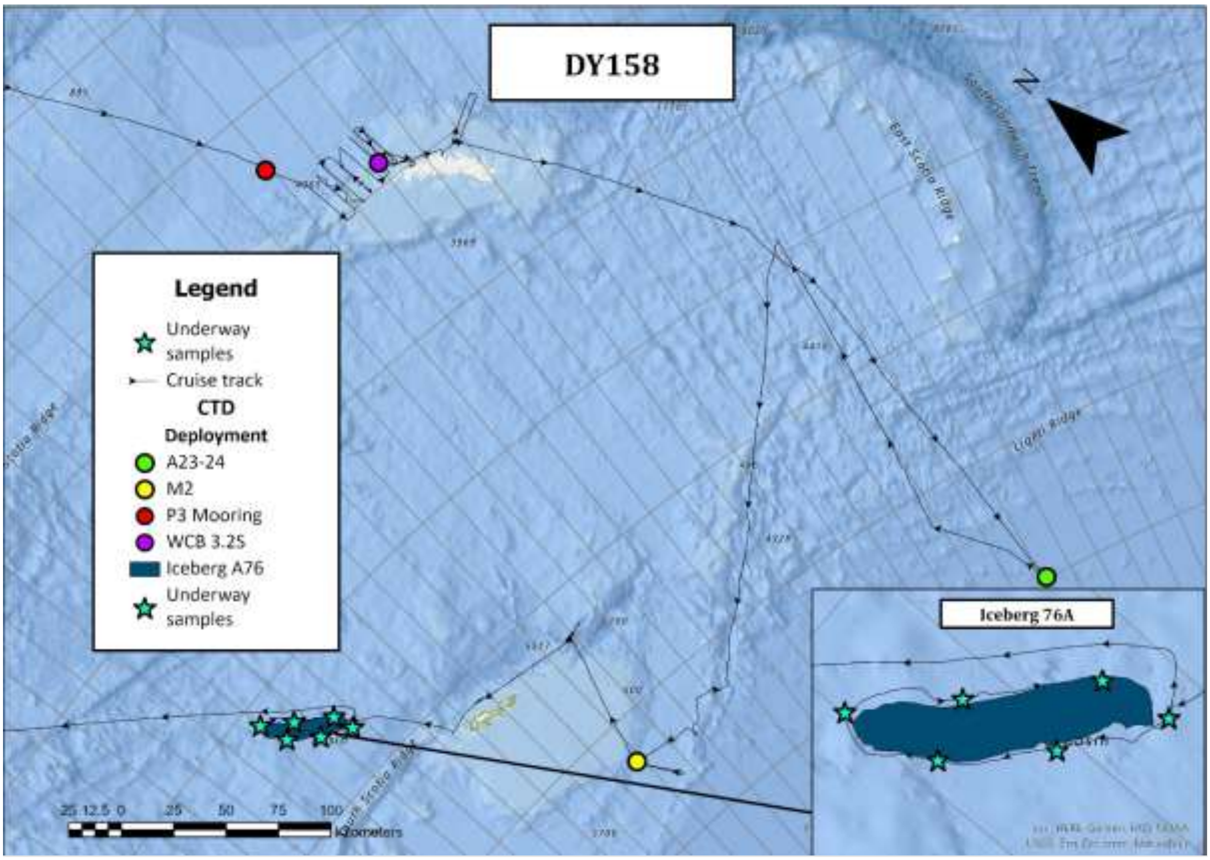


Figure 31. An overview of microplastic sampling sites. Different coloured dots indicate water column sampling from CTD stations, Table 11, and blue stars indicate underway sampling around Iceberg A76.

Sample Collection and Processing

Figure 32. Microplastic sampling from a CTD. A: Filling up of carboy from a Niskin bottle with microplastic contamination precaution in place. B: Filtering MilliQ in preparation for sample processing in the trace metals lab onboard.

Sea water from stations P3-2, W3.2, A23-24, M2, fig 1, was collected using a CTD cast equipped with Niskin bottles at 6 depths (10 m, 50 m, 150 m, 200 m, 500 m, and 1000 m). Samples were stored in large carboys in the cold room at -4 degrees Celsius for later processing. Samples (23 L per depth, two carboys worth in total) were filtered in a clean lab onto metal meshes and preserved at -20°C for later laboratory analysis, Figure 32. Back in Cambridge samples will be investigated using a FTIR (Fourier Transform Infra-Red) machine to identify microplastic characteristics (polymers, type, size, etc).

Table 12: Information showing station, CTD cast and event number, sampling times, niskins and sample keys of depths sampled for microplastics. Full 20 L carboys were used per sample key except for A23-24 100 m, highlighted blue, which was sampled opportunistically and 1/3 full. One filter was used per depth, except for samples collected at 10 m and 50 m where one filter was used per carboy. This was due to higher organic content (predominantly phytoplankton) present at these shallower depths saturating filters at a faster rate. 13.54 L of M2 10 m samples (highlighted in green) was processed out of the 23 L collected, due to a fastidious bloom.

Station	Event	Cast	Key	Carboy	Bottle	Depth (m)	Blanks	Start	End
P3-2	11	3	A	1	23	10	B1	3:03 am	3:34 am
			B	2	22	10	B2		
			C	3	19	50			

			D	4	18	50			
			E	5	14	150			
			F	6	13	150			
			G	7	11	200			
			H	8	10	200			
			I	9	7	500			
			J	10	6	500			
			K	11	3	1000			
			L	12	2	1000			
W3.2 S	37	10	M	1	9	10	B3 B4	6:54 am	7:06 am
			N	2	9	10			
			O	3	7	50			
			P	4	7	50			
			Q	5	3	100			
			R	6	3	100			
A23-24	80	27	S	1	22	10	B5 B6	10:35pm	11:46pm
			T	8	22 + 23	10			
			U	2	18	50			
			V	9	18 + 19	50			
			W	3	17	100			
			X	4	15	150			
			Y	10	15 + 16	150			
			Z	5	13 + 14	225			
			AA	11	13	225			
			AB	6	11	500			
			AC	12	11 + 12	500			

			AD	7	10	1000		
			AE	13	10 + 9	1000		
M2				1	22	10	B7		
				2	22 + 21	10	B8		
				3	16 + 15	50			
				4	16 + 15	50			
				5	14	100			
				6	14 + 13	100			
				7	10	200			
				8	10 + 8	200			
				9	7	500			
				10	7 + 6	500			
				11	5	1000			
				12	5 + 4	1000			

Table 12. Information showing station, CTD cast and event number, sampling times, niskins and sample keys of depths sampled for microplastics.

Iceberg A-76a

Opportunistic underway sea water sampling was conducted on a circumnavigation around iceberg A-76a, at six events (Figure 31). One carboy was filled per event of surface seawater from an inlet pipe, and stored at -4°C for processing using the same method in the trace-metals lab. A separate control was created.

Contamination control

Samples were taken of commonly worn clothing whilst in the lab and of various ship/kit to create a contamination polymer library. As for all microplastic analysis precautions were taken at all steps in sample handling and exposure to the environment to mitigate plastic contamination.

Sample collection:

- Covering carboy openings with tinfoil when being filled. All carboys were rinsed thoroughly with filtered 0.2 µm MilliQ before use, and tubing was rinsed.

Sample processing:

Samples were processed in the onboard trace metals laboratory, a clean lab that was repurposed for the duration of the cruise for plastic analysis. In the lab:

- Vent was shut off to reduce external airflow.
- Cotton lab coats were worn when entering the room to reduce fiber pollution and nitrile gloves were worn when handling samples and blanks. Similar clothing was worn when filtering, with sleeves pushed up underneath coat to reduce risk of exposure.
- Worktops were cleaned thoroughly before and after each use.
- Most analysis was conducted with one person in the room.
- All MilliQ used was double filtered; once at 0.22 µm in the machine and again manually using 0.2 µm Sartorius cellulose acetate filter.
- Samples and filtered Milli Q were covered with tinfoil at every opportunity.
- Equipment was rinsed x3 with double filtered 0.2 µm MilliQ before use
    - Filtration setup
    - Metal meshes used
    - Petri dishes used for housing end samples
    - Tweezers
- Two 2 µm polycarbonate filters where dampened with MilliQ, to replicate the samples being filtered, and placed either side of the filtering setup. They were covered/uncovered whenever the main samples were to account for potential airborne plastic contamination, predominantly fibres.
- The two atmosphere blanks were kept throughout all depths filtered per CTD and replaced every new event. During later analysis, the fibres caught in these two blanks will be counted and averaged across all depths filtered for that CTD.
- One control was created using filtered 0.2 µm MilliQ onto a 10-micron metal filter, using the same equipment and in the same environment where all sample processing took place.

Floating trap: sinking flux of Microplastic along the water column

Floating sediment traps (Figure 33) were deployed at the P3 station for 24h in order to investigate the extent of daily microplastic penetration in the ocean. The Floating trap line consisted of three units deployed at 50, 100 and 150 m. Each unit consisted of 4 metal collectors (with a cylindrical shape) to allow replicate. Each collector is provided with a lid that can be closed with a release messenger mechanism prior to the contamination during the recovering phase and ensure it truly sampled at the specified deployment depths. In terms of processing the water samples, post recovery, two bottles from each depth are filtered using the vacuum pump filtration system (flushed with milli-q before use) and a 45 micron nylon mesh for microplastic analysis. During filtering, in order to minimise contamination, aluminium foil is used to cover both the filtration and decanting beakers when not transferring liquid. A blank filter is exposed to the air each time liquid is poured. After filtration, all water is preserved at -20°C for analysis in the UK. In addition to plastics analysis, a further two bottles from each depth are filtered onto GFF filters for carbon analysis in Cambridge. Unfortunately, after 24h no samples were retried because the cylindrical units were lost during the recovering (see details on gear set up).

Figure 33. Deployment of floating sediment trap with the detail of the unit including a metal cage and four microplastic collectors. No plastic materials were used to build up the floating trap to avoid contamination; b- schematic of the floating trap deployment.

11. *Calanoides acutus* Experiments

Nadine Johnston and Geraint Tarling (Ecosystems Team)

Respiration Experiments

Rationale

As a contribution to the BIOPOLE project, direct respiration experiments were conducted on the copepod species *Calanoides acutus* to determine their metabolic rate. Over the course of their development *Calanoides 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). DY158 provided an ideal opportunity to conduct respiration experiments on stage CV specimens during the austral summer. Further planned BIOPOLE cruises on RRS SDA will provide an additional opportunity to investigate the metabolic requirements of this species (principally stage CV) during spring (2023) and the autumn period (2024/25) when they begin their descent for winter diapause.

Methods

See also detailed protocol and chapter on 'Bongo netting' for description of net deployments from which C. acutus specimens were obtained. 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). Once fridges had settled, 3x PreSens Oxodishes and Sensor Dish Readers (SDRs) were calibrated at these temperatures (using filtered seawater; 100% oxygen, and deoxygenated seawater; 0% oxygen). Two test runs were conducted in the absence of copepods. Copepods were collected at the locations given in Table 13 and Figure 34; one at P3, 3 at WCB, 7 along A23 and 1 at mooring station M2 and 1 in the South Orkney Passage using Bongo Nets (Figure 35). Contents of the codends were emptied into 50 L buckets (partially filled with seawater) and transferred to a controlled temperature lab (approximating sea temperature at the sampling location). Copepods were removed using a fine mesh hand-held filter and examined under the microscope to select for *C. acutus* CV individuals. For each station 15x specimens were immediately collected for Dr Dan Mayor (University of Exeter), cleaned in filtered seawater, divided between 3x (2 ml) Eppendorf tubes, sealed in a plastic bag, and stored at -80°C in a 2 L plastic container. A further 90 specimens were collected, cleaned in filtered seawater, and divided between 3 x 250 ml 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 of at least 6-8 hrs). Copepods were transferred from starvation vessels (sequentially) to each of the three 24 well Oxodish (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 (Figure 36). Once all Oxodishes were in place, respiration experiments were initiated and run for 4hrs. Data was stored on RRS Discovery Public drive, USB, and NMJs laptop. Following completion of experiments, each Oxodish was removed, wells examined under the microscope for presence/absence and condition of individuals. Individuals were then removed and photographed on a rimmed petri dish and prepared for C:H:N analyses (see below).

Issues encountered

1) Initially, PreSens software would not connect successfully with all SDRs (3 in an array) using the 'main laptop' we prepared and packed for the respiration experiments. Following the trouble shooting guide of the PreSens manual did not resolve the issue, however, connection to a different laptop (CLANNO), with a more recent software version (PreSens v4.1), did.

2) We discovered that the SDRs will not operate at below 0°C (errors were encountered in temperature data within the PreSens software, with temperatures below 0°C resulting in temperatures readings of the individual Oxodish wells of >600°C). We therefore changed fridge 1 (SDR-655) to 0.5°C. Fridges and external thermometers took several hours to settle and generate consistent readings.

3) 3) Parafilm caused the silicone pad and weight block to slip around, and off the Oxodish, pulling with it water and copepods. We initially tried running the experiments without parafilm (replying on silicon pad as an O2 barrier) but some copepods became stuck to the silicone (at least on removal). We solved the movement issue by taping the sides with electrical tape.

4) 4) Some well readings indicated oxygen generation, particularly on days when seas were rough. We tried to reduce incursion of oxygen bubbles by reverting to use of parafilm. Although complete removal of air bubbles not possible when laying on the parafilm, and again once securing the silicone and weight in place, we tried to record bubbles by taking photos of parafilm, and the underside after silicone and block added. Issues 3) and 4) need further thought on better logistics to improve experiments (and reduce death, movement of copepods between and out of wells, and slippage of parafilm, silicon and blocks) and the data must be carefully assessed after the cruise (to determine any patterns of 02 readings associated with individual SDRS/wells).

5) 5) Station A23-32 was largely devoid of *C. acutus*. It was also very difficult to find sufficient CV copepods from Station A23-41, so a limited number of individuals were used in the experiments, and taken from the first catch (200m depth) usually set aside for subsequent preservation. Specimens were dominated by CV, and individuals were smaller than those found in other stations, with soft (perhaps freshly moulted) individuals. The catches from these stations were dominated by phytoplankton, and small numbers of other copepod species and appendicularians. Also of note was the difference in size of *C. acutus* from the most southerly stations along the A23 Transect (Stations A23-24 and A23-28); Specimens were significantly larger in body size and lipid sac, and dominated by more females, than the more northerly stations along this transect (with individuals possibly representing a 2-year population vs a 1-year population further north).

6) 6) Downloading the data from the VWR Traceable Excursion-Trac Datalogging Thermometer was not straightforward, or as per the instructions. You must set datalogger to View Memory Capacity. The probe LED does not light up when USB stick is inserted; rather you need to wait until 'MEM' appears on the screen (to the right of the number of days left) which indicates that the data is downloading, once it has finished downloading it beeps. You can then remove the USB and download data to laptop. If MEM does not appear you must as per instructions 'wiggle the flash drive while inserting it until MEM appears and the data begins to download. Data from the 2.5°C fridge downloaded, but we could not get the data from the 0.5 and 5°C fridges. This was resolved eventually by replacing the batteries and wiggling the flash drive. 6) Thermometer of the 0.5°C fridge in the final two experiments was reading -1.4 to -2.7°C, however the fridge temperature reading remained consistent at around 0.5-0.7°C, unsure what caused his discrepancy. Will need to look at datalogging information when back in Cambridge and consider purchase of a new fridge.

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 within -80°C freezer for subsequent elemental analysis in the UK, to establish amounts of C, N and H in each specimen. This was done (1) for all *C. acutus* incubated within Oxidishes as detailed above and (2) for between 30 and 90 specimens extracted from the net catches at the same time as those extracted for the Oxidish incubations. 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 37Figure 37).

Issues encountered

1) it was very easy for copepods to dry out or die between the time they are placed on the counting plate and being photographed. To avoid this NMJ removed individuals from the wells, placed them on plate, photographed and inserted into tin capsule one at a time.

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. Female, CV, CIV and CIII individuals were preserved, also trying to get a range of lipid sac sizes.

Issues encountered

2 ml Eppendorfs are a space inefficient way of preserving individual *C. acutus*.

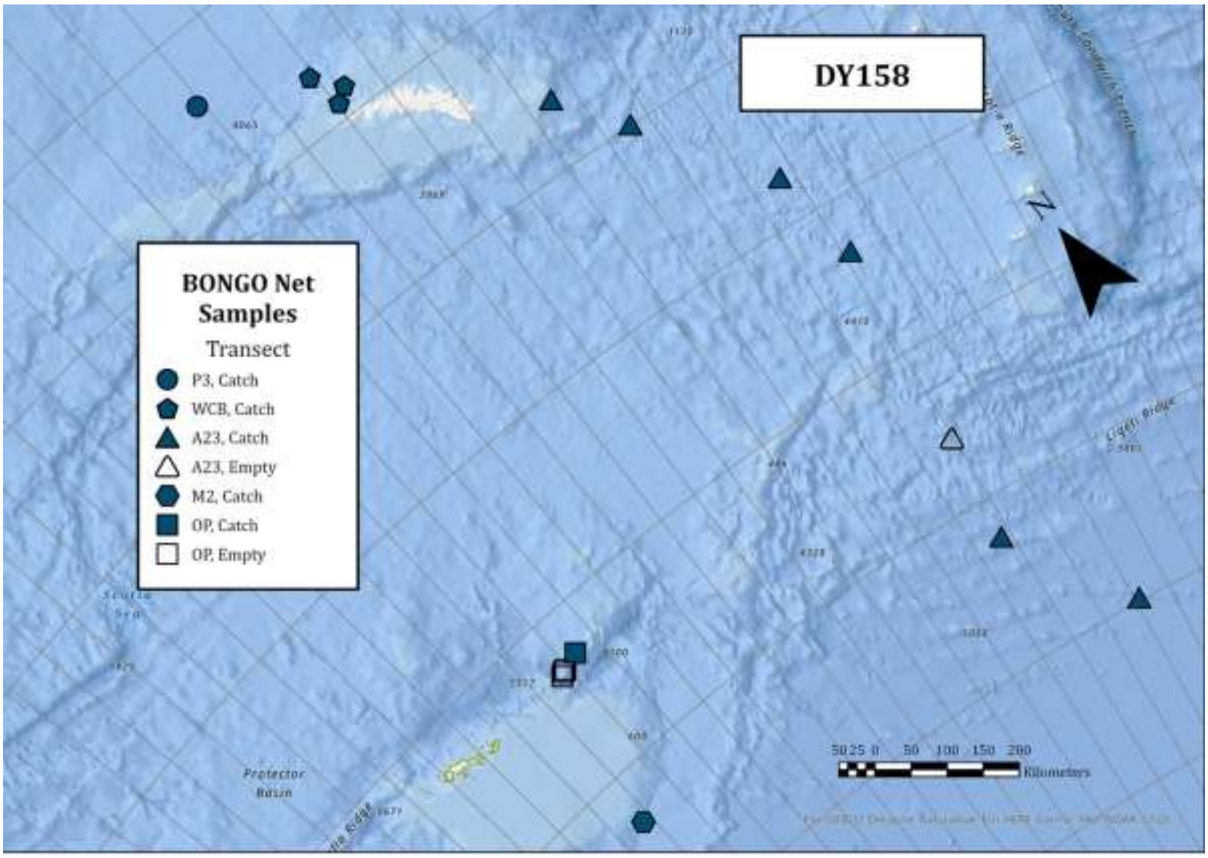


Figure 34. Map of sampling locations for Calanoides acutus on DY158. See Table 13 and Table 14 for details. Image prepared by Sarah Manthorpe (BAS).

Figure 35. Collection of Calanoides acutus samples on DY158.

Figure 36. Respiration experiments on Calanoides acutus CV on DY158.

Figure 37. Calanoides acutus stage CV pictured in a calibrated rimmed petri under an Olympus SZX Light microscope using a Canon 60D camera.

Transect/ Mooring	General location	Station	Event	Depth	Purpose	Date (UTC)	Comment
P3 Mooring	Scotia Sea	P3	10	200 m	RE #1, CHN	29/12/22	
WCB	South Georgia, Scotia Sea	WCB3.2N	29	100 m	RE #2, CHN	01/01/23	
WCB	South Georgia, Scotia Sea	WCB4.2S	45 (*incorrectly labelled as 44, there were three bongos; first one, 43, was aborted*)	100 m	RE#3, CHN, TOCHN	04/01/23	
WCB Mooring	South Georgia, Scotia Sea	WCB Mooring	53	100 m	TOCHN	05/01/23	

A23 Transect	Scotia Sea	A23-51A	65	100 m	RE#4, CHN, T0CHN	07/01/23	
A23 Transect	Scotia Sea	A23-48	73	100 m	RE#5, CHN, T0CHN	08/01/23	
A23 Transect	Scotia Sea	A23-44	79	200 m	RE#6, CHN, T0CHN, LIP	09/01/23	
A23 Transect	Weddell Sea	A23-24	81	100 m	RE#7, CHN, T0CHN, LIP	11/01/23	
A23 Transect	Weddell Sea	A23-28	89	100 m	RE#8, CHN, T0CHN, LIP	12/01/23	
A23 Transect	Scotia Sea?	A23-32	96/97	200 m & 100 m	LIP (97)	13/01/23	Not enough *C. acutus* for RE or T0CNH
A23 Transect	Scotia Sea	A23-41	110	200 m	RE#9, CHN, T0CHN	15/01/23	
M2 Mooring	Orkney Passage, Weddell Sea	M2 Mooring	119	100 m	RE#10, CHN, T0CHN	20/01/23	
Orkney Passage Moorings	Orkney Passage, Weddell Sea	OP1 Mooring (500m S, SE of OP1 Mooring)	122/123	200 m/20 0 m		21/01/23	Not enough *C. acutus* for RE, T0CHN, or LIP
Orkney Passage Moorings	Orkney Passage, Weddell Sea	OP6 Mooring	131	200 m	RE#11, CHN, T0CHN, LIP	21/01/23	
Orkney Passage Moorings	Orkney Passage, Weddell Sea	OP2 Mooring	139/140	200 m/20 0 m		22/01/23	Not enough *C. acutus* for RE, T0CHN, or LIP
Orkney Passage Moorings	Orkney Passage, Weddell Sea	OPCTD4 (near OP3)	148/149	200 m/20 0 m		23/01/23	Not enough *C. acutus* for RE, T0CHN, or LIP

Table 13. Details of sampling locations for Calanoides acutus on DY158. Copepods were sampled using a Bongo net (fitted with 1x 200 and 1x 100 m mesh net and rigid codends, deployed vertically to 100 or 200m at a rate of approx. 20m/min) for respiration experiments (RE), carbon, nitrogen, and hydrogen (CHN), time zero CHN (T0CHN), and lipid (LIP) analyses.

Date/Time (UTC)	Station	Event No.	Comment	Latitude	Longitude
29/12/2022 00:34	P3	10	Bongo net deployed	-52.8079	-40.1139

29/12/2022 00:46	P3	10	Bongo at 200m start recovery	-52.8079	-40.1139
29/12/2022 00:59	P3	10	Bongo net recovered to deck; picked and discarded	-52.8079	-40.1139
01/01/2023 21:50	WCB3.2N	29	Bongo nets deployed	-53.3615	-38.0822
01/01/2023 22:02	WCB3.2N	29	Bongo nets recovered; 100m down; picked and discarded	-53.3615	-38.0823
04/01/2023 02:03	WCB4.2S	45	Bongo net deployed	-53.678	-37.6527
04/01/2023 02:08	WCB4.2S	45	Bongo max wire out 100m, start recovery	-53.678	-37.6527
04/01/2023 02:15	WCB4.2S	45	Bongo nets recovered to deck; 100m down; picked and discarded	-53.678	-37.6527
05/01/2023 15:32	WCB Mooring	53	Bongo deployed	-53.799	-37.939
05/01/2023 15:45	WCB Mooring	53	Bongo recovered; 100m down; picked and discarded	-53.799	-37.939
07/01/2023 12:20	A23-51A	65	Bongo net deployed	-55.2302	-34.49
07/01/2023 12:24	A23-51A	65	Max wire on Bongo net 100m	-55.2302	-34.49
07/01/2023 12:31	A23-51A	65	Bongo net recovered to deck; picked and discarded	-55.2302	-34.49
08/01/2023 09:46	A23-48	73	Bongo nets deployed	-55.9902	-33.4192
08/01/2023 09:59	A23-48	73	Bongo nets recovered; picked and discarded	-55.9902	-33.4192
09/01/2023 09:05	A23-44	79	Bongo net deployed	-57.4583	-31.3272
09/01/2023 09:15	A23-44	79	Max wire out 200m	-57.4583	-31.3272
09/01/2023 09:28	A23-44	79	Bongo net recovered; picked and preserved	-57.4582	-31.3272
11/01/2023 09:06	A23-24	81	Bongo net deployed	-63.9646	-28.874
11/01/2023 09:17	A23-24	81	Max wire out 200m	-63.9645	-28.874
11/01/2023 09:28	A23-24	81	Bongo net recovered; picked and remnants preserved	-63.9645	-28.874
12/01/2023 12:01	A23-28	89	Bongo net deployed	-62.491	-31.2605
12/01/2023 12:07	A23-28	89	Bongo max wire out 100m	-62.491	-31.2605
12/01/2023 12:14	A23-28	89	Bongo net recovered to deck; picked and discarded	-62.491	-31.2605
13/01/2023 11:27	A23-32	97	Bongo net deployed	-61.1707	-31.046
13/01/2023 11:27	A23-32	97	Bongo net recovered to deck; picked and discarded	-61.1707	-31.046
13/01/2023 11:32	A23-32	97	Bongo net max wire out 100m	-61.1707	-31.046

15/01/2023 11:59	A23-41	110	Bongo net deployed	-58.6346	-30.8241
15/01/2023 12:12	A23-41	110	Max wire out 200m	-58.6346	-30.8241
15/01/2023 12:23	A23-41	110	Bongo net recovered; picked and remnants preserved	-58.6346	-30.824
20/01/2023 02:02	M2 Mooring	119	Bongo net deployed	-62.6151	-43.2439
20/01/2023 02:11	M2 Mooring	119	Bongo net max wire 100m	-62.6151	-43.2439
20/01/2023 02:25	M2 Mooring	119	Bongo net recovered to deck	-62.6151	-43.2439
21/01/2023 01:39	OP1	122	Bongo net deployed	-60.6311	-42.0874
21/01/2023 01:50	OP1	122	Bongo max wire out 200m	-60.6312	-42.0875
21/01/2023 02:02	OP1	122	Bongo net recovered; preserved	-60.6312	-42.0875
21/01/2023 02:04	OP1	123	Bongo net deployed	-60.6312	-42.0875
21/01/2023 02:15	OP1	123	Bongo net max wire out 200m	-60.6312	-42.0875
21/01/2023 02:26	OP1	123	Bongo net recovered; picked and discarded	-60.6312	-42.0875
21/01/2023 22:40	OP6	131	Max wire out 200m	-60.5626	-41.6326
21/01/2023 22:50	OP6	131	Bongo net recovered; picked and discarded	-60.5626	-41.6326
22/01/2023 19:38	OP2	139	Bongo deployed	-60.6413	-42.1692
22/01/2023 19:47	OP2	139	Max wire out 200m	-60.6413	-42.1692
22/01/2023 19:57	OP2	139	Bongo recovered; preserved	-60.6413	-42.1692
22/01/2023 19:58	OP2	140	Bongo net deployed	-60.6413	-42.1692
22/01/2023 20:07	OP2	140	Max wire out 200m	-60.6413	-42.1692
22/01/2023 20:17	OP2	140	Bongo net recovered; picked and discarded	-60.6413	-42.1692
23/01/2023 22:47	OPCTD4	148	Bongo net deployed	-60.6653	-42.256
23/01/2023 22:55	OPCTD4	148	Max wire 200m	-60.6653	-42.256
23/01/2023 23:04	OPCTD4	148	Bongo recovered; preserved	-60.6653	-42.256
23/01/2023 23:07	OPCTD4	149	Bongo net deployed	-60.6653	-42.256
23/01/2023 23:16	OPCTD4	149	Bongo net max wire out 200m	-60.6653	-42.256
23/01/2023 23:25	OPCTD4	149	Bongo net recovered; picked and discarded	-60.6653	-42.256

Table 14. Detailed information on Bongo deployments.

12. CASS Project: Methane investigation in the Atmosphere and the Water Column

Evelyn Workman

Atmospheric methane is a potent greenhouse gas. It is unknown how much methane the Southern Ocean releases into the atmosphere. This investigation aims to add to the current knowledge around methane in and above the Southern Ocean to help better understand how the Southern Ocean contributes to the atmospheric methane budget.

This study measures atmospheric methane concentrations, isotopic composition of atmospheric methane and methane concentration in the water column. Additionally, a methane flare search around South Georgia takes place, as this is an area of interest due to there being many active methane flares from the seabed.

The location of the different samples taken in this study are shown in Figure 38:

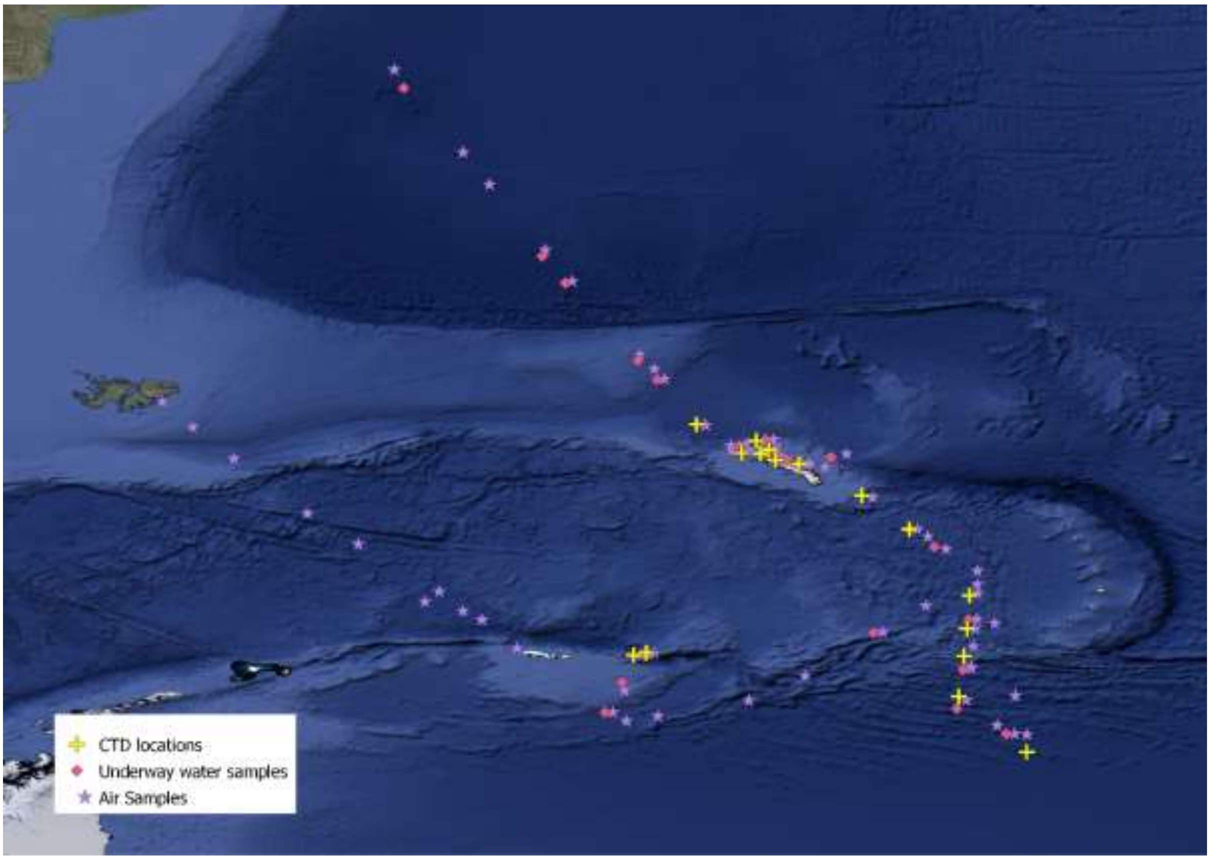


Figure 38. Location of samples (underway water, air and CTD) taken in the methane study.

Atmospheric methane

Methane concentration

Atmospheric methane concentrations are continuously measured using a Los Gatos Ultra Portable Greenhouse Gas Analyser (UGGA). The UGGA is setup in the meteorological laboratory, which sits towards the front of the ship on the boat deck. The inlet of the UGGA is on the meteorological mast at the front of the ship. This was chosen as the front of the ship should be minimally affected by pollution from the stack at the back of the ship. A 30-metre inlet tube (dekabon tubing, 3/8") joins the mast to the UGGA in the met lab. The UGGA takes measurements of atmospheric methane, carbon dioxide and water vapour every second. A KNF pump (type N816.1.2KN.18) pulls air from the inlet down the tube. The response time (time it takes air to travel from the inlet to the UGGA) is 10 seconds. A water trap, which is located just downstream of the inlet, will catch majority droplets of water entering the inlet. There are 2 inline filters in the setup to stop particles entering the pump/UGGA which could cause damage. Dryers (magnesium perchlorate drying tube and Nafion dryer) were used initially but were removed after a leak was identified in the Nafion. After the removal of the dryers the water vapour measured by the UGGA stays below 1% which is acceptable for operation.

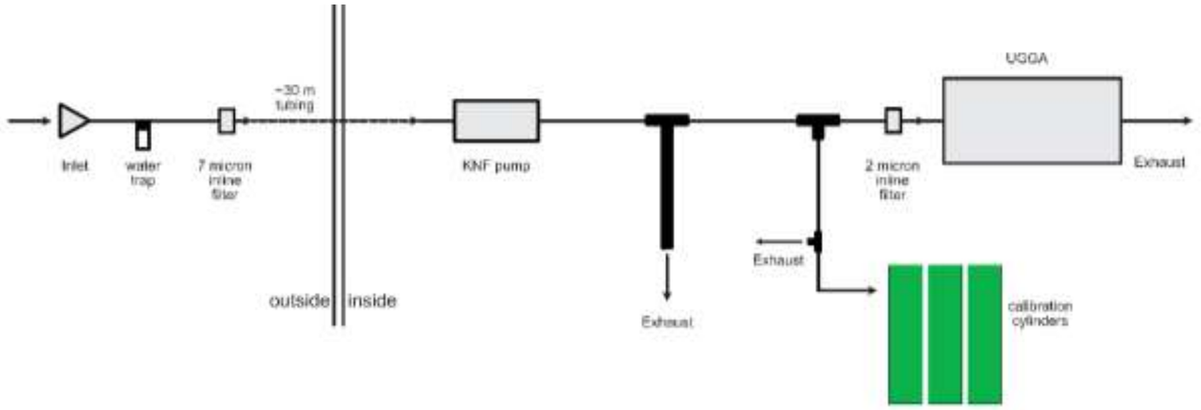


Figure 39. Setup of UGGA on Discovery. Air is travelling from left (inlet) to right through the system. The calibration gases are measured by switching from outside.

The UGGA is regularly calibrated by measuring gases of known CO_2 and CH_4 concentrations to get calibration equations to apply to the UGGA data. The calibration suite consists of 2 calibration gases and 1 target gas. The calibration gases are measured every 5 days and the target gas is measured every 2/3 days. Daily checks are performed on the instrument to make sure everything is working properly. These checks include looking at the gas pressure, water vapour, gas temperature.

Methane isotopic composition

Samples of air are collected for measurement of relative abundance of carbon 13 and deuterium which will help to identify the source of the methane (e.g., biogenic/thermogenic).

Procedure

Tedlar bags are filled with air using a handheld pump on the front deck during the afternoon and at night (ideally during darkness). As the afternoon sample coincides with when the atmospheric boundary layer is highest, it should detect a long-range source. As the night sample coincides with when the atmospheric boundary layer is lowest, it should detect a local source. Samples are usually taken underneath the mast on the starboard side as this area has least likelihood of contamination by ship pollution from the stack, which is located aft port side. However, at times of rough weather/wind/at night samples were taken on the upper deck (closer to the bridge). The inlet tube goes over the side of the ship when weather allows. The sampling process is demonstrated in Figure 40:

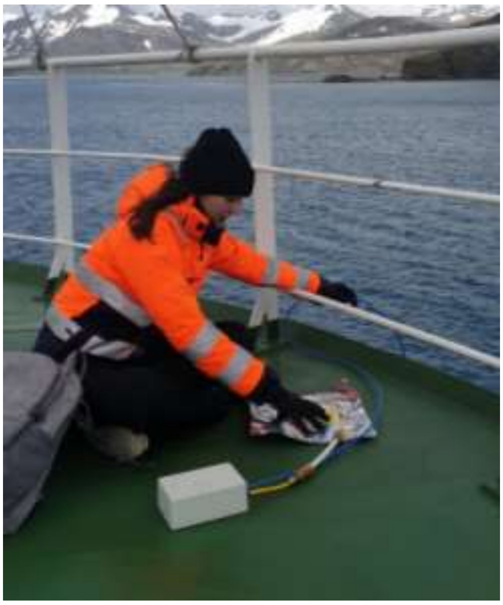


Figure 40. Sampling procedure for filling samples of tedlar bags with ambient air for methane isotope analysis. Blue tube is the inlet tube to the pump, yellow tube is the outlet tube of the pump going into the tedlar bag. There is a drying tube with magnesium perchlorate attached to the outlet tube which dries the sample, allowing it to be preserved for longer before analysis.

The tedlar bags of air are taken to Royal Holloway, University of London, UK, to be measured for carbon 13 and deuterium isotopes of methane.

Water methane concentration

Methane in the ocean can be produced at the seabed or near the surface. Methane at the seabed can be produced by degrading methane hydrates and can reach the sea surface by ebullition (in bubbles) or by diffusion. Methane hydrates can be biogenic or thermogenic in origin. Methane can also be produced biologically at the top of the water column by phytoplankton.

The aims of this section include comparing the methane concentrations in the water across different regions in the study area and calculating the sea-air methane flux to understand if different regions act as sources or sinks of atmospheric methane. Water samples are taken from the underway water system (surface) and from CTD casts (water column).

Procedure

Water samples are collected in 60 ml glass bottles. It is necessary to make sure that there are no bubbles in the bottle or the tube. The sample is then poisoned with 60 µL of mercuric chloride solution (7.7 g/L) to stop biological processes, which could change the methane concentration in the water before it is analysed. The bottle is then firmly closed with the stopper, crimped, and stored at room temperature/refrigerated. Bottles were filled with water in either the hangar (for CTD samples) or underway water sampling room (for underway water samples) and taken back to the filter laboratory to be poisoned under a fume hood.

16 CTD cast locations are chosen which cover a range of latitudes, off-shelf/on-shelf and areas of particular interest due to known presence of methane seeps. Samples are taken from between 8 and 11 depths for each CTD, spanning the whole water column with more samples taken near the surface as there is particular interest in the dynamics at the sea-air interface. Underway water samples are

taken more regularly, again at a range of latitudes and off-shelf and on shelf, usually between CTD casts. The location of sampling is shown in **Error! Reference source not found.**:

Time UTC	Event	Latitude	Longitude	Depth	Number of samples	CTD
28/12/2022 20:00	8	-52.8074	-40.114	3801.08	9	P3-1
01/01/2023 01:40	23	-53.7833	-38.5834	214.61	8	WCB 2.1 S
01/01/2023 21:00	27	-53.3614	-38.0819	2665.89	11	WCB 3.2 N
02/01/2023 05:08	32	-53.6772	-37.6551	135.01	8	WCB 4.2 S
04/01/2023 09:55	46	-54.0166	-37.4292	59.13	9	Rosita Harbour
05/01/2023 13:47	51	-53.799	-37.939	310.03	10	WCB mooring
05/01/2023 23:33	55	-54.1535	-36.6334	120.52	11	Stromness
07/01/2023 11:44	63	-55.2302	-34.4899	1011.35	9	A23-51A
08/01/2023 13:36	74	-56.3811	-32.8724	3175.24	9	A23-47
11/01/2023 06:06	80	-63.9646	-28.874	4826.87	9	A23-24
12/01/2023 17:53	90	-62.0758	-31.1829	4889.55	9	A23-29
13/01/2023 20:26	99	-60.6997	-31.0095	1596.79	9	A23-34
14/01/2023 11:42	103	-59.7658	-30.9051	3845.52	10	A23-37
15/01/2023 11:44	110	-58.6346	-30.8241	3541.13	9	A23-41
2023-01-22 01:06:19	132	-60.5900	-41.8287	2997.14	8	OP4
2023-01-23 22:28:46	147	-60.6652	-42.2560	1540.62	8	OPCTD4

Table 15. CTD casts from which samples for methane concentration analysis were taken.

The water samples will be analysed for methane concentration at University of Liège, Belgium.

Methane flares

Previous studies have found widespread methane seepage from the seabed around South Georgia (Römer et al., 2014, Bohrmann et al., 2019). However, it is not clear how much (if any) of this methane makes its way into the atmosphere. This study aims to find flares in the water column around South Georgia, including in bays and to investigate the methane concentration in the water, methane concentration in the atmosphere, and isotopic composition of atmospheric methane around the site of the flares, in order to investigate the impact flares have on the atmospheric methane concentration.

Procedure

A modified version of the method used by Bohrmann et al., 2017, is followed to detect methane flares in the water column around South Georgia. This entailed using a multibeam echosounder (EM710) to search for flares at the seabed on-the-fly. The nominal frequency of the EM710 is 100 kHz. The settings used are shown in Table 16. Note that some EM710 settings were adjusted (swath width, ping mode) throughout the survey, within the ranges in Table 16. A single beam echosounder (EK80) is also used at the same time (diverging from the method of Bohrmann et al., 2017) to spot flares on-the-fly. EK80 settings were the same as used during the WCB survey (41). The EK80 operates at five different frequencies (18 kHz, 38 kHz, 120 kHz, 200 kHz, 333 kHz). Both EM710 and EK80 are used as the EM710 has a larger spatial range than the EK80, but flares can be seen more clearly on the EK80.

The EM710 data is not recorded, as it is just being used for on-the-fly flare detection. The EK80 is also used for on-the-fly flare detection, but the data is recorded for later analysis as well. This data is initially viewed using the EK80 software to pinpoint exact timestamps of flares, then Echoview 30.0 software is used to look more clearly at the pinpointed flares and to generate the echograms (e.g. Figure 41 and Figure 42).

Settings used	EM710
Swath width used	110° to 140°
No. of beams used per swath	200
Ping mode	Very shallow/shallow
Spacing	High density equidistant mode
Dual swath mode	DYN

Table 16. Settings used for the EM710 echosounder during methane flare search.

Table 17 shows the date, time, and location that the methane flare searches took place, along with what echosounder was used in the search.

Survey number	Date Time period (UTC)	From	To	Echosounder(s) used
1	04/01/2023 0440 – 04/01/2023 0940	Western Core Box (-53.850792, -37.462225)	Rosita Harbour (-54.01615, -37.427937)	EK80, EM710
2	05/01/2023 0300 – 05/01/2023 1215	Rosita Harbour (-54.01615, -37.427937)	Western Core Box mooring (-53.796764, -37.926465)	EK80
3	05/01/2023 1646 – 05/01/2023 0245	Western Core Box mooring (-53.843212, -37.748261)	Stromness Bay (-54.15352, -36.634107)	EK80, EM710

Table 17. Date, time, location and echosounder used in methane flare searchers.

Using the method described here, no flares were detected on the EM710, but flares were identified on the EK80, as in Figure 41, for example, which was identified off north-east coast of South Georgia. The flares might only be detectable at lower frequencies, capable of the EK80, and not at the higher frequencies (100 kHz) of the EM710. This theory is supported by the fact that the flares are seen most strongly at the lowest frequency of 18 kHz, and weaker or not visible as frequency is increased (e.g., Figure 41).

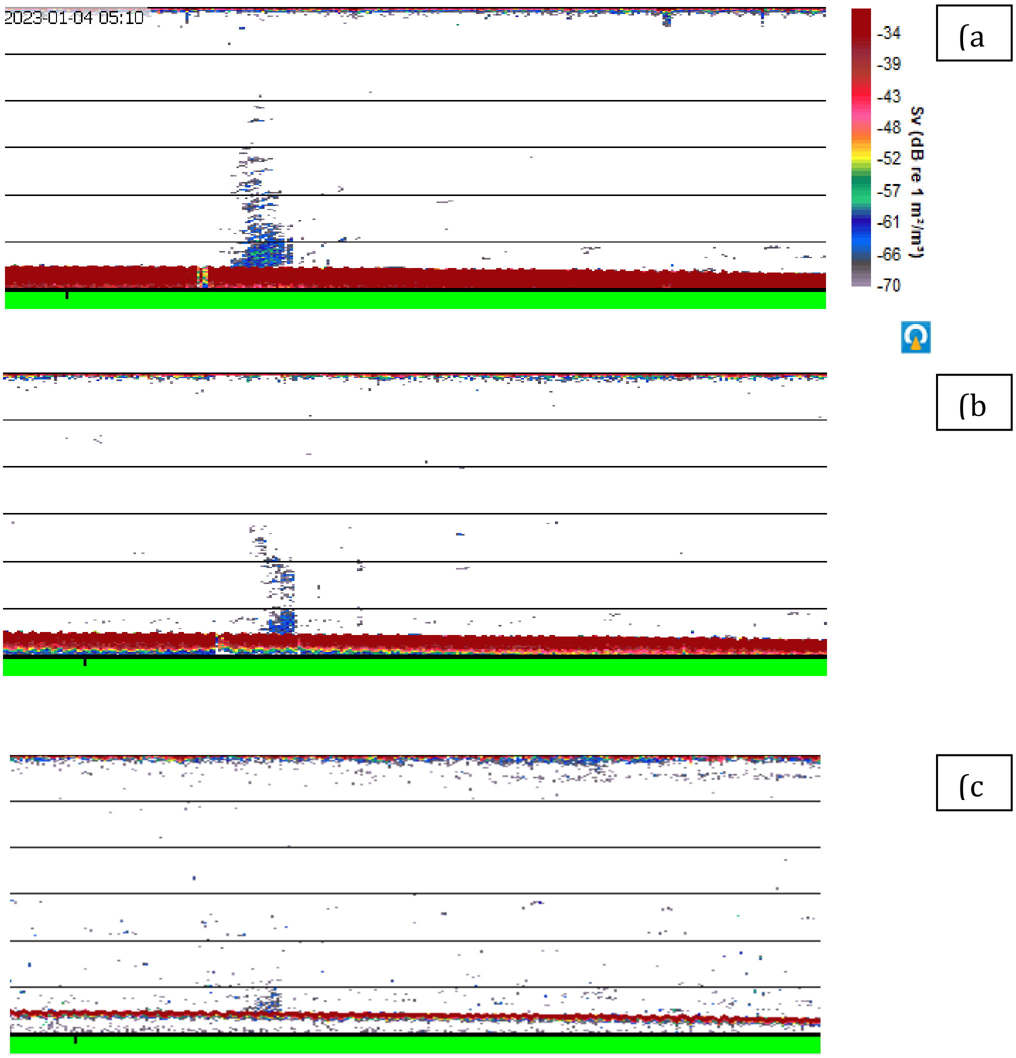


Figure 41. Echograms showing methane flare on the seabed off North-East coast of South Georgia looked at through the EK80 echosounder at different frequencies: (a).

Bay of Isles search

The EM710 was switched on 04/01/2023 (survey 1, Table 17) before going into Bay of Isles, South Georgia (for instrument calibration at Rosita Bay), and was switched off once we had reached the calibration site. Several flares were identified on the EK80, but not the EM710. Just the EK80 was used the next day (survey 2, Table 17) to look for flares around the Isle of Bays, no flares were detected during this period.

Stromness Bay search

EM710 and EK80 were used to look for flares down the east coast of South Georgia and into Stromness Bay, when travelling from WCB mooring site (survey 3, Table 17). Some flares were detected along the east coast of South Georgia, mainly on ridges, by EK80, but none appeared on the EM710.

The EM710 and EK80 are used to detect flares on the way going into the bay. The location of any flares would be pinpointed and the strongest flare (Figure 42) revisited on the way back out of the bay for further examination. Water column samples from a CTD cast and air samples are taken at the location of the strongest flare. The water samples will be analysed for methane concentration, and the air samples analysed for methane isotope abundance, as described previously. When flares were identified on-the-fly, air samples and underway water samples were also taken. The air samples bags were filled on the front deck starboard side with the tube of the pump hanging over the side of the ship, in attempt to detect a sea signal.

A few potential flares were identified in Stromness Bay; however, these signals were not as strong as had been identified the previous day in Bay of Isles. The strongest (potential) flare is shown in Figure 42. This is not a confirmed flare, however the site was still revisited and water samples were taken from a CTD (event number 55) and air samples taken. The flare was not seen again by the echosounders when the site was revisited. The water samples will be analysed at a later date for methane concentration, which could confirm if a flare is present here.

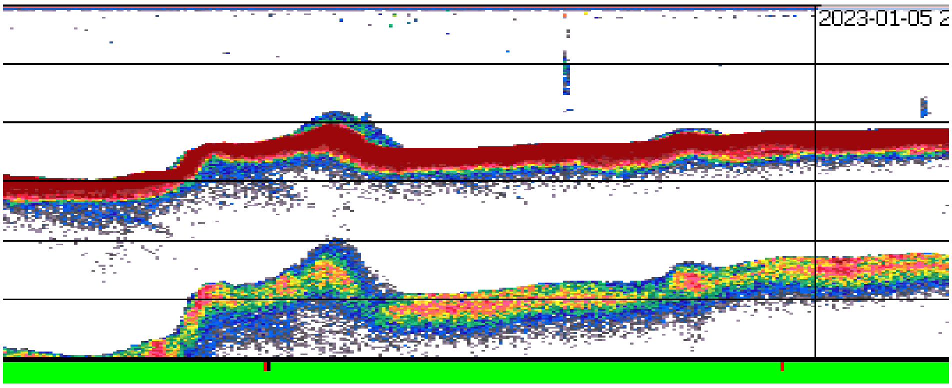


Figure 42. Echograms showing a potential methane flare on the seabed in Stromness Bay detected with the EK80 echosounder at a frequency of 18 kHz.

References

Bohrmann, G. et al. 2017. R/V METEOR Cruise Report M134, Emissions of Free Gas from Cross-Shelf Troughs of South Georgia: Distribution, Quantification, and Sources for Methane Ebullition Sites in Sub-Antarctic Waters, Port Stanley (Falkland Islands) - Punta Arenas (Chile), 16 January - 18 February 2017. http://nbn-resolving.de/urn:nbn:de:gbv:46-00106081-12

Römer et al., 2014. First evidence of widespread active methane seepage in the Southern Ocean, off the sub-Antarctic island of South Georgia. Earth and Planetary Science Letters, 403, pp.166-177.

11. National Oceanography Centre

NMF Sensors and Moorings

CTD, LADCP, & Salinometry

Cruise Report

Dougal Mountifield, Paul Henderson, Jon Short & Steve Corles

Figure 43. Photo of CTD011 in Rosita Harbour by Jon Short.

CTD Summary

The DY158 CTD work included a re-occupation of the A23 transect that was completed on DY113 (Feb-March 2020) and JC211 (Feb-March 2021). There were also a series of CTD deployments at the WCB sites NE of South Georgia, and ECB site SE of South Georgia, during EK80 fisheries acoustic surveys. Inter-calibration profiles were undertaken at the P3, WCB & ECB mooring sites. One CTD was completed in Rosita Harbour, South Georgia, prior to the EK80 calibration in the bay. An additional CTD was completed near Stromness for a Methane plume survey. There was an inter-calibration CTD at the M2 mooring site in the Weddell Sea and a series of CTDs in Orkney Passage at the OP mooring sites including some intermediate stations. No CTDs were undertaken during the circumnavigation of the A76A iceberg at the end of the cruise.

56 CTD casts were undertaken with an NMF 24-way Stainless Steel CTD frame with 24 off 20l OTE water samplers. Dual SBE 43 dissolved oxygen sensors were used as on DY113 and JC211. The temperature, conductivity and dissolved oxygen sensors mounted to the vane were connected to the secondary channel as per DY113. The WETLabs BBrtd sensor was mounted in a horizontal orientation on the vane and a SBE35 was mounted on a vertical stanchion of the CTD frame as per DY113 and JC211.

A single TRDI Workhorse 300 kHz LADCP was used in a down-looking configuration, and a single TRDI Workhorse 600 kHz LADCP was used in an up-looking configuration powered by an NMF LADCP battery pack with a titanium housing. Although the two LADCPs were connected as usual with a star-cable which facilitates synchronisation using the ‘B’ serial ports, the instruments were configured to free-ping. The ping periods were 0.8 seconds for the WH300 and 0.6 seconds for the WH600.

The Rolls-Royce ODIM (now Kongsberg) winch system Active Heave Compensation (AHC) system was used on all casts apart from shallower casts. The AHC system is currently engaged at the 100m changeover depth where winch control is changed from joystick manual mode to HMI automatic mode and the out-haulers are disengaged. The reverse happens at the same depth on the return to the surface.

One test-cast (CTD001) was successfully completed to 2000 m in 5450 m of water.
Mooring inter-calibration casts were undertaken at each of the P3, WCB, ECB, M2, and OP (1-6) mooring sites and a further seven casts completed during the WCB EK80 acoustic survey. Single casts were undertaken in Rosita harbour for EK80 calibration, near Stromness for CH4 Plume investigation and during the ECB EK80 acoustic survey.

31 casts were completed at 30 stations on the A23 line. The A23 line was initially commenced North-South starting with A23_52 near South Georgia. The CTD transect was broken off after A23_44 to steam for 2 days to the southern end of the line to avoid bad weather. The line was then recommenced South-North starting with A23_24. Problems were encountered with the scrolling of the CTD winch storage drum during the up-cast of A23-37 (CTD040). A second CTD cast (CTD041) was undertaken at A23_37 to resolve the scrolling problems whilst in the same water depth. The LADCPs were not run for this cast. All bottles were fired at 100m, but not sampled and the SBE35 DOST data was deleted. Therefore, there is no SBE35 DOST or LADCP data for CTD041. Due to the time expended resolving the winch scrolling issue and to keep on schedule, station A23_38 was not occupied.

The A23 line was completed in 9 days which is comparable with 7 days for both DY113 and JC211 once the 2-day steam south to avoid unworkable weather is accounted for.

The deepest cast was CTD020 at station A23_26 which descended to 4868 m. The shallowest cast was CTD011 in Rosita Harbour for EK80 calibration which descended to 46 m.

Stainless Steel CTD Configuration

Instrument Package

The following sensors were installed on the CTD frame:

CTD Underwater Unit	Seabird SBE 9plus	09p-0758
Primary Temperature Sensor	Seabird SBE 3P	3p-4381
Primary Conductivity Sensor	Seabird SBE 4C	4c-3873
Pressure sensor	Paroscientific Digiquartz	90074
Secondary Temperature Sensor	Seabird SBE 3P	3p-4383
Secondary Conductivity Sensor	Seabird SBE 4C	4c-4143
Primary Pump	Seabird SBE 5T	05-3085
Secondary Pump	Seabird SBE 5T	05-3607
Primary Dissolved Oxygen Sensor	Seabird SBE 43	43-1624
Secondary Dissolved Oxygen Sensor	Seabird SBE 43	43-3847
Altimeter	Valeport VA500	81629
Back Scattering Sensor	WETLabs BBrtd	168
Transmissometer	WET Labs C-Star	1719TR
Fluorimeter	CTG Aquatracka MKIII	88-2960-163
Deep Ocean Standards Thermometer	Seabird SBE 35 DOST	35-66264-0070
Down-looking LADCP	TRDI Workhorse 300kHz	24609
Up-looking LADCP	TRDI Workhorse 600kHz	21071

Table 18. Sensors installed on the CTD frame.

The WETLabs BBrtd backscatter sensor was fitted in a side-looking orientation on the CTD vane to site it in cleaner water-flow. This is the same arrangement as used on DY113 and JC211. The rationale is to improve the signal to noise ratio and reduce offset between down-cast and up-cast that has been observed in the past. The centre of the BBrtd face was located **0.77 m *above the pressure sensor***.

Figure 44. WETLabs BBrtd Backscatter Sensor Mounting Location same as DY113 and JC211.

The down-looking, 300 kHz TRDI Workhorse LADCP was located at the centre of the CTD frame. The up-looking 600 kHz unit was mounted within an out-rigger sub-frame on the opposite side of the CTD frame to the vane.

All instrument serial numbers and all channels of the 9plus underwater unit checked prior to completing the Sensor Information Sheets for DY158.

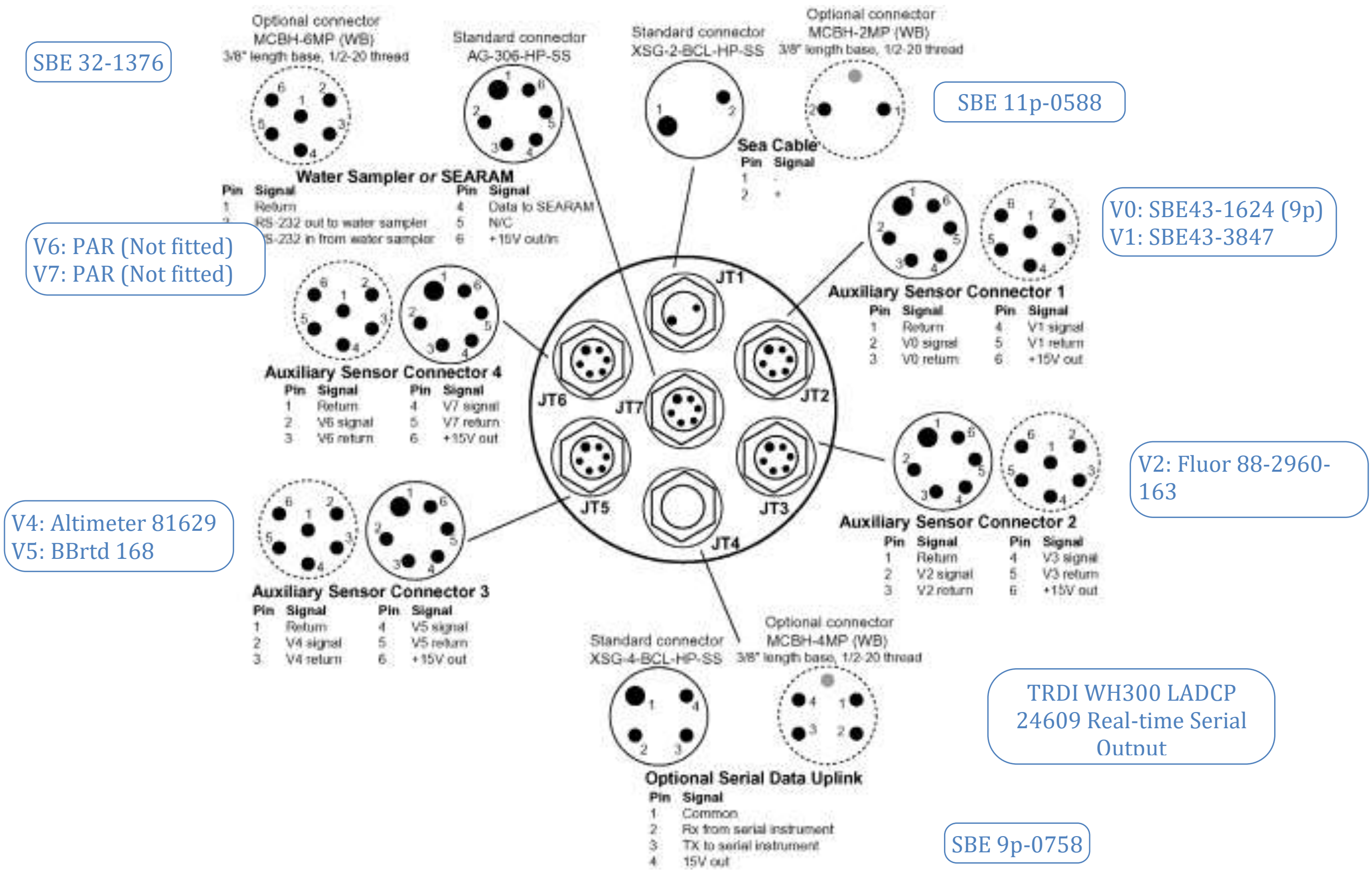
Use of Sonardyne WMT USBL Beacon

An NMF Ship Systems provided Sonardyne WMT USBL beacon was fitted to the CTD frame for most of the cruise as an aid to recovery in the unlikely event that the frame be lost. Beacon 3003 was used initially, but it became unresponsive when its battery fully discharged. Beacon 2707 was subsequently fitted in its place.

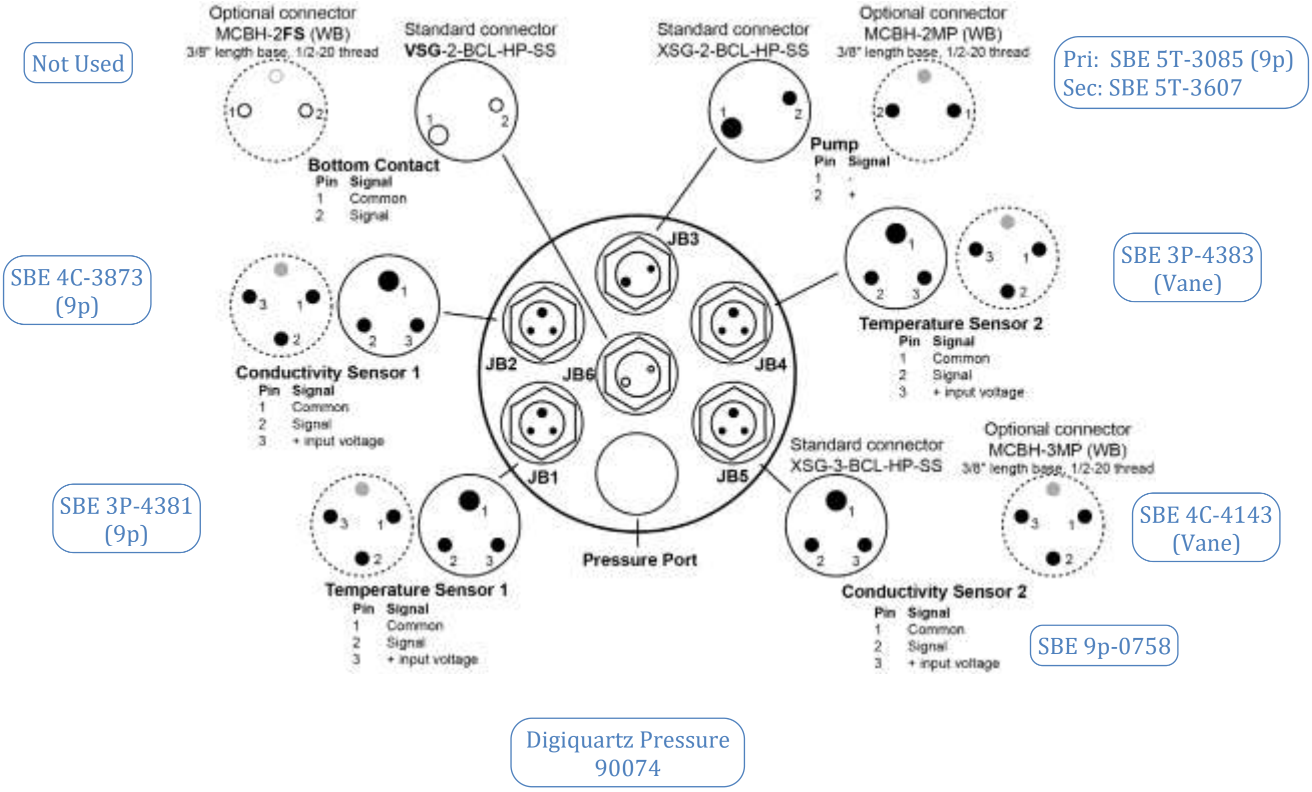
Mooring Release Tests and Instrument Inter-Calibration

There were five casts where mooring equipment was piggy-backed onto the CTD frame for inter-calibration or release tests. IxBlue acoustic releases, SBE 37 MicroCATs and RBRsolo instruments were attached to the frame as required for P. Abrahamsen. Bottle stop protocol was normally a 2-minute wait before firing the first bottle at each stop, then a further 30 second wait between bottles to allow the SBE35 DOST to complete its averaged measurements. When moored instruments were being carried, bottle stops were extended to 5 minutes.

SBE 9plus CTD Top End Cap Configuration



SBE 9plus CTD Bottom End Cap Configuration



Seasave Configuration & Instrument Calibrations

The Seasave Instrument Configuration file used for all casts was DY158_SS_0758_nmea.xmlcon

Date: 12/22/2022
Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY158\Data\Seasave Setup Files\DY158_SS_0758_nmea.xmlcon
Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4381
Calibrated on : 11-August-2021
G : 4.42358835e-003
H : 6.44921520e-004
I : 2.26464950e-005
J : 1.96836584e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-3873
Calibrated on : 18-August-2021
G : -1.02114237e+001
H : 1.35957511e+000
I : -1.44994712e-003
J : 1.74002759e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 90074
Calibrated on : 23-September-2022
C1 : -6.571123e+004
C2 : 2.050504e-001
C3 : 1.612220e-002

D1 : 2.883800e-002
D2 : 0.000000e+000
T1 : 2.986693e+001
T2 : -2.678465e-004
T3 : 3.986390e-006
T4 : 7.472100e-010
T5 : 0.000000e+000
Slope : 1.00012000
Offset : 0.01710
AD590M : 1.283700e-002
AD590B : -8.642460e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4383
Calibrated on : 14-August-2021
G : 4.39883014e-003
H : 6.55680856e-004
I : 2.43679732e-005
J : 2.03485058e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-4143
Calibrated on : 25-August-2021
G : -9.80139768e+000
H : 1.32180863e+000
I : 4.06486066e-005
J : 6.55692892e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-1624
Calibrated on : 06-January-2022
Equation : Sea-Bird
Soc : 3.49900e-001
Offset : -7.21400e-001
A : -3.61040e-003
B : 1.53800e-004
C : -2.58670e-006
E : 3.60000e-002
Tau20 : 1.22000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002

H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Oxygen, SBE 43, 2

Serial number : 43-3847
Calibrated on : 17-May-2022
Equation : Sea-Bird
Soc : 3.81200e-001
Offset : -7.21300e-001
A : -4.81590e-003
B : 2.03150e-004
C : -3.02670e-006
E : 3.60000e-002
Tau20 : 1.78000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3

Serial number : 88-2960-163
Calibrated on : 20-April-2022
VB : 0.099110
V1 : 1.905480
Vacetone : 0.471530
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Transmissometer, WET Labs C-Star

Serial number : CST-1719TR
Calibrated on : 2-February-2021
M : 21.2880
B : -0.0788
Path length : 0.250

10) A/D voltage 4, Altimeter

Serial number : 81629
Calibrated on : 9-June-2022
Scale factor : 15.000
Offset : 0.000

11) A/D voltage 5, OBS, WET Labs, ECO-BB

Serial number : BBRTD-168

Calibrated on : 14-April-2020
ScaleFactor : 0.003243
Dark output : 0.043000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 04
Calibrated on : 3-September-2020
M : 0.51511971
B : 1.00565570
Calibration constant : 21740000000.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 09
Calibrated on : 3-September-2020
M : 0.52185597
B : 1.00704213
Calibration constant : 21740000000.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 45

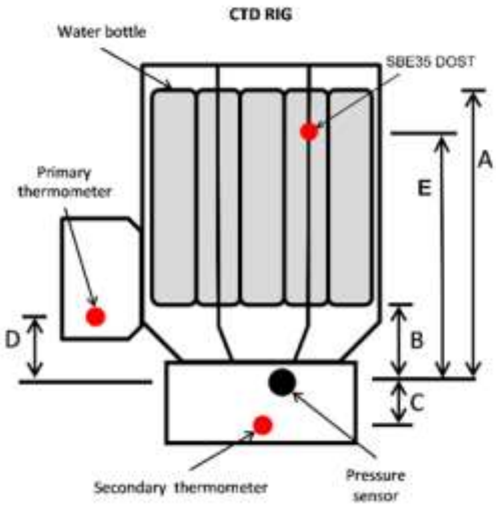
Sea-Bird SBE35 DOST Configuration

The SBE35 was connected to the SBE9plus underwater unit and the SBE32 carousel using its 'Y'-cable. It was configured to take 8 temperature samples each time that a bottle was fired.

** SBE35 V 2.0a SERIAL NO. 0070 24 Dec 2022 15:09:11*
** number of measurement cycles to average = 8*
** number of data points stored in memory = 0*
** bottle confirm interface = SBE 911plus*

** SBE35 V 2.0a SERIAL NO. 0070*
** 20-oct-22*
** A0 = 4.768966980e-03*
** A1 = -1.330483160e-03*
** A2 = 1.991284030e-04*
** A3 = -1.109066190e-05*
** A4 = 2.364790630e-07*
** SLOPE = 0.999992*
** OFFSET = -0.000113*

Stainless Steel CTD Frame Geometry



ID	Vertical distance from pressure sensor (/m positive-up)
A	1.3 (Top of 20l water samplers)
B	0.2 (Bottom of 20 L water samplers)
C	-0.075 (***Primary T/C mounted on 9p***)
D	0.085 (***Secondary T/C mounted on Vane***)
E	1.025 (SBE35 DOST probe sheath tip)

Figure 45. Seabird SBE 35 DOST Mounting Location Overview same as DY113 and JC211.

CTD Operations

CTD Deployment Method

The CTD was operated out of the Water Sampling Annex at the forward end of the hangar. It was deployed on the 11.43 mm conducting CTD wire (CTD2 storage drum) using the starboard P-frame. To provide shelter to the science party whilst sampling, the CTD was transferred to the water-sampling laboratory using the overhead hoist after recovery to deck. Closing the roller shutter door also allowed for the ship to be kept as dark as possible at night to minimise the risk of bird-strikes. This incurred a small time overhead for each deployment but allows the vessel to move off station more promptly.

There were a few occasions where the CTD was not recovered to the Water Sampling Laboratory between casts to facilitate a quick turnaround for closely spaced stations.

A normal operating range of 10m for the CTD package from seabed was used at the end of the down-cast and the winch operator was notified of the maximum wire-out. During stations with steep bottom topography or otherwise lower acoustic reflectivity, the time spent finding the bottom was extended. Shorter veer calls were issued at slower wire speeds to provide additional safety margin. When there was a strong current, and the vessel was moving over the ground, the proximity to the bottom at the end of the downcast was marginally increased for similar reasons.

Active Heave Control was used were possible. Eventually AHC was used throughout when the CTD was deeper than 100 m including the approach to the bottom and the bottom bottle stop.

MDS EM CTD Swivel

No problems were encountered with the NMF MDS EM CTD swivel. A spare EM CTD swivel was available but unfortunately this was not serviceable due to damage to its lower wet-pluggable bulkhead connector. The CTD wire was frequently insulation tested after disconnecting the termination pigtail from the swivel. The CTD wire maintained an insulation resistance of >999MΩ at 250V throughout the cruise.

AHC Performance

The winch AHC system performed faultlessly throughout the cruise (with the exception of cast CTD002), significantly damping the effect of vessel motion on CTD package motion. This significantly improves CTD data by reducing CTD package wake effects. CTD descent rate (dP/dt) was plotted for CTD002 when the AHC disengaged due to damper saturation. The difference in package motion with AHC on is remarkable.

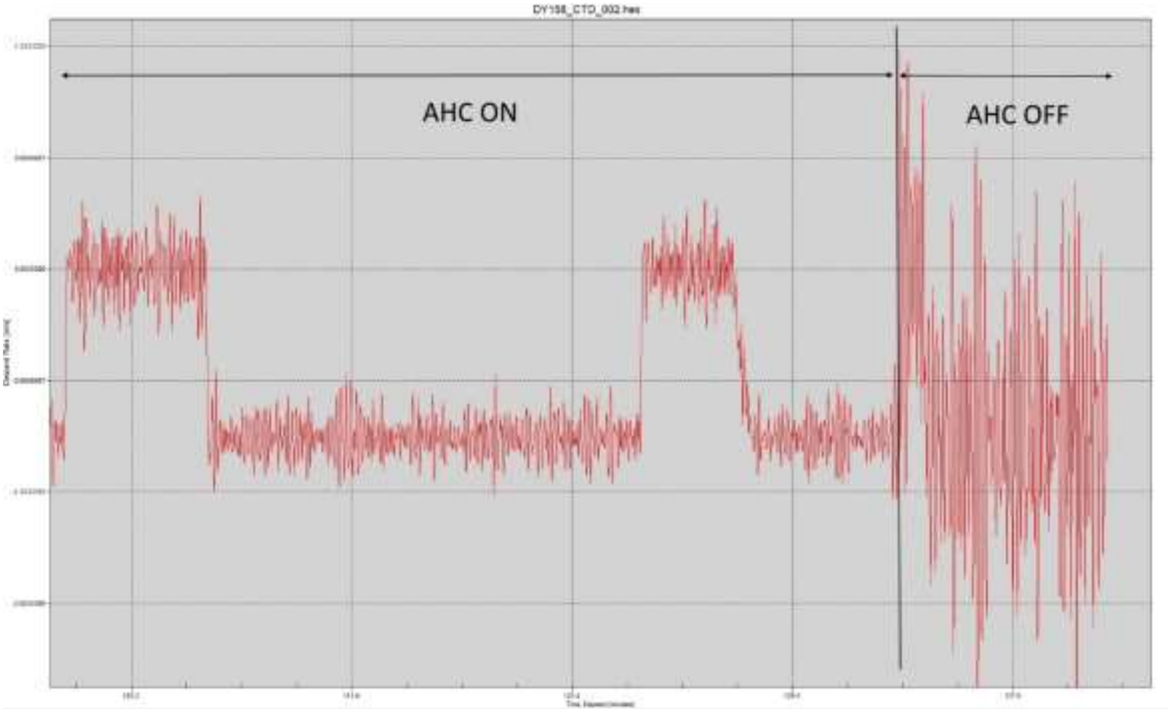


Figure 46. AHC performance on CTD 002.

CTD Sensor Cleaning Protocol

During the mobilisation, both TC ducts were cleaned with Triton-X and dilute bleach solutions agitated with a syringe. The TC ducts were thoroughly flushed with Milli-Q after each cleaning solution. All optical instruments (PARs, Fluorimeter, Transmissometer, BBrtd) were rinsed with Milli-Q, squirted with Triton-X solution, dried with Kimwipes, then polished with Optic Prep wipes.

Between casts the TC & DO sensor pairs were flushed with Milli-Q three times and drained before installation of caps on the TC-duct inlet and pump exhaust of both sensor ducts. When air or sea surface temperatures were approaching zero, Milli-Q flushing was stopped, and the TC ducts were drained of seawater after each cast by sucking the residual water out using a syringe.

The optical instrument faces were frequently rinsed with Milli-Q after recovery. A full clean with Milli-Q, Triton, Kimwipes and a final polish with Optic-Prep wipes was carried out when the interval between casts was greater than a few hours.

Between transects, the whole CTD package was rinsed with fresh water to prevent salt crystals forming on the sensors, associated tubing and particularly the carousel latch assembly.

The TC-ducts were not cleaned with Triton-X or bleach solutions during the cruise unless fouling was observed. There was one sensor fouling event during the cruise. After this fouling event both CTD ducts were syringe-cleaned with both Triton-X and bleach solutions and well flushed with Milli-Q.

During cast CTD031 (A23_28), the primary vane-mounted sensor duct fouled when the CTD package was at 2750 m on the downcast. The primary dissolved oxygen shifted ~4 µmol/kg low, the primary temperature and conductivity did not seem to be significantly affected. The oxygen offset slowly improved as the downcast continued and appeared normal as the bottom of the cast was approached. When the up-cast was begun, a very large ~40 µmol/kg negative spike in the primary dissolved oxygen was observed. Once again, this improved as the up-cast continued. The sensor package was inspected after recovery to deck. The 9p-mounted primary duct appeared to be clear with no signs of fouling.

Sea-Bird SBE35 Clock Reset & Deployment

The SBE35 Real-time Clock was set correctly to GPS UTC time during the mobilisation using the DDMMYY and HHMMSS commands. The SBE35 data was downloaded after each cast using Seaterm and the memory pointer reset using the samplenum=0 command, then confirmed with the ds command.

Unfortunately, the SBE35 RTC does drift, and the offset between GPS UTC and the SBE35 RTC did increase throughout DY158 to the order of one minute. This is normal and expected.

All discrete salinity samples were taken and analysed by the science party.

CTD Performance, Technical Issues & Instrument Changes

Calculation of Transmissometer Deck Calibration

During the mobilisation, the air and dark voltages of the transmissometer were measured as 4.8535 V (V_{air} or A1) and 0.0037 V (V_{dark} or Y1). When these measurements are applied to the manufacturer's calibration of 4.829 V (V_{air} or A0), 0.021 V (V_{dark} or Y0) and 4.678 V ($V_{purewater}$ or W0), the calibration coefficients of 21.2880 (M) and -0.0788 (B) were calculated and applied.

Please refer to the separately provided spreadsheet *'DY158 Transmissometer Seasave Calibration Calculations.xls'*, which also includes calculation for the PAR sensors. Please note that the PAR sensors were not fitted to the CTD frame for DY158.

CTD Instrument Performance

There were no major technical issues with the CTD suite during the cruise and no scientific instruments required changing for spares. There was no noticeable change in the differences indicated in Seasave between the primary and secondary sensors for temperature (<0.001°C), salinity (<0.001 PSU), and dissolved oxygen (<4 µmol/kg) during data acquisition. There was negligible drift in either of the SBE 3P temperature sensors when comparing them to the SBE 35 data during bottle stops. There was negligible drift in either of the SBE 4C conductivity sensors throughout the cruise when comparing them to discrete bottle samples.

The characterisation of CTD Temperature, Conductivity and Salinity offsets provided by Mike Meredith (BAS) indicates that the largest average offset is of the order of 3mK, 3 µS/cm and 3 mPSU respectively.

Characterisation of CTD Sensor Temperature, Conductivity & Salinity Offsets - Mike Meredith (BAS)		
Sensor Residuals	Mean of All Samples	Mean of all Samples > 1000 dbar
SBE3P T1 – T2	-0.2253 mK	-0.2306 mK
SBE3P T1 - SBE 35	-2.99 mK	0.74 mK
SBE3P T2 – SBE 35	-2.77 mK	0.98 mK
SBE4C C1 – C2	0.00106 mS/cm	0.0012 mS/cm
SBE4C C1 – Autosal Discrete	0.00226 mS/cm	0.00325 mS/cm
SBE4C C2 - Autosal Discrete	0.00120 mS/cm	0.00205 mS/cm

CTD S1 – CTD S2	1.79 mPSU	1.74 mPSU
CTD S1 – Autosal Discrete	1.82 mPSU	3.02 mPSU
CTD S2 – Autosal Discrete	0.04 mPSU	1.28 mPSU

Table 19. Characterisation of CTD sensor offsets.

CTD Suite Spares Availability

Two full suites of spare instruments were available for use. There were no instrumentation issues during the cruise and no instruments were changed during the cruise.

The PAR sensors that were allocated for DY158 were Chelsea Technologies Group (CTG) 2π hemispherical scalar units which have a depth rating of 500 m. Due to the majority of the casts being deep, the science party did not require these to be used and they were not fitted for any casts during the cruise. The two sets of spare PAR sensors available for use were also CTG 2π hemispherical scalar units with a depth rating of 500 m.

CTD Wire Condition

A full drum of new spare CTD wire was available on the CTD1 storage drum.
CTD2 storage drum was used on the cruise with no issues aside from the poor scrolling encountered during the up-cast of CTD040 (A23_37). The wire on CTD2 storage is in good condition. The mechanical termination and electrical splice was completed at the start of DY159 and is still in serviceable condition (DCR 75 Ω, IR > 999 MΩ). This termination has now completed 70 casts during DY159 and DY158.

The compass data from the LADCP instruments on the CTD frame was reviewed. The compass data indicate that the vane is doing its job – orienting the CTD package into the prevailing water current. A cast may have around eight rotations of the CTD frame during the downcast of a 4,000 m cast. All but one or two of these rotations will be unwound by opposite rotation on the up-cast, i.e. it is not the CTD package which is creating residual torque in the wire.

A spare CTD mechanical termination was available on-board. The Deep-tow wire was terminated during DY159 using the ROV Group Evergrip termination. Both the CTD2 and Deep Tow wires were load-tested, and functionally tested during DY159. The Deep Tow termination was used for BAS RMT-8 net deployment on both DY159 and DY158, completing about 35 deployments to 1000m maximum depth.

Water Sampler and Carousel Maintenance

All the water sampler bottles were leak-tested during the mobilisation by filling with fresh water, seating the end caps, closing the vents, and opening the taps. Weeping or dripping taps thus indicated if the bottle has an air leak. All were good.

During the mobilisation, the carousel head latch assemblies on the CTD frame was removed, dismantled, and thoroughly cleaned. Then the head assembly was reassembled and refitted to the carousel.

The carousel latches were occasionally rinsed with fresh water and Triton-X / Milli-Q solution and exercised to keep them free.

At the end of the cruise all bottles were leak tested again after cleaning throughout with fresh water, and no leaks were observed.

Noise on VA500 500 kHz Altimeter Caused by Up-looking Workhorse 600 kHz LADCP

DY158 was the first cruise where the recently procured Valeport VA500 500 kHz altimeter has been used at the same time as a 600 kHz LADCP. Considerable noise was observed on the altimeter channel throughout the water column. The noise was markedly reduced once within the 100 m range of the altimeter, but was occasionally still present.

Two consecutive casts highlight the issue. The first is CTD052 where the LADCPs were not run following the failure of the battery pack. The second is the following cast CTD053 where the LADCPs were once again run following the replacement of the battery pack. The Valeport VA500 500 kHz altimeter has been used recently with WH300 kHz LADCPs without this interference being observed.

There was a corresponding, but very small amount of noise from the VA500 altimeter present in the up-looking WH600 kHz LADCP data when in close proximity to the sea-bed. The noise in the LADCP data was not significant, and did not compromise the integration of the velocity profiles from the LADCPs.

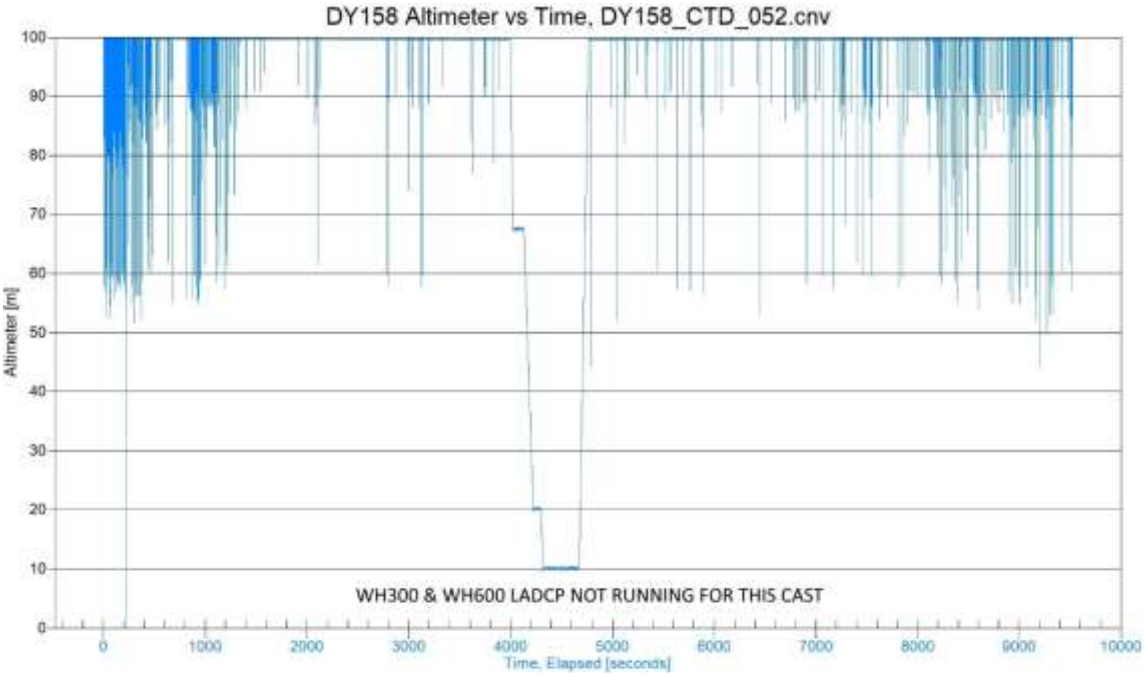


Figure 47. Noise on VA500 500 kHz Altimeter during CTD 052.

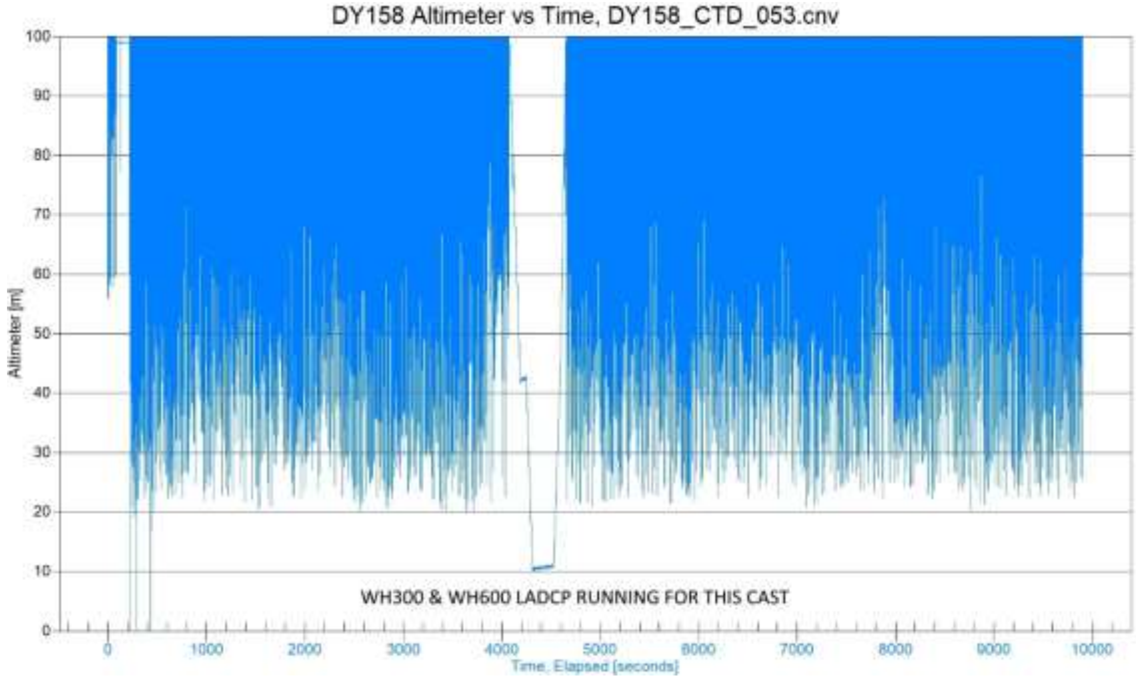


Figure 48. Noise on VA500 500 kHz Altimeter during CTD 053.

Issues with NMEA Navigation Feed to CTD Seasave PC

During cast CTD054, the NMEA navigation feed to the CTD Seasave PC developed issues with GPS fix stability which created significant errors in the recorded positions. The issue was resolved by the NMF SSS technician after the cast, and 1 Hz GPS positions were provided from the Seapath GPS. Subsequently further testing was completed to confirm that Seasave could successfully parse alternative sources of navigation feed.

Normally the NMEA feed comes from the POSMV via an NMEA splitter:
$GPGGA, $GPHDT, $GPRMC, $GPZDA and $GPGLL

It was established that Seasave could also successfully parse the POSMV directly without an NMEA splitter, even though this stream included additional NMEA sentences:

$GPGGA, $GPHDT, $GPVTG, $GPRMC, $GPZDA, $PASHR, $GPGLL and $GPGST

It was also confirmed that Seasave could successfully parse the Seapath GPS direct without an NMEA splitter, even though most of the NMEA talker IDs are IN instead of GP:

$INRMC, $GPGST, $INHDT, $INZDA, $INGGA and $INVTG

This testing established that there are other NMEA sources that could be used as a failover for the CTD Seasave NMEA navigation feed in the future.

Issues with Windows Update load on PC resources

During the cruise, both CTD Seasave PCs would periodically become very unresponsive and sometimes the displayed time would get behind by 10 s of minutes. The PCs were rebooted, but the problem persisted. Following discussions with the NMF SSS technicians, the problem was isolated to the Windows Update service attempting to access the internet. 3 changes were made to the PCs using ‘gpedit’ to change the local policies for Windows Update:

Configure Automatic Updates – set to Disabled (prevents automatic updates, manual updates still possible)

Specify intranet Microsoft update service location – set to Enabled and local WSUS server configured for intranet update service and intranet statistics server (attempts to get updates from the local WSUS server)

Do not connect to any Windows Update Internet locations – set to Enabled (prevents the update service from attempting to access the internet outside the ship)

Comments were added to all three settings to clarify which were changed. The settings table has a column for comments which can be used to identify which were changed.

To effect these changes, or to return to the default configuration, run *gpedit.msc* and browse to *'Local Computer Policy -> Computer Configuration -> Administrative Templates -> Windows Components -> Windows Update'*

The issue with unresponsive PCs ceased completely once these changes were made.

CTD Topside Moxa NPort Serial Device Servers

Two Moxa 5210A NPort serial device servers were installed in the CTD topside racks during DY158. Each NPort has two serial ports which are presented as standard RS-232 serial 9-way D-sub connectors.

Fixed IP addresses were allocated for the NPorts and added to the DNS as follows:

s/n: 665 - ctdmoxa1.discovery.local was installed in SBE CTD Topside Rack 1A with IP address 192.168.62.160

s/n: 689 - ctdmoxa2.discovery.local was installed in SBE CTD Topside Rack 1B with IP address 192.168.62.161

Both NPorts currently have firmware version 1.6 Build 20101317 installed.

CTD Cast Events

'Shake-down' Test-Cast

One 'shake-down' test-cast was completed early in the cruise. Two days after sailing, the test-cast was undertaken in 5450 m of water for verification of system functionality at depth (CTD001 – Jday 358). The CTD was only deployed to 2000 m, and no problems were encountered other than a winch HMI power issue that was quickly resolved.

P3 Mooring, WCB & ECB EK80 Survey and WCB & ECB Moorings

Following the single test cast, 14 casts were completed in the WCB and ECB work area including the EK60 calibration profile in Rosita Harbour.

Cast	Station	Julian Day	Max Depth/m	Altimeter /m	Notes
001	TEST	358	1985	-	Winch HMI Power/Comms Issue
002	P3-1	362	3735	12	AHC off @1648m – damper saturation
003	P3	363	1018	-	No AHC

004	W1.2 CTD N	364	1003	-	Commence EK80 Survey – No AHC
005	W1.2 CTD S	365	272	10	No AHC
006	W2.2 CTD S	001	199	8	Shallow – No AHC
007	W3.2 CTD N	001	1004	-	
008	W4.2 CTD S	002	120	11	Transmissometer caps left on - No AHC
009	W4.2 CTD N	002	1004	-	
010	W3.2 CTD S	003	122	11	
011	ROSITA	004	47	9	EK80 Calibration – Shallow – No AHC
012	WCB	005	290	10	WCB Mooring Calibration Cast
013	CH4 PLUME	005	111	5	Methane Plume Survey near Stromness
014	ECB 1.1 N	006	997	-	
015	ECB Mooring	006	261	9	

Table 20. CTD casts in the WCB and ECB work area.

A23 Transect – South Georgia through the Scotia Sea to 64°S in the Weddell Sea

31 casts were completed at thirty stations on the A23 line.

Cast	Station	Julian Day	Max Depth/m	Altimeter /m	Notes
016	A23_52	007	544	10	16 bottles fired
017	A23_51a	007	1020	10	20 bottles fired
018	A23_51	007	1500	10	12 bottles fired
019	A23_50a	007	2068	9	24 bottles fired
020	A23_50	007	2442	10	24 bottles fired
021	A23_49	008	3519	11	24 bottles fired
022	A23_48	008	3035	10	12 bottles fired
023	A23_47	008	3127	10	24 bottles fired
024	A23_46	008	3205	10	24 bottles fired
025	A23_45	009	3414	15	22 bottles fired
026	A23_44	009	3755	10	18 bottles fired – 48 hr steam to A23_24
027	A23_24	011	4781	12	24 bottles fired
028	A23_25	011	4722	10	24 bottles fired
029	A23_26	011	4868	10	12 bottles fired
030	A23_27	012	4818	10	24 bottles fired
031	A23_28	012	4749	10	24 bottles fired – Fouling of Primary DO
032	A23_29	012	4839	10	24 bottles fired
033	A23_30	013	3375	10	12 bottles fired
034	A23_31	013	4052	10	8 bottles fired
035	A23_32	013	3465	10	24 bottles fired
036	A23_33	013	2579	10	24 bottles fired
037	A23_34	013	1618	9	24 bottles fired
038	A23_35	014	2683	9	22 bottles fired

039	A23_36	014	2982	10	24 bottles fired
040	A23_37	014	3782	10	24 bottles fired – Scrolling issues on upcast
041	A23_37	014	3520	-	Repeat cast to resolve scrolling No LADCP
042	A23_39	014	3439	9	19 bottles fired 3 x Ixsea AR, 3 x SBE37, 3 x RBRsolo
043	A23_40	014	3109	10	24 bottles fired
044	A23_41	015	3520	11	24 bottles fired
045	A23_42	015	3991	9	24 bottles fired
046	A23_43	016	3568	9	24 bottles fired

Table 21. CTD casts in the A23 work area.

On Jday 009, the weather forecast indicated unworkable weather in the northern half of the A23 line. After Station A23_44 (CTD026) the vessel was relocated to the southern end of the A23 line which incurred a 48-hour steam. Upon arrival at A23_24, the conditions were indeed workable and A23 was recommenced northwards from A23_24 (CTD027).

During A23_37 (CTD040), scrolling of the CTD storage drum deteriorated by 2000 m on the up-cast. The winch was veered back down to ~2200 m, followed by numerous hauls and veers in an attempt to resolve the scrolling issue, but this was not successful. As bottles at 2500 m had already been fired, the CTD up-cast was resumed, firing bottles as planned. As the upcoming stations were shallower, a repeat cast was undertaken at A23_37 (CTD041) to clear the poorly scrolled wire. No LADCPs were run, and no bottles were sampled for this cast.

M2 Mooring, and Orkney Passage Moorings (OP1-OP6)

10 casts were completed at the M2 and OP mooring sites including an additional 3 casts on the OP line.

Cast	Station	Julian Day	Max Depth/m	Altimeter /m	Notes
047	M2	020	3032	9	23 bottles fired - 2 x SBE 37
048	OP1	021	3647	10	12 bottles fired
049	OP3	021	1833	10	18 bottles fired
050	OP6	021	2295	10	24 bottles fired – No LADCP (battery flooded)
051	OP4	022	2933	10	16 bottles fired – No LADCP – 6 x SBE 37
052	OP5	022	3374	10	8 bottles fired – No LADCP – 2 x SBE 37
053	OP2	022	3136	11	23 bottles fired - LADCP Battery Replaced
054	OPCTD 8.5	022	3540	9	8 bottles fired – NMEA Nav failure
055	OPCTD 11.5	023	3489	10	8 bottles fired
056	OPCTD 4	023	1518	10	23 bottles fired (but #8 & #9 not fitted) 3 x SBE 37

Table 22. CTD casts in the OP line.

Three of the OP stations (OPCTD 8.5, OPCTD 11.5 and OPCTD 4) were intermediate stations on the OP line, the remainder (M2, and OP1-OP6) were on or adjacent to mooring sites.

Data Processing

At the request of the science party, basic Sea-Bird CTD data pre-processing of the raw data was completed using Sea-Bird Data Processing software. The science party undertook full data processing using their tools, and they will be submitting the definitive quality-controlled processed dataset to BODC in due course.

The pre-processing order used was:

- Data Conversion
- AlignCTD 6s on oxygen channels only
- CellTM

Scan count, elapsed time (seconds), NMEA latitude and longitude, and all instrument channels in engineering units were selected for data conversion. The primary and secondary oxygen channels were output in µmol/kg and SBE raw V. The pressure hysteresis correction was de-selected in the conversion as it was applied later in the data processing workflow by the science party.

The 6s advance that was applied in AlignCTD was applied to both primary and secondary oxygen channels for both the µmol/kg and SBE raw V fields.

The default parameter values were applied for the CellTM processing module.

There was also a requirement to produce 25 m binned speed of sound profiles for correcting multi-beam swath data. The bin sizes were later reduced to 10m. The Bin Averaged files are named in the form DY158_CTDxxx_align_ctm_SV_10m.cnv and contain the Chen-Millero (m/s) speed of sound algorithm on the secondary channel.

Workhorse 300 kHz LADCP

Instrument Configuration

Two self-logging Teledyne RDI Workhorse LADCPs were installed on the CTD frame. The down-looking unit was a 300 kHz unit, but the up-looking unit was a 600 kHz. Both units had the Lowered mode option installed. Although the units were connected using a star cable as normal, the instruments were configured to free-ping to allow an increased ping rate.

The down-looking unit (S/N: 24609) was sited at the centre of the frame with its transducers just above the bottom tube of the CTD frame. The up-looking unit (S/N: 21071) was located within an outrigger frame with its transducers just below the top tube of the CTD frame.

The instruments were powered with NMF Workhorse Battery Pack serial number WH011T.

Due to cable routing constraints, the instrument heads did not have their beams aligned in azimuth and therefore an offset will be observed between the compass headings of the two units. By convention, the down-looking unit is deployed as the master, and the up-looking unit as the slave.

Both instruments were configured with 25 bins and a 4m blank. The 300 kHz unit was set to 8 m bins (maximum range 204 m) and the 600 kHz unit to 4m bins (maximum range 104 m). Bench testing identified that the 300 kHz unit could achieve 0.8 seconds per single ping ensemble even with the status serial output enabled. Although the 600 kHz unit could achieve much faster ping rates, it was configured for 0.6 seconds per single ping ensemble to limit the file-size and download time.

The LADCPs were configured with 330 cm/s for the Ambiguity Velocity (LV330) which was the value that was eventually used on DY113 and also JC211. 330 cm/s is the maximum that LV can be set to in Narrowband mode (LW1).

Real-time Remote LADCP Status Data via Sea-Bird 9plus 9600 Baud Uplink

The down-looking 300 kHz instrument was configured to output status information via its serial port. The serial port was connected to the 9plus 9600 baud uplink cable prior to deployment. The configuration of the Workhorse instrument serial port is achieved by sending two commands in the deployment script file:

CF11211 Enable Serial Output (CRLF terminated Hex ASCII)
CD000010000 Serial Data Out Fields (status words only)

The Hex ASCII status information from the down-looking WH 300 kHz instrument could then be monitored in real-time via the 9600 baud uplink serial port on the Sea-Bird 11plus. Note that the 11plus 9600 baud uplink serial port is 19200 baud at the topside.

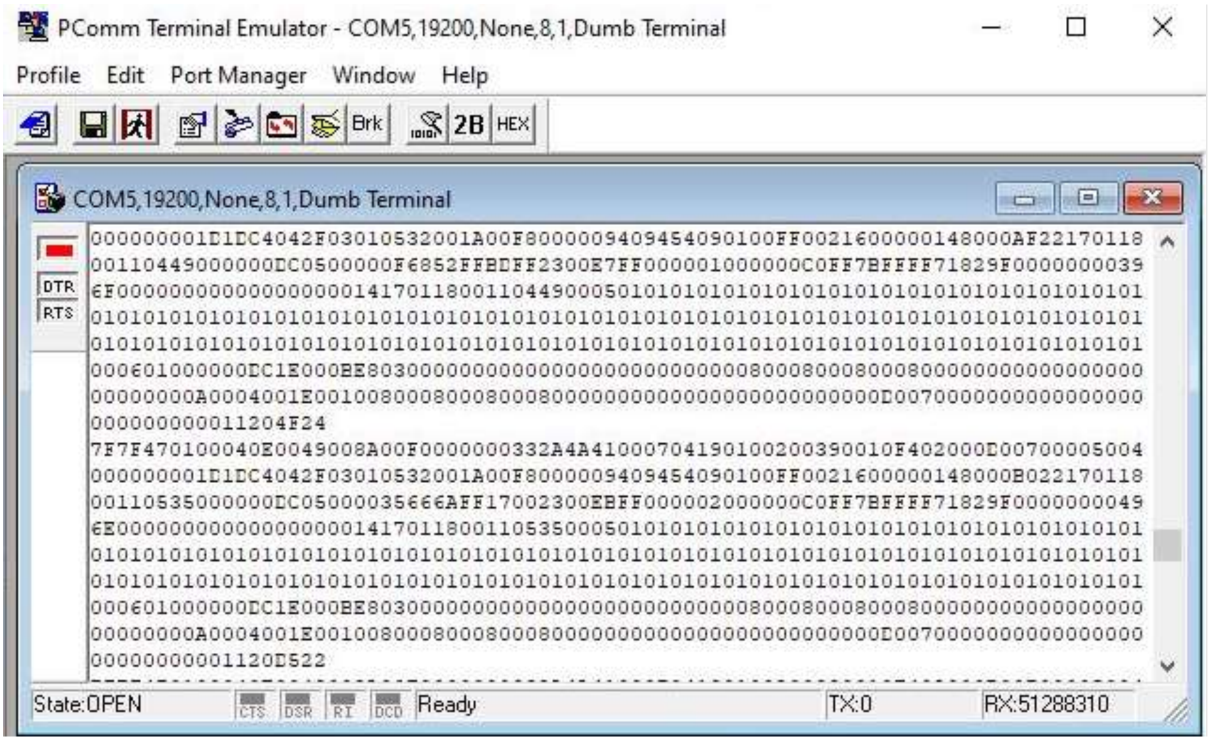


Figure 49. LADCP status updates/deployment status commands.

Comments on SB0 Command

The recommendation in the 'Workhorse Commands and Output Data Format' manual (March 2016) for the use of SB0 to use Master/Slave setup was adhered to. This disables hardware-break detection on Channel B:

'Set SB0 to prevent noise from being processed as a <Break> on the RS-422 lines. This command is used when another system is connected to the ADCP over the RS-422 lines. In this configuration, disconnecting or connecting the other system can cause the ADCP to interpret this as a <Break> over Channel B. A break will cause the ADCP to stop pinging and the deployment will be interrupted.'
The manual also states: *'The SB command must be set to SB0 to use the Master/Slave setup.'* and *'When changing the SB command, confirm the change by immediately following the SB change with a BREAK.'*

The SB0 command was used on DY113, but this caused some issues with the master instrument locking up when processing its command script. For JC211, the SB0 command was omitted. For DY158, the use of SB0 was resumed, but the script also sent a break ($B) immediately afterwards, and waited for up to 2 seconds for the prompt ($W'>',2) before continuing the deployment script.

The host laptop that was used for BBTalk was NTP time synchronised to the Discovery GPS clock using the Meinberg PC port of the UNIX NTP client. Thus, using the BBTalk script command $T to set the LADCP clock to the PC time at the start of the command files ensures that the RTC of the Workhorses remain a close as feasible to UTC.

Deployment Command Scripts

Down-looking 300 kHz	Up-looking 600 kHz
; DY158 Saunders, BAS. Down LADCP WHM 300 kHz (Free-pinging) ; Dougal Mountifield, Povl Abrahamsen, Chris Auckland $T ; Set LADCP Clock to PC Time PS0 ; Display System Configuration CR1 ; Restore Factory Defaults WM15 ; LADCP Water Mode 15 ;CF11101 ; Disable Serial Output CF11211 ; Enable Serial Output (CRLF terminated Hex ASCII) CD000010000 ; Serial Data Out Fields (status words only) EA00000 ; Zero Beam 3 Misalignment (default) EB00000 ; Zero Heading Bias (default) EC1500 ; Speed of sound 1500 m/s (default) ED00000 ; Zero Transducer Depth (default) ES35 ; Salinity 35PSU (default) EX00100 ; Beam Coordinates, use tilts EZ0011101 ; Use temp, heading and tilt sensors (use EC speed of sound, ED depth, ES salinity) TE00:00:00.80 ; 0.8 Second Minimum Time Per Ensemble TP00:00.80 ; 0.8 Second Minimum Time Between Pings LP00001 ; 1 Ping Per Ensemble (default) LD111100000 ; Collect and Process all data (default) LF0400 ; LADCP 4m Blank LN025 ; LADCP 25 Bins LS0800 ; LADCP 8m Bins LV330 ; LADCP 330cm/s Ambiguity Velocity (limited to max 330 in LW1 mode) LJ1 ; LADCP High Receiver Gain (default) LW1 ; LADCP Narrow Bandwidth (default) LZ30,220 ; LADCP Default Bottom Detect and Correlation Thresholds SM0 ; RDS3 mode off (free-ping)	; DY158 Saunders, BAS. Up LADCP WHS 600 kHz (Free-pinging) ; Dougal Mountifield, Povl Abrahamsen, Chris Auckland $T ; Set LADCP Clock to PC Time PS0 ; Display System Configuration CR1 ; Restore Factory Defaults WM15 ; LADCP Water Mode 15 CF11101 ; Disable Serial Output EA00000 ; Zero Beam 3 Misalignment (default) EB00000 ; Zero Heading Bias (default) EC1500 ; Speed of sound 1500 m/s (default) ED00000 ; Zero Transducer Depth (default) ES35 ; Salinity 35PSU (default) EX00100 ; Beam Coordinates, use tilts EZ0011101 ; Use temp, heading and tilt sensors (use EC speed of sound, ED depth, ES salinity) TE00:00:00.60 ; 0.6 Second Minimum Time Per Ensemble TP00:00.60 ; 0.6 Second Minimum Time Between Pings LP00001 ; 1 Ping Per Ensemble (default) LD111100000 ; Collect and Process all data (default) LF0400 ; LADCP 4m Blank LN025 ; LADCP 25 Bins LS0400 ; LADCP 4m Bins (1/2 bin size of 300 kHz Master) LV330 ; LADCP 330cm/s Ambiguity Velocity (limited to max 330 in LW1 mode) LJ1 ; LADCP High Receiver Gain (default) LW1 ; LADCP Narrow Bandwidth (default) LZ30,220 ; LADCP Default Bottom Detect and Correlation Thresholds SM0 ; RDS3 mode off (free-ping) SB0 ; Disable Hardware Break Detection on Channel B $B ; Send a Break $W">",2 ; Wait up to 2 seconds for prompt before continuing RN UP___ ; Set filename header to UP___ CK ; Save As User Defaults CS ; Start Pinging

SB0 ; Disable Hardware Break Detection on Channel B $B ; Send a Break $W">",2 ; Wait up to 2 seconds for prompt before continuing RN DOWN_ ; Set file name header to DOWN_ CK ; Save As User Defaults CS ; Start Pinging	

Table 23. Deployment Command scripts.

LADCP Deployment & Recovery Procedure

Prior to each deployment the following standard checklist was followed:

Pre-deployment

- Baud rate changed to 9600 baud (**CB411**) to ensure correct parsing of command script file.
- Logging started **(F3)** to create deployment terminal capture log files named in the form *DY158_CTDxxxd.txt* for the down-looking 300 kHz and *DY158_CTDxxxu.txt* for the up-looking 600 kHz.
- Instrument time checked **(TS?)** by comparing to GPS time. Manual setting of the instrument time was not required as the **$T** script command was used in the command files.
- Free data storage available was checked and recorded **(RS?)**, reformatting the card if required.
- The number of deployments on instrument storage card **(RA?)** was recorded.
- Three pre-deployment tests **(PA, PT200 and PC2)** were run being mindful of humidity sensor value.

Note that some of these tests are intended to be run with the instrument submerged in still water and can therefore be expected to fail in air.

- The command script files were sent to the instruments **(F2)** to deploy them and start them pinging. The 300 kHz unit was started first using *DY158_Down_300.TXT*, followed by the 600 kHz using *DY158_Up_600.TXT*. Finally the logging to the terminal capture was stopped **(F3)**.
- As the serial output of status information was enabled on the 300 kHz unit for real-time use with the 9p/11p uplink channel, this could be observed streaming into the BBtalk terminal once the CS command was parsed by the instrument.
- The battery was then taken off charge, the deck-cables were disconnected and the star-cable leg for the down-looking 300 kHz instrument was connected to the 9600 baud uplink cable to the 9plus CTD underwater unit. A dummy was installed on the star-cable leg for the up-looking 600 kHz instrument ready for deployment.
- Prior to deployment pinging was confirmed by listening to the buzzers in the instruments.

Post-recovery

- Pinging was confirmed by listening to the buzzers in the instruments.
- The 9plus 9600 baud uplink cable was disconnected from the down-looking instrument star-cable leg and the star-cable dummy was removed from the leg for the up-looking instrument. The deck-cables were reconnected after drying the cables and connectors.
- The instruments were stopped pinging by sending a break to each in BBTalk, down-looking RS-232 output data was confirmed first.
- The battery pack was put on charge (Float charge at 54.6 V at the battery and 55.6 V at the charger, 0.4A current limit).
- The baud rate was changed to 115200 baud **(CB811)** to reduce the data download time.
- The number of deployments on instrument storage card **(RA?)** was recorded.

- Download of data was started using BBTalk **'File>Recover Recorder'** menu command, selecting appropriate file(s) and noting their number in the default filename sequence *DOWN_xxx.000* and *UP___xxx.000*.
- The baud rate was changed to 9600 baud (**CB411**) to ensure correct parsing of command script file for the next deployment.

The downloaded files were renamed using the form DY158_CTDxxxd.000 for down-looking 300 kHz and DY158_CTDxxxu.000 for the up-looking 600 kHz. The files were then backed up to the network archive.

Data File Integrity & Data Quality Checks

Both the down and up data files were checked using WinADCP. A region of data with high echo intensity (near bottom for master, near surface for slave) was selected. All four beams were checked for consistent echo intensity and beam correlation. Further similar checks were also done mid water-column and near the end of the profile. The start and stop times of the data files were checked for correspondence with the log-sheet deployment and recovery times. The number of pings (ensembles) in each data file was recorded on the log-sheet.

LADCP Deployment Comments

Instrument Terminal Lock-up During Data-Download

An issue that has previously been experienced during deployment, was seen during data download on DY158. After starting download on one instrument, the second instrument would lock up. If the download was cancelled, and multiple breaks were sent to the instrument, the locked-up instrument would say Wake-up AB, then finally Wake-up A. Once this had happened, both instruments could then be downloaded with no problems.

The cause is still undetermined, but one work around is to send the flurry of breaks to both instruments after the RA command, but before starting download.

Reported Number of Deployments (RA) Bug

Whilst the instruments were being tested during the mobilisation, it was noticed that the instruments were reporting the number of deployments (RA) incorrectly. The response to the RA command was double the number of deployments present on the recorder cards. The file numbering incremented by one, but the RA response incremented by two. To isolate the problem, the deployment configuration was simplified to a set defaults (CR1) followed by start pinging (CS) on a single instrument, but the issue remained. The instruments continued to double the number of deployments until CTD015 where the problem resolved itself. The pre-deployment RA response was 30 for 15 files on the recorder. The post-deployment RA response was 16 for 16 files on the recorder. This is obviously a bug with the instrument firmware.

Hence prior to cast CTD016 (< 16 files on the recorder), RA reports double the number of files. From cast CTD016 onwards, RA reports the correct number of deployments (>= 16 files on the recorder, file number 15 onwards).

Failure by Low-Pressure Flooding of WH Battery Pack WH011T

During the deployment of the LADCPs at the start of cast CTD050 the pre-deployment checks and tests were completed whilst the LADCP battery pack was still on charge. The charger was then disconnected prior to sending the deployment script files to the instrument. Once the charger was disconnected, communication with the instruments ceased. The battery was vented at the vent-plug to confirm that there was no pressure within the battery housing. The battery voltage was metered at the battery bulkhead connector at 14 V (it should be ~52 V). The initial diagnosis was that the star-cable may have failed or one of its connectors may have flooded. The science party were offered the option of incurring a delay to resolve the issue, but they decided to continue with CTD work without LADCPs until a suitable gap in the schedule provided a natural opportunity for fault-finding and rectification. Hence casts CTD050, CTD051 and CTD052 were completed without running the LADCPs and therefore no LADCP data was obtained for these casts.

After cast CTD052, the LADCP star cable was disconnected from the instruments and battery pack for DCR continuity, IR and diode testing. No problems were found with the star cable, or the deck cables. All connectors on the star-cable, deck cables and the instruments were cleaned with Milli-Q and lubricated with Rocol silicone spray. The pack voltage of WH011T was once again measured at 12V. The LADCP battery pack was removed from the CTD fame and replaced with WH006T. The LADCP instrument suite was then successfully tested prior to its use for the remaining CTD casts CTD053-CTD056. A third spare LADCP battery pack (WH007) was also available on-board, but was not used during the cruise.

WH011T was vented once more, with no stored pressure observed. The bulkhead end end-cap of battery pack WH011T was then removed to allow inspection inside the housing. The internals of the pack were found to be covered in water. The volume of water inside could not be determined, but based on the angle of the pack for inspection, it is estimated that it can be no more than 1/4 – 1/3 full of water. The exact location of the low-pressure leak will be likely be difficult to determine. 24 hours later the terminal voltage had fallen to 7V, and still no pressure had built within the housing.

TRDI Workhorse Spares Availability

Five WH 300 kHz instruments and one WH 600 kHz instrument were available as spares on-board but were not used for deployment. The instruments deployed on the CTD frame performed without fault. The science party confirmed that both instruments used were operating normally with no identified issues, aside from a very small interference from the Valeport VA500 (500 kHz) altimeter in the 600 kHz WH data files when the CTD was in close proximity to the sea-bed. In fact, there seems to be much more interference in the Valeport VA500 output caused by the WH600 – see comments in the CTD instrument section.

Salinometry

Following each CTD cast, discrete salinity samples were taken from the OTE 20 L water samplers by the science party. The science party also did all the analysis of these samples using the NMF provided Autosal salinometers. The salinometers were operated in the dedicated Salinometer Room with the bath temperature set to 21 °C. The HVAC plant in the Salinometer Room was set at 18 °C to achieve an ambient temperature of 18.5 °C.

Provision of Salinometry Training for the Science Party

NMF Sensors & Moorings technicians provided Autosal salinometry training on 26 December 2022 for two members of the science party and refresher training for two other members of the science party including use of the NMF Autosal 2009 data-logging software. The two trainees analysed their first sample test crate (Crate 16) on 26 December 2022 under supervision from NMF Sensors & Moorings technicians and their more experienced colleagues. Subsequently all discrete salinity samples were analysed by the science party using the NMF supported Autosals.

Salinity Sample Summary

408 discrete CTD salinity samples were taken during the cruise filling 17 crates.

Samples were initially analysed on Autosal s/n: 71185 before it developed problems in read mode on 15 January 2023. The display flashed x.x+/-0000 regardless of the setting on the suppression switch. A partially used (but re-capped) standard was used as a check, and the same problem was observed. The conductivity cell was filled with Milli-Q as a further blank check, and the machine read slightly high at ~ 0.0+0200 (normally 0.0+0010 – 0.0+0020 with Milli-Q). When the suppression was set to 0.1, the display showed roughly correct at about 0.1-0800. The problem remained through a further check with SSW. The bath temperature appeared to be stable, and the stirrer was functioning correctly. There was no visible signs of air bubbles within the conductivity cell. The zero reading is normal, as is the standby reading. The standardisation pot has not moved since standardisation (confirmed by reference to digital photos taken during the mobilisation). Further investigation is required, with the chopper electronics/conductivity board, conductivity cell connector, conductivity cell electrode wiring, and display electronics all possible candidates for causing the problem.

Commissioning of Spare Autosal s/n: 68958

On 17th January, a NMF Sensors & Moorings technician did a software standardisation of the spare Autosal s/n: 68958. The Autosal.ini file from the standardisation of s/n: 71185 was backed up prior to standardising s/n: 68958. The machine was correct with standard in the cell to within 0.2 mPSU, and the pot was not adjusted. This machine had been standardised manually during the mobilisation some 4 weeks earlier, and has thus proven to be remarkably stable. One of the science party analysts was present throughout the standardisation to build their confidence in the spare machine. All further samples were analysed using Autosal s/n: 68958, and no problems were experienced with the instrument.

The analysis protocol was to run a standard as a sample before and after each crate of samples as a control. The RS pot was not changed during the cruise and the machine was not re-standardised using the software.

A data file from the analysis software was produced for each crate as an Excel spreadsheet. All raw double conductivity measurements were also logged manually by the analyst on paper log-sheets. These log-sheets were scanned to pdf format by the science party.

IAPSO Standard Seawater Batches

Remaining IAPSO Standard Seawater batch ***P165*** was used for initial manual standardisation and testing:

Batch Date: 15th April 2021
Expiry Date: 15th April 2024
K15 = 0.99986 ± 0.00001 (2xK15 = 1.99972 ± 0.00002)

Practical Salinity = 34.994 ± 0.001

IAPSO Standard Seawater batch ***P164*** was used for final standardisation and controls during the cruise:

Batch Date: 23rd March 2020
Expiry Date: 23rd March 2023
K15 = 0.99985 ± 0.00001 (2xK15 = 1.99970 ± 0.00002)
Practical Salinity = 34.994 ± 0.001

50 bottles of P164 standard were available and 15 bottles of newer P165 standard was also available for testing purposes. P164 has a label conductivity ratio 0.00001 less than P165 and the same label Practical Salinity as P165. No observable difference in conductivity ratio was observed when P164 was compared to P165 using the Autosal. 39 bottles of P164 were used during DY158 (11 bottles of P164 remaining). 11 bottles of P165 were used for initial manual standardisation (21 December 2022) and testing during the cruise (4 bottles of P165 remaining).

Autosal Analysis Software

The NMF Labview Autosal program was checked to ensure correct read/write access and function of the standardisation .ini file on both machines. Both machines functioned correctly, writing the correct offset to the file at standardisation and reading the correct offset during analysis of samples. Standard deviation limits of 0.00002 were used throughout the cruise.

Manual Pre-Standardisation Stability Check

A pre-standardisation stability check was completed on 21 December 2022 by Dougal Mountifield on both Autosals during the mobilisation using P165. Both machines were then standardised manually without using the software, again using P165.

Autosal s/n: 71185 had been previously standardised on DY159 and was used with no problems during that cruise. The instrument was found to be measuring 0.00003 low in double conductivity ratio from the P165 label value (RS 446, standby 5710/5711, reading 1.99969), the pot was not moved.

Autosal s/n: 68958 had not been used on DY159 and had not been standardised for some time. The instrument was found to be reading 0.00010 low in double conductivity ratio, and therefore the pot was adjusted. Subsequently the machine was found to be measuring 0.00002 low in double conductivity ratio from the P165 label value (RS 497, standby 6146/6147, reading 1.99970).

Software Standardisation

Autosal s/n: 71185 was standardised using the NMF Autosal_2009 software on 5 January 2023. The instrument was found to be reading 0.00002 high in double conductivity ratio from the P164 label value (RS 446, zero 0.00003, standby 5710/5711, reading 1.99972), the pot was not moved.

Following the failure of Autosal s/n: 71185 on 15 January 2023, Autosal s/n: 68958 was standardised using the NMF Autosal_2009 software on 17 January 2023. The instrument was found to be reading 0.00002 low in double conductivity ratio from the P164 label value (RS 497, zero 0.00004, standby 6151/6152, reading 1.99968), the pot was not moved.

Software Used

Sea-Bird SeaTerm v1.59 (SBE 35 configuration, operation and data upload)
Sea-Bird Seasave 7.26.7.121 (SBE 9/11plus data acquisition)
Sea-Bird SBE Data Processing 7.26.7.121 (SBE 9/11plus data processing)
Moxa PComm Terminal Emulator 2.10 (Serial port testing and instrument configuration)
TRDI BBtalk v3.09 (LADCP testing, configuration, deployment and data-download)
TRDI WinADCP v1.14 (LADCP data visualisation and QC)
NMF Autosal 2009 (Data-logging of Autosal salinometer discrete samples and standards)
Notepad ++ 7.6 (Data-file and Header viewing)
Paint.NET v4.14 (Image editing for documentation)

12. CTD Data Processing

Mike Meredith, Povl Abrahamsen, Jon Rosser, Chris Auckland

Initial processing

Instrumental setup, deployment and operation are described in the NMF section of the cruise report. Following completion of each cast, the CTD data were subject to preliminary processing by NMF personnel using SeaBird software. The following steps were executed:

i) Data Conversion – to export the data as text (.cnv and .ros) files

ii) Align CTD – apply a time offset to align the data streams temporally

iii) Cell Thermal Mass, to correct the conductivity readings for the thermal mass effect.

The settings used for these steps were the recommended values as provided by SeaBird. After processing, the CTD data plus SBE35 high-precision thermometer data were uploaded by NMF personnel to the following drive spaces for access by the science party:
/current_cruise/Sensors_and_moorings/CTD/DY158/Data/CTD_Raw_Data
/current_cruise/Sensors_and_moorings/CTD/DY158/Data/CTD_Pro_Data
/current_cruise/Sensors_and_moorings/CTD/DY158/Data/SBE35_Data

Matlab processing

From the above locations, data were ingested into the matlab processing environment. For this, a set of scripts were used that have been evolved by BAS and partners over many years. The latest iteration of this code is a generalised set of programs with an initial startup file that creates cruise-specific details; subsequent matlab processing steps draw information from this startup.

Matlab steps followed were:

i) CTDvarn – allows specification of input and output directories for different processing steps, with input directories being those listed above and output being :
/current_cruise/public/DY158/Scientific work area/CTD/processed_data_BAS
/current_cruise/public/DY158/Scientific work area/CTD/processed_data_BAS/plots
/current_cruise/public/DY158/Scientific work area/CTD/processed_data_BAS/salts
/current_cruise/public/DY158/Scientific work area/CTD/processed_data_BAS/SBE35

This script sets up the generic cruise name ('DY158'), choices for which variables to include in the processing, which variables to derive, and so on, for both CTD and bottle data outputs. It is important that the choices made here are compatible with the variables outputted by the SeaBird processing.

This script also allows a choice to be made concerning whether to use primary or secondary sensors as the preferred data stream; for DY158, this was set to secondary, for reasons elaborated on below.

ii) ctdreadGEN(XXX) – where XXX is station number. This script ingests data from the above-processed SeaBird data file into Matlab and allocates to the correct variable names. Output is .red

iii) setparNaN_DY158 –script created specifically for DY158, to blank the PAR variable to NaN in the Matlab processing. PAR was retained in the processing as a variable since initial thinking at the start of the cruise was to potentially add PAR sensors later on, but this did not happen. Output is .red

iv) editctdGEN(XXX) – launches a series of data plots and an interactive editor that allows identification of the start of the downcast and removal of the most egregious outliers in the conductivity and temperature data. Output is .edt

v) deriveGEN(XXX) – calculates a set of routine variables from the .edt file, based on choices made in CTDvarn. Output is .var

vi) onehzctdGEN(XXX) – creates a 1 Hz data file from the 24 Hz data that has been processed thus far, primarily for ingestion into the LADCP processing stream. Output is .1 Hz

vii) splitcastGEN(XXX) – divides the cast into upcast and downcast sections. Outputs are .var.up and .var.dn

viii) fallrateGEN(XXX) – applies a correction to the .var.dn file to attempt to account for package wakes associated with variable downward speed of the package through the water column. Output is .var.dn and .vhc.dn

ix) gridctdGEN(XXX) – derives 2dbar averages of data for both downcast and upcast. Output is .2db.mat and .2db.up.mat

x) ctdplotGEN(XXX) – create a series of standard plots from the CTD data for inspection and checking.

The above steps (iv) to (viii) were most commonly run in batch mode via batch_ctdGEN

xi) makebotGEN(XXX) – ingests the .ros file created by the SeaBird processing and allocates data to appropriate variable names. Output is _bot_XXX.1st

xii) sb35readGEN(XXX) – ingests the SBE35 high-precision thermometer data. Output is .sb35 and tempcals.all.mat, the latter being the overall compilation of CTD/SBE35 comparison data.

xiii) readsalGEN(XXX) – reads bottle salinity data from .csv spreadsheets, previously exported from the overall DY158 salinity master spreadsheet (DY158_master.xls in …/salts). Output is _sal_XXX.mat

xiv) addsalGEN(XXX) – reads the .1st file and adds sample salinity. Output is .sal

xv) salcalGEN(XXX) – calculates the adjustment to nominally calibrated CTD salinity. Output stored in overall DY158 master file salcals12.all.mat

xvi) mergebotGEN(XXX) – reads the .1st, .sal and .sb35 to create overall bottle file _bot_XXX.all

Stn	YYYY	MM	DD	HH	MM	SS	°S	‘S	°W	‘W	Identifier
1	2022	12	24	11	55	37	40	40.83	50	37.08	Test Cast
2	2022	12	28	23	8	3	52	48.47	40	6.83	P3-1
3	2022	12	29	4	7	18	52	48.47	40	6.84	P3-2
4	2022	12	30	22	18	31	53	29.51	39	15.05	W1.2N
5	2022	12	31	4	42	26	53	50.81	39	8.58	W1.2S
6	2023	1	1	1	39	46	53	47	38	35	W2.2S
7	2023	1	1	21	8	19	53	21.69	38	4.93	W3.2N
8	2023	1	2	5	1	22	53	40.63	37	39.3	W4.2S

9	2023	1	2	23	40	41	53	19.47	37	46.35	W4.2N
10	2023	1	3	5	54	28	53	42.88	37	57.95	W3.2S
11	2023	1	4	9	53	18	54	1	37	25.75	Rosita Harbour
12	2023	1	5	13	29	55	53	47.94	37	56.34	WCB mooring
13	2023	1	5	23	32	12	54	9.21	36	38.01	Stromness
14	2023	1	6	14	40	43	53	41.41	35	15.1	E1.1N
15	2023	1	6	23	15	44	54	6.25	36	14.55	ECB mooring
16	2023	1	7	9	48	42	55	12.93	34	30.49	A23-52
17	2023	1	7	11	30	51	55	13.81	34	29.4	A23-51A
18	2023	1	7	14	5	28	55	15.57	34	26.61	A23-51
19	2023	1	7	16	26	7	55	17.39	34	23.97	A23-50A
20	2023	1	7	20	22	0	55	29.07	34	7.98	A23-50
21	2023	1	8	1	9	8	55	43.49	33	47.08	A23-49
22	2023	1	8	7	23	48	55	59.41	33	25.15	A23-48
23	2023	1	8	13	32	37	56	22.86	32	52.35	A23-47
24	2023	1	8	19	57	23	56	46.53	32	18.22	A23-46
25	2023	1	9	1	49	52	57	7.09	31	48.86	A23-45
26	2023	1	9	8	0	35	57	27.5	31	19.63	A23-44
27	2023	1	11	5	59	39	63	57.87	28	52.44	A23-24
28	2023	1	11	15	14	30	63	20.8	29	34.13	A23-25
29	2023	1	11	21	51	29	63	4.34	30	6.93	A23-26
30	2023	1	12	4	8	59	62	46.95	30	41.67	A23-27
31	2023	1	12	11	6	1	62	29.46	31	15.63	A23-28
32	2023	1	12	17	51	58	62	4.55	31	10.97	A23-29
33	2023	1	13	0	48	21	61	39.62	31	6.55	A23-30
34	2023	1	13	4	43	27	61	33.05	31	6.26	A23-31
35	2023	1	13	10	28	4	61	10.24	31	2.76	A23-32
36	2023	1	13	14	44	38	61	6.58	31	2.43	A23-33
37	2023	1	13	20	24	53	60	41.98	31	0.57	A23-34
38	2023	1	14	1	19	7	60	18.9	30	57.42	A23-35
39	2023	1	14	6	29	46	59	59.71	30	55.75	A23-36
40	2023	1	14	11	39	12	59	45.95	30	54.3	A23-37
41	2023	1	14	17	13	51	59	46	30	54.43	(winch fix)
42	2023	1	14	23	12	52	59	26.18	30	51.58	A23-39
43	2023	1	15	5	32	10	59	3.01	30	49.74	A23-40
44	2023	1	15	11	36	17	58	38.07	30	49.44	A23-41
45	2023	1	15	17	59	58	58	12.77	30	49.26	A23-42
46	2023	1	16	0	5	54	57	48.09	30	49.9	A23-43
47	2023	1	20	1	19	3	62	36.9	43	14.63	M2 mooring
48	2023	1	21	1	21	58	60	37.86	42	5.22	OP1 mrng (OPCTD10)
49	2023	1	21	5	26	20	60	39.21	42	13.23	OP3 mrng (OPCTD5)
50	2023	1	21	21	45	46	60	33.76	41	37.95	OP6 mrng (OPCTD19)

51	2023	1	22	1	3	39	60	35.4	41	49.72	OP4 mrng (OPCTD16)
52	2023	1	22	4	58	39	60	36.44	41	58.02	OP5 mrng (OPCTD13)
53	2023	1	22	19	23	59	60	38.48	42	10.15	OP2 mrng (OPCTD7)
54	2023	1	22	23	0	23	60	38.04	42	7.74	OPCTD8½
55	2023	1	23	2	26	57	60	37.24	42	1.72	OPCTD11½
56	2023	1	23	22	24	37	60	39.92	42	15.36	OPCTD4

Table 24. CTD casts details.

Calibration

The SBE35 data were used to calibrate the CTD primary and secondary temperatures, and the bottle salts analysed were used to calibrate the CTD primary and secondary conductivities. No bottle oxygens were run on this cruise, so primary and secondary CTD dissolved oxygens were left uncalibrated and are thus interpretable as relative values only.

a) Temperature

Both primary and secondary CTD temperature sensors showed small offsets with respect to the SBE35 data, each of which was well characterised by linear terms with pressure (Figure 50). Different approaches to data inclusion were trialled, including accounting for the standard deviations of the measurements, accounting for the temperature gradients within which the data were collected (where comparison of data is expected to be less accurate), and considering only deeper waters. Expectedly, only small differences were found from adopting these different approaches; we here adopt calibrations that exclude the large temperature gradients typically found in the upper layers.

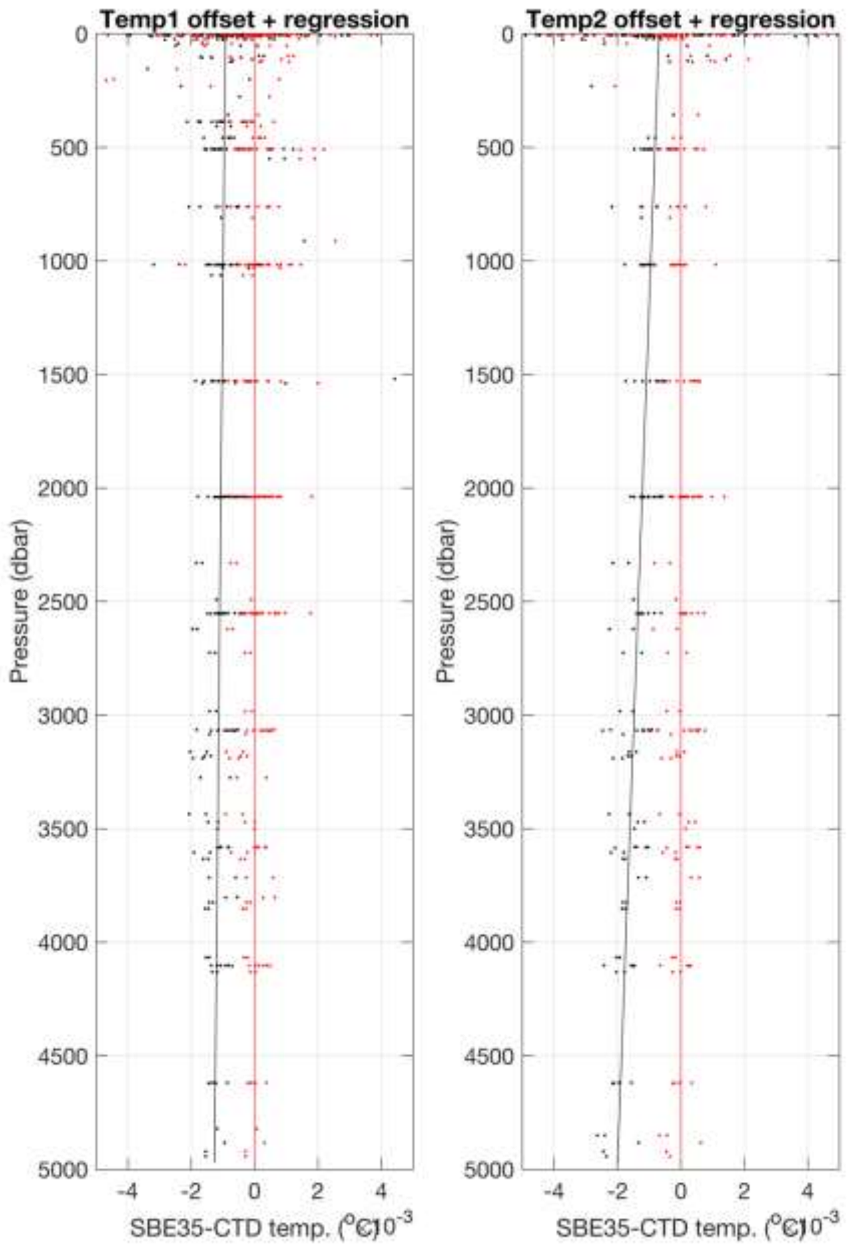


Figure 50. Offsets between SBE35 and CTD temperatures for (left) primary sensors and (right) secondary sensors, with data points residing in large temperature gradients excluded. Black denotes uncalibrated CTD data offsets; red denotes calibrated.

The temporal stability of the temperature offsets was also examined (Figure 51). No evidence of drift in either sensor was detected, and hence no term that was dependent on time/station number was included in the calibration.

Final calibration values obtained were:
Primary temperature: -0.000921 – 6.874e-08*pressure
Secondary temperature: -0.000688 – 2.630e-07*pressure

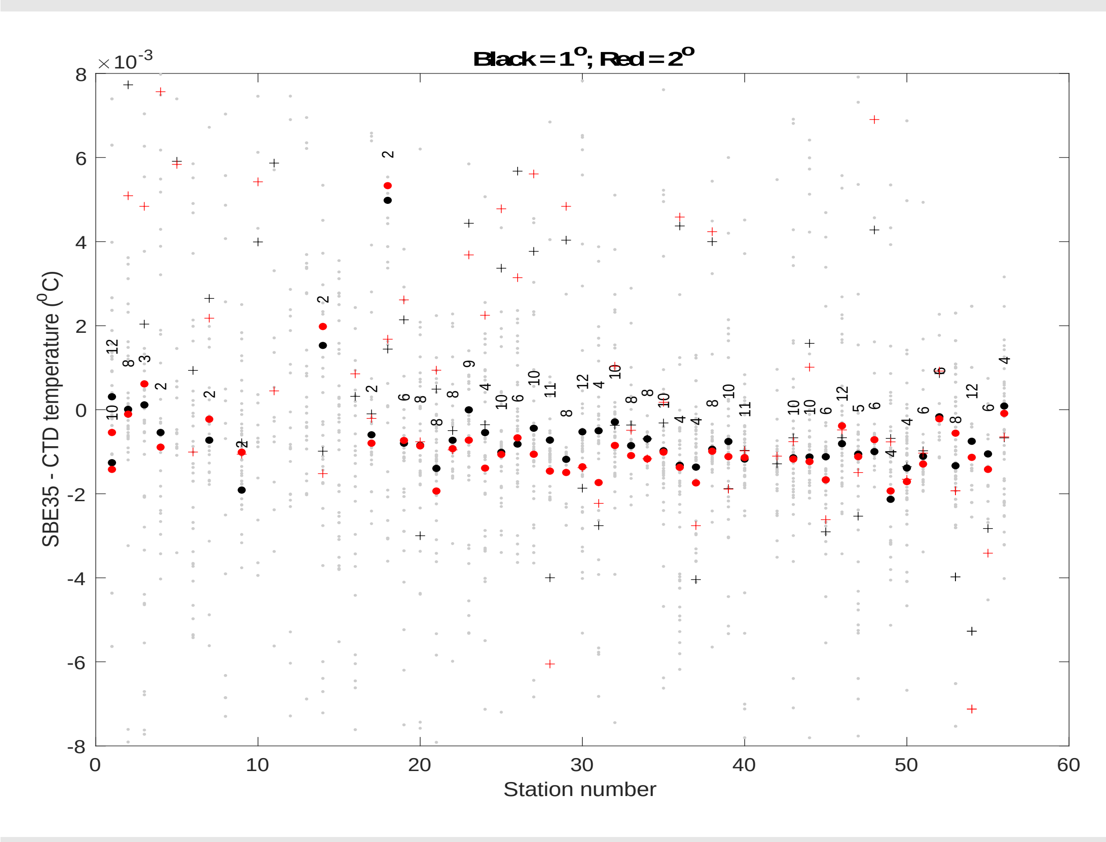


Figure 51. Offsets between SBE35 and CTD temperature data, as a function of station number. Small grey dots denote individual data points; small plusses denote averages for each station taken over all depths. Large dots denote averages for each station considering waters below 1000 dbar only. Floating numbers mark the number of data points in the latter category, hence dots with small numbers should not be considered especially informative. The first few stations include many shallow casts around South Georgia, hence averages are based on few numbers or include no deep samples. Station 19 onwards denotes the period of deep-water casts along section A23 and in the vicinity of Orkney Passage.

b) Conductivity

Conductivity offsets relative to CTD values were examined to determine calibrations that needed applying to the CTD data. As for the temperature offsets, there was no evidence for drift in the conductivity offsets (bottle minus CTD over time) based on deep water properties at stations where several deep samples were collected (A23 and Orkney Passage; Figure 52). It is also the case that there is no discernible shift in conductivity or salinity offsets at the time when the salinometer in use was switched from unit 71185 to unit 68958; this occurred midway through the salt samples from station 37. Accordingly, no time-dependent term was included in the conductivity calibration.

Both primary and secondary CTD conductivity were found to contain small offsets with some pressure dependence (Figure 53). In general, the secondary CTD conductivities aligned better with the bottle conductivities. Suitable calibrations were obtained as:

Primary conductivity: -0.001899 – 5.801e-07*pressure
Secondary conductivity: -0.001026 – 4.441e-07*pressure

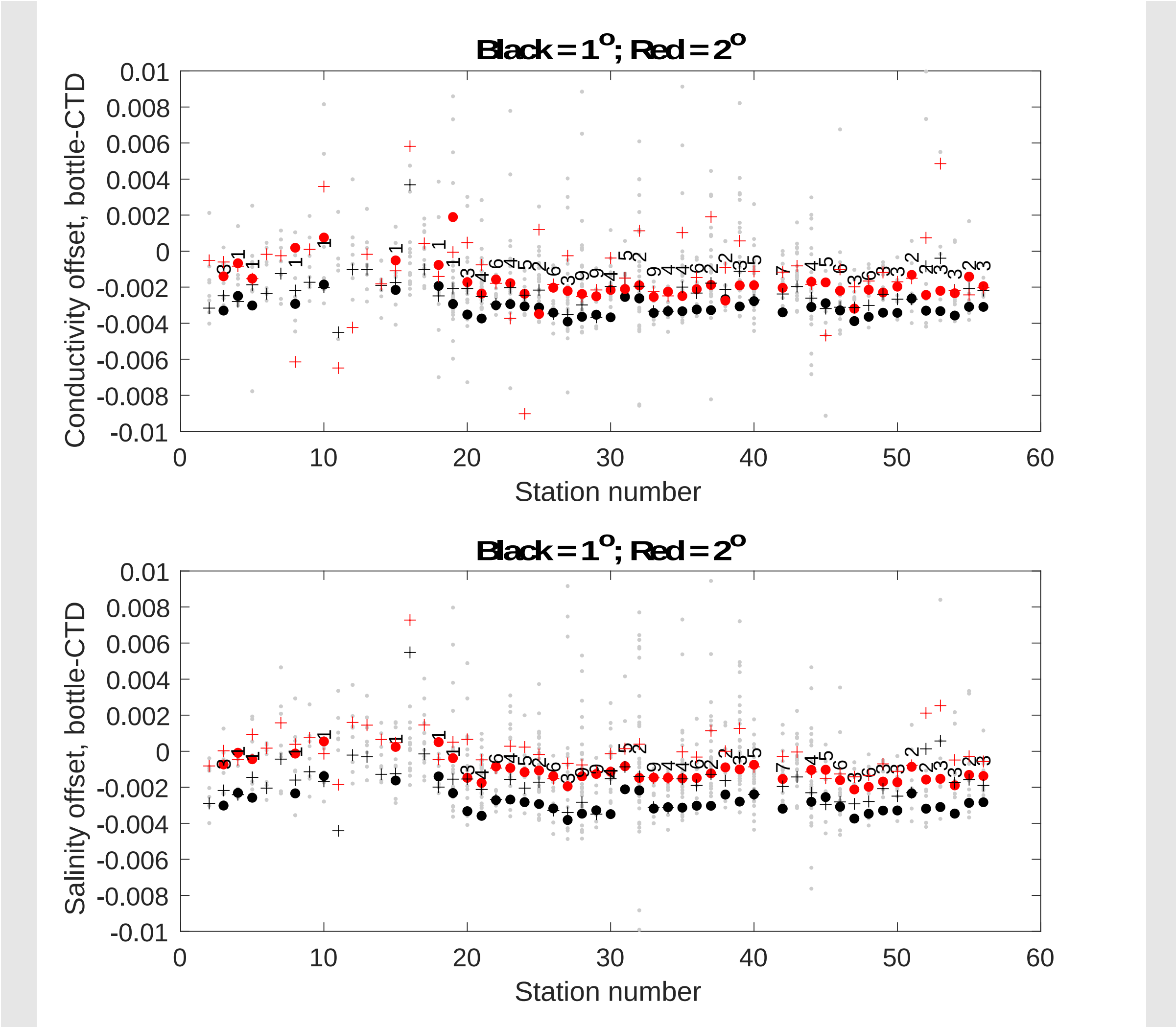


Figure 52. As for Figure 51 but for offsets derived from bottle salinities and CTD data. Upper panel shows data in terms of conductivity; lower panel shows equivalent in terms of salinity. The salinometer in use was switched midway through the analyses of samples from station 37.

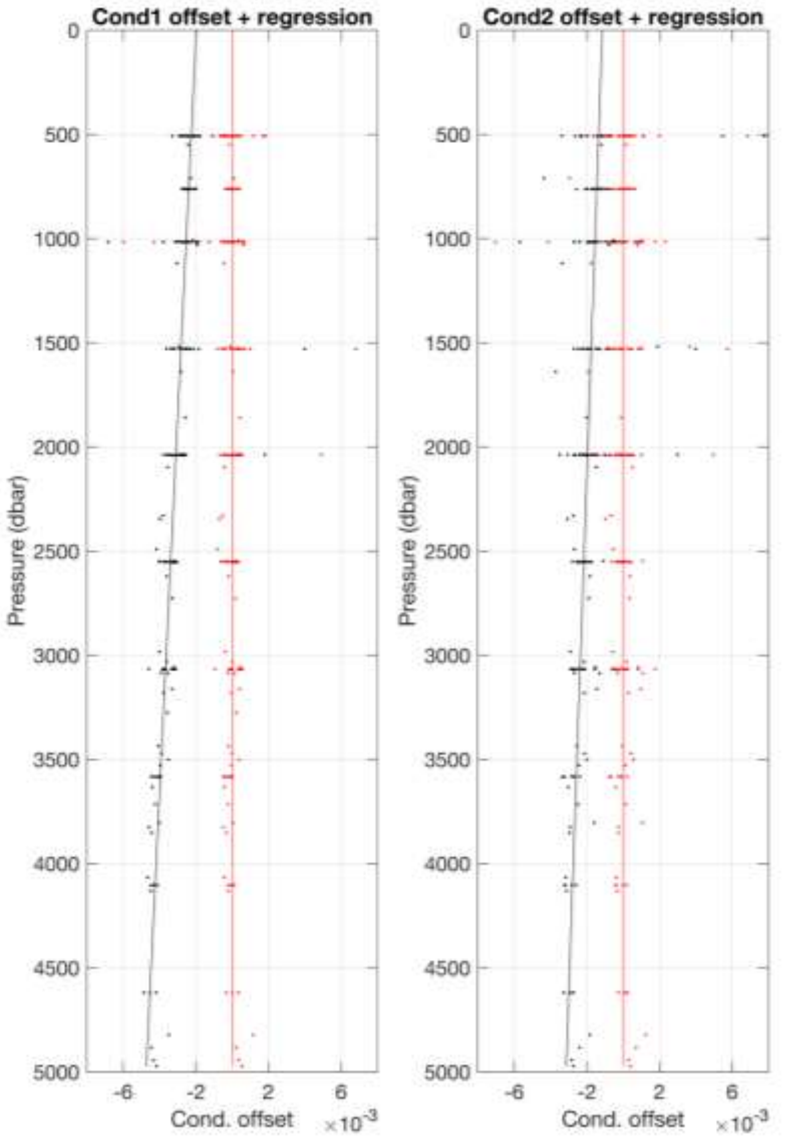


Figure 53. Offsets between bottle conductivity and CTD conductivity for (left) primary sensors and (right) secondary sensors, for deeper waters only. Black denotes uncalibrated data; red denotes data transformed according to the calibration given above.

Calibrations were applied in batch process mode using batch_calGEN.m
This calls the following routines, station-by-station:-

i) salcalappGEN.m – applies calibrations to the _bot_.all file, creating _bot_.cal, and the .edt file creating .clb

ii) splitcastGEN.m – divides cast into downcast and upcast profiles, creating .clb.dn and .clb.up

iii) fallrate_calGEN – applies correction for variable descent rate on downcast to .clb.dn file

iv) gridctd_calGEN – takes 2 dbar averages of both downcast and upcast profiles, creating .cal.2db.mat and .cal.2db.up.mat

v) onehzctd_calGEN – creates 1Hz output data from .clb file, creating _cal.1hz

Cast 031 was reprocessed manually due to significant sections of primary sensor data that had been blanked due to biofouling (see below).

Issues Encountered and Recommendations

Data quality is generally high for the CTD, with data seemingly stable and with offsets between primary and secondary streams generally small and in line with expectations. Issues encountered were:

a) Package wake effects

It is not unusual for vessels in the Southern Ocean to be subject to large waves and swells, and DY158 was no exception. As has been noted widely on previous cruises, this can result in variable speed in the CTD package's vertical motion, which can induce troublesome vortex/wake effects. These were noted frequently on DY158, and whilst the Active Heave Compensation (AHC) system appeared effective in combatting these, this was only deployed when the package was deeper than approximately 100 m on both downcast and upcast. Unfortunately, in many stations there were steep property clines shallower than this depth, and when the CTD package punched through these the effect of wakes shedding around the package produced pronounced unrealistic wavelike variations in properties. Some stations were strongly impacted even though the ship felt relatively stationary; it is thought that the large package size (with 22 x 20 litre Niskins fitted, and 2 x 10 litre) will have contributed to this, by presenting a larger cross-section of displacement to the ocean.

The fallrateGEN.m routine implemented above was able to remove some of the effects of these wake effects, but at some stations the effects were profound to the level that the data stream is too impacted and the question then becomes how one wishes to subsample bad data. Efforts were made to clean the data insofar as possible, though many stations retain visible wake effects still. The secondary sensors were less affected than the primary sensors, being mounted on the fin as opposed to within the main frame, and hence further from the centre of the wakes. **Recommendation: use of secondary sensor data instead of primary sensor data as main data stream.** This is hardwired into the processing for DY158 such that the secondary sensor data appears as the preferred variable.

The typical interval affected is between ~50 and 100m depth; on deep casts (such as A23 or Orkney Passage), this is only a small percentage of the overall cast depth, but on shallower casts (e.g. the Western Core Box shelf stations) it becomes a much more significant proportion. **For stations so impacted, we recommend considering the use of upcast data instead of downcast data, since this appears often less impacted by wakes**.

A further **recommendation for future cruises would be to investigate the possibility of using AHC above 100m on Discovery, and ideally entirely to/from the surface.** This might require new procedures to be established and/or engineering solutions to be implemented, but the improvement in data quality in the ~50-100 m depth layer would likely be significant, and for shallow casts would be a very worthwhile investment.

Further details on package wake effects and their dynamics are given in *Munday and Meredith* (2017).

b) Cast 31 likely biofouling

Station 31 (A23-28) showed large amplitude unrealistic spikes in many variables (temperature, conductivity, oxygen) on the downcast below around 2800 m and on the upcast below around 4750m. The cause of this is not known unambiguously but seems likely related to the ingestion of biological material into the tubing for the primary sensors – the effect was not manifest on the secondary sensors. Sections of the primary datastream were accordingly set to NaN; **recommendation, consistent with above, is to use secondary sensor data as main data stream.**

Example Data

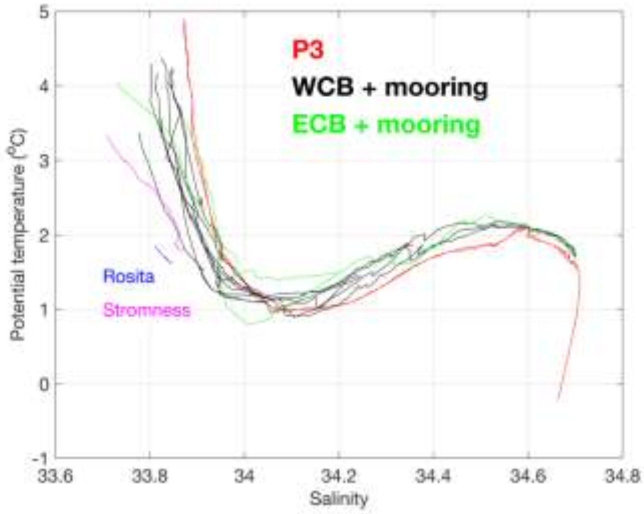


Figure 54. Potential temperature – salinity characteristics of CTD stations conducted at P3, in the Western Core Box and in the Eastern Core Box. Stations for echosounder calibration in Rosita Harbour and methane seep research in Stromness are included.

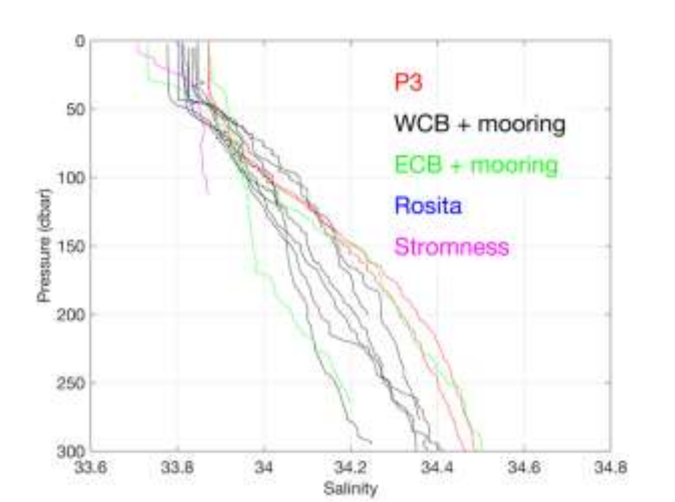


Figure 55. As per Figure 54, but for salinity versus pressure.

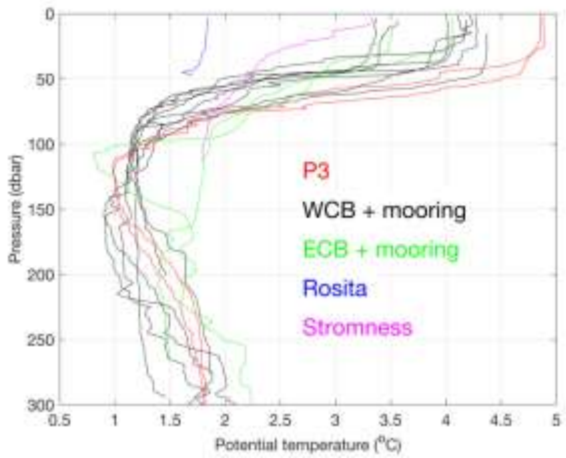
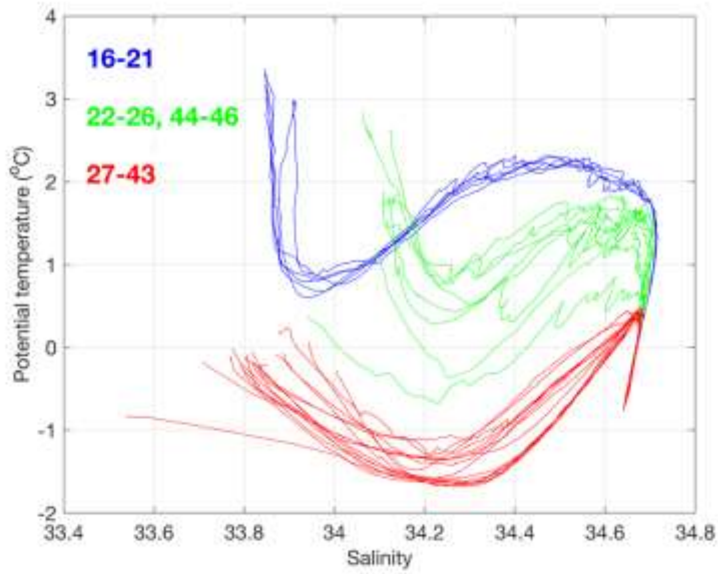


Figure 56. As for Figure 54, but for potential temperature versus pressure.



.

Figure 57. Potential temperature versus salinity for stations conducted along the A23 section. Stations are arbitrarily coloured by water mass characteristics, with blue denoted Antarctic Circumpolar Current (ACC) waters, red denoting Weddell Gyre waters, and green denoting the Weddell-Scotia Confluence sequence and other intermediate waters.

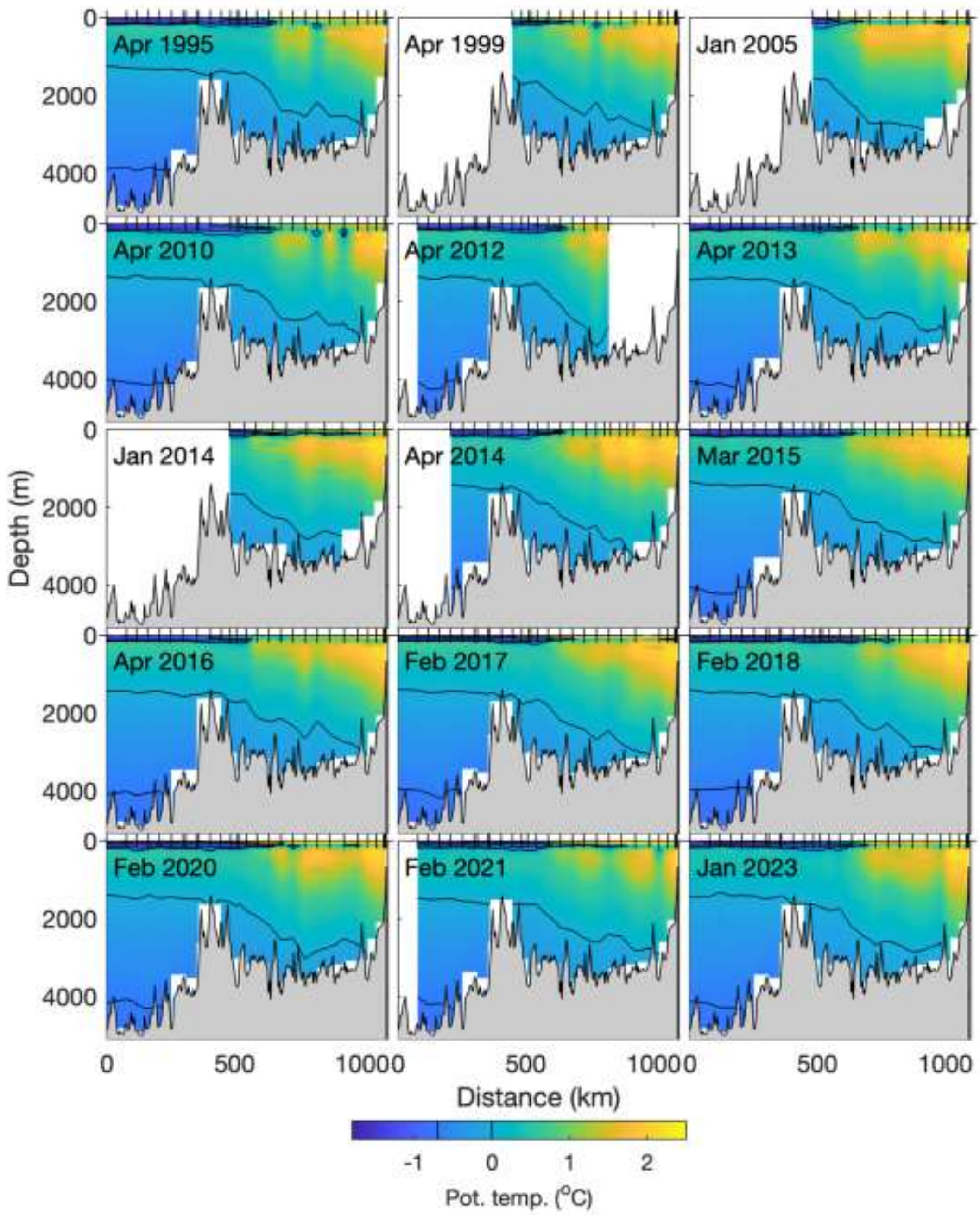


Figure 58. Potential temperature for the DY158 A23 section (January 2023), alongside the previous occupations of this section. These data will be used for various investigations, with a particular focus on extending the time series of volume/thickness of dense waters exiting the Weddell Sea and flowing northward into the lower limb of the Atlantic Meridional Overturning Circulation, as per *Abrahamsen et al.* (2019).

References

Abrahamsen, E.P., A.J.S. Meijers, K.L. Polzin, A.C. Naveira Garabato, B.A. King, Y.L. Firing, J.-B. Sallée, K.L. Sheen, A.L. Gordon, B.A. Huber and M.P. Meredith. "Stabilisation of the decline of dense Antarctic water supply to the Atlantic Ocean overturning circulation". *Nature Climate Change,* 10.1038/s41558-019-0561-2, 2019.

Munday, D.R. and M.P. Meredith. "On the dynamics of flow past a cylinder: Implications for CTD package motions and measurements". *Journal of Geophysical Research,* 10.1002/2017JC012708, 2017.

13. Salinometry

Jonathan Rosser, Chris Auckland, Michael Meredith, Povl Abrahamsen

Sampling

A total of 400 salinity samples were taken from 57 CTD casts. These samples were taken to calibrate the CTD and also to obtain known salinities for the O18 samples. These samples were taken from the relevant Niskin bottles in 200ml glass bottles, rinsed three times (at least once with the cap) and then filled up to the shoulder. The bottles' rims were wiped dry and closed with a single use plastic stopper and a screw cap. Once a crate had been filled it was placed in the controlled temperature salinometry room and left for at least 24 hours to equilibrate to the ambient temperature of ~18 °C before being analysed.

For most of the CTDs we took four salinity samples at depths with low gradients in salinity (as determined from the downcast) to use for calibration. Within the A23 section we took one salinity measurement for each O18 sample.

We also drew 122 underway samples along with the O18 samples at 3-hour intervals throughout the cruise with the same method as described above. This also included more frequent underway samples as we circuited the A76a iceberg which was 30 minutes for much of the time.

Analysis

Salinity samples were run through a Guildline Autosal using the Autosal software. The first N crates were done on the machine SN 71185 but this developed an issue with reading incorrect salinities partway through the cruise and so we moved to the backup machine SN 68958. They were both used in the same way, with standardisation completed initially before the machines were used for samples but then left at the same setting for the rest of the cruise. The bath temperature was set to 21 °C and the lab temperature was set at roughly 18 °C throughout the cruise.

Before and after each crate, a seawater standard (OSIL IAPSO standard seawater batch P164, K_{15}=0.99985) was run to track any offsets or calibration changes over the course of the cruise/crate. In general, two or three crates were run in succession and so a seawater standard measurement could sometimes be used as both the start of the one run and the end of another. Before running a seawater standard, the cell was flushed three times with an old opened standard but otherwise the standards were treated the same as general measurements.

For each sample, the cell was flushed and filled 4 times with the sample before the first reading and once more before the following two readings. The readings, mean and standardisation are logged by the software but also by hand as a backup. If the standard deviation was greater than 0.0002 then one of the readings would be taken again until the measurements were within error.

14. Oxygen Isotope Sampling

Mike Meredith, Povl Abrahamsen, Chris Auckland, Jon Rosser

The ratio of stable isotopes of oxygen in seawater (δ^{18}O), when measured in addition to salinity, informs on the relative contributions of sea ice melt and meteoric water (glacial melt and precipitation) to the overall freshwater budget of waters sampled. For DY158, samples for δ^{18}O analysis were drawn from CTD casts along the A23 section only, with no samples collected from CTDs at South Georgia or in Orkney Passage. The primary purpose of collection on the A23 section is to extend the time series of data here, which has already revealed the response of this part of the Southern Ocean to the remarkable retreat in sea ice in 2015/16 and thereafter, and to the megaberg A68 (*Meredith et al.,* 2023). Between 5 and 18 samples were collected on each CTD sampled, with vertical spacing reduced in the near-surface layers where salinity/freshwater gradients are largest.

Samples were also drawn from the ship's underway water supply at the same times as the underway salinity samples, typically every six hours. The frequency of underway sampling was greatly increased when in proximity to the giant iceberg A76A, as part of our circumnavigation survey: during this period, samples were collected every 20 or 30 minutes.

In each case, the δ^{8}O samples were stored in 50 ml glass vials, which had been pre-rinsed with the water to be sampled. These were sealed with rubber inserts and closed with metal crimp seals via hand crimpers. These samples will be shipped to the UK for stable isotope analysis at the NERC Environmental Isotope Facility, British Geological Survey, Keyworth. In total, 425 δ^{18}O samples were collected, comprising 243 from CTD casts and 182 from the underway supply. 71 of the latter were associated with the iceberg A76A.

References

Meredith M.P., E.P. Abrahamsen, F.A. Haumann, M.J. Leng, C. Arrowsmith, M. Barham, Y.L. Firing, B.A. King, P. Brown, J.A. Brearley, A.J.S. Meijers, J.-B. Sallée, C. Akhoudas and G.A. Tarling. "Tracing the impacts of recent rapid sea ice changes and the A68 megaberg on the surface freshwater balance of the Weddell and Scotia Seas". *Philosophical Transactions of the Royal Society A,* 10.1098/rsta.2022.0162, 2023.

15. Underway data processing

Povl Abrahamsen, BAS

RRS *Discovery* currently runs two concurrent data acquisition systems, RVDAS (jointly developed at NOC and BAS - and the main system installed on RRS *Sir David Attenborough*) and TechSAS. In similarity to JC211, we used the RVDAS data acquisition system as the basis for processing the underway instrument data streams. On this cruise this worked well until 21-24 Jan 2023, when an error in the virtual machine setup caused dropouts in some data streams for 5/10 minutes at a time [see SST report]. The values for these times had to be added from TechSAS after the end of the cruise and will be used to produce the final dataset for archival.

Unlike JC211, we did not use mstar to process the underway data, but instead used a series of Matlab scripts, developed on SD020 and this cruise to process the data. These are in part based on an earlier set of Matlab scripts developed at UEA and BAS on cruises on RRS *Charles Darwin* and RRS *James Clark Ross*.

The scripts query the RVDAS postgresql database using the psql command-line program and load the data into Matlab files for each day. Editing and calibrations can then be applied to the data before the daily files are concatenated and averaged into 1-s and 30-s data files. A final CF-compliant NetCDF file is generated at the end.

The scripts are intended to be flexible enough to run on either of the NMF-operated vessels (RRS *Discovery* [DY] and RRS *James Cook* [JC]) or RRS *Sir David Attenborough* [SDA], despite the differences in instrumentation and RVDAS database configuration between the vessels.

As the software was largely rewritten from scratch during this cruise, this chapter will describe the general workflow using these scripts, for reference during future cruises, in addition to cruise-specific sensor calibrations applied, and problems encountered.

Folder structure

For data processing, the code is contained in a sub-folder called “code_underway”, while daily files are contained within subfolders “nav” (for navigation streams), “bathy” (for depth sounders), and “ocl” (deriving from the “Oceanlogger” on JCR, equivalent to “Surfmet” on the NMF vessels, containing oceanographic, meteorological, and other scientific sensors). Averaged files are saved at the top level, as shown below:

Underway (top folder, e.g. on Public\DY158\scientific work areas)
- bathy (daily bathymetry files)
    - ea640_sddpt (files for the EA640 single-beam sonar)
        - ea640_sddpt_23003.mat (raw file)
        - ea640_sddpt_23003_clean.mat (clean file)
    - em122_kidpt (files for the EM122 multibeam sonar)
- code_underway (Matlab scripts – described below)
- dy158.gpx (GPX file of cruise track)
- dy158_bathy_1s_ave.mat (1-s average bathymetry data)
- dy158_bathy_30s_ave.mat (30-s average bathymetry data)
- dy158_nav_posmv_1s_ave.mat (1-s nav data from PosMV)
- dy158_nav_posmv_30s_ave.mat (30-s nav data from PosMV)
- dy158_nav_seapath_1s_ave.mat (1-s nav data from SeaPath)
- dy158_nav_seapath_30s_ave.mat (30-s nav data from SeaPath)
- dy158_ocl_1s_ave.mat (1-s science data)

- dy158_ocl_30s_ave.mat (30-s science data)
- dy158_underway.nc (merged NetCDF file with nav, depth, and science)
- nav (daily nav files – in subfolders by instrument/sentence)
- ocl (daily science files – in subfolders by instrument)
    - sbe45_nanan (files for SBE45 thermosalinograph)
        - sbe45_nanan_23005.mat (raw file)
        - sbe45_nanan_23005_clean.mat (clean file)
        - sbe45_nanan_23005_clean_cal.mat (clean, calibrated file)
    - surfmet_gpxsm (files for Surfmet data logger)
        - surfmet_gpxsm_23005.mat (raw file)
        - surfmet_gpxsm_23005_clean.mat (clean file)
- rtables_dy158.mat (list of tables on the RVDAS server)

Below, we assume that all code will be run from the “code_underway” folder.

RVDAS data streams and databases

On the NMF vessels, a database is created for each cruise, while on SDA there is a single database, with a view for each cruise, which will display only the instruments used and the date range of the cruise in question. Database details are shown in the table below.

Ship	Sir David Attenborough	James Cook	Discovery
Server	sdl-rvdas-s1.sda.bas.ac.uk	rvdas.cook.local	ram.discovery.local
Port	5432	5432	5432
Username	rvdas_ro	rvdas	rvdas
Password	9Gb3QG3dLUZ7gRJXegQf	rvdas	rvdas
Database	20210321	[cruise number]	[cruise number]
View	[cruise number]		

Table 25. RVDAS data streams and database details.

At the start of a cruise, or if the database has changed for some reason, a local file with a list of tables in the database is created by running the following lines, in the code directory:

```
rtables=rvdas_tables('ram.discovery.local','','rvdas','DY158');
save ../rtables_dy158 rtables
```

By saving a local file, we do not need to query the database structure every time data are downloaded. It can take a long time to generate this file, depending on the speed of the server.

Setup file

The list of variable names for the cruise, and metadata for the cruise itself, are stored in script set_underway_params.m. This is called by the other functions, most of which will not require cruise-specific editing. A partial template for SDA has been written in set_underway_params_sda.m; this will require editing with final stream and variable names, as it is based on an incomplete list of streams from SD020, when many instruments had not yet been commissioned. The file sets up structures mapping the variable names in RVDAS onto those exported in the averaged data files. If raw voltages are stored for a sensor, as is the case for the radiometers, fluorometer and transmissometer on the NMF vessels, a function handle can also be provided to convert these to engineering values.
The script from DY158 is provided as an appendix to this chapter.

Daily workflow

A daily workflow, in which the data for the previous day (or days) is usually followed.
Initially, data are downloaded from the database onto the local disk and stored in a Matlab file. For most of the scripts, the day number can be provided as an argument. If a year is not provided, the nearest year to the current date will be chosen. If a day number is not provided, the user will be prompted for this on the command line. Examples below are for 6 Jan (day number 6):

load_daily_nav(6); % load daily navigation streams
append_daily_nav(6); % append daily navigation to concatenated file
load_daily_bathy(6); % load daily bathymetry streams
edit_daily_bathy(6); % edit daily bathymetry streams manually
append_daily_bathy(6); % append daily bathymetry
load_daily_ocl(6); % load daily science sensors
dy158_edit_ocl(6); % apply cruise-specific editing to science sensors
plot_daily_ocl(6); % plot edited science sensors to check editing
append_daily_ocl(6); % 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_[whatever]. However, any subsequent files also need to be appended. Alternatively, all files can be concatenated using make_total_[whatever].

Next, we make the averaged files:
make_ave_nav; % calculate averaged navigation files
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

Applying calibrations

While any sensor factory calibrations should be applied when the data are loaded, cruise-specific calibrations, such as for TSG conductivity/salinity, are best applied together with edits for bad data in a cruise-specific script, in this case dy158_edit_ocl.m. This script applies edits for when the TSG instruments were being cleaned, a few other range checks and errors with sensors, and then corrects the conductivity, and re-calculates salinity and speed of sound. After applying these edits to all days in the cruise, the concatenated file is recreated using the calibrated values:
for n=[356:365,1:29], dy158_edit_ocl(n); end
make_total_ocl;
Then the files can be averaged and exported to NetCDF as above.

Calibration of DY158 TSG

The SBE-45 thermosalinograph salinities were compared against salt samples collected from the uncontaminated seawater tap in the underway laboratory during the cruise. The offset between the uncalibrated salinities and conductivities are shown in the figure below.

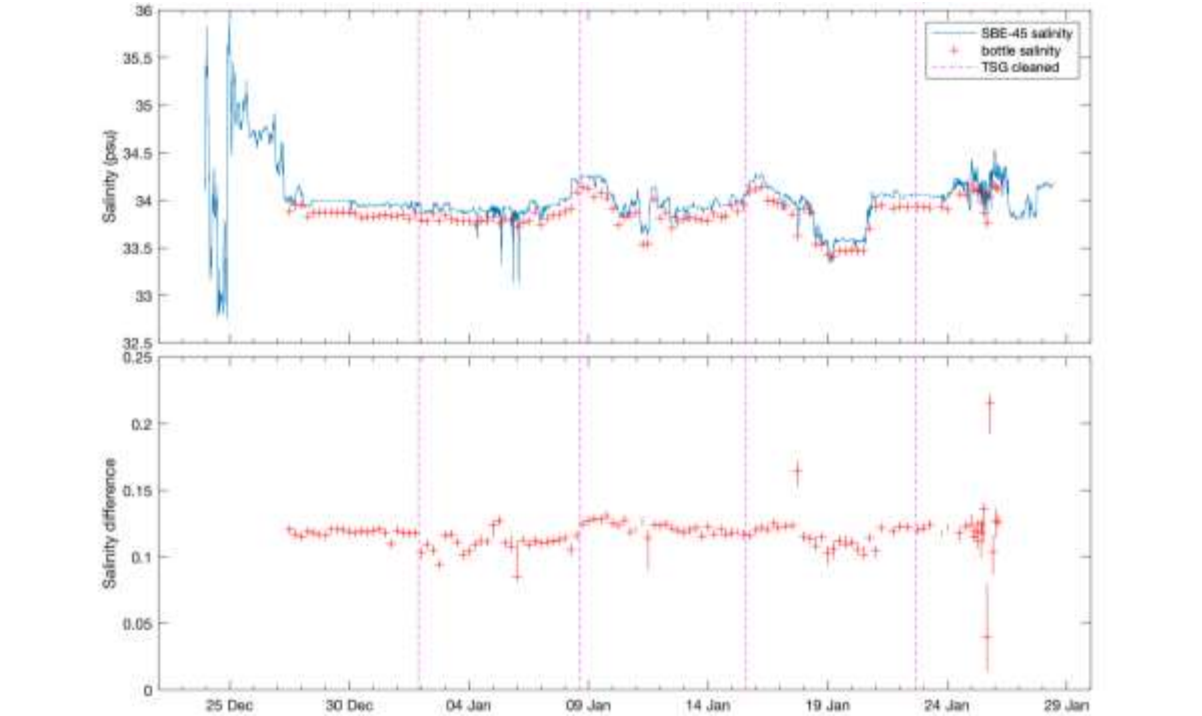


Figure 59. Offsets between uncalibrated SBE-45 and salinity samples. The vertical red lines in the lower panel indicate the range of values one minute before and after the time stamp of the sample collection.

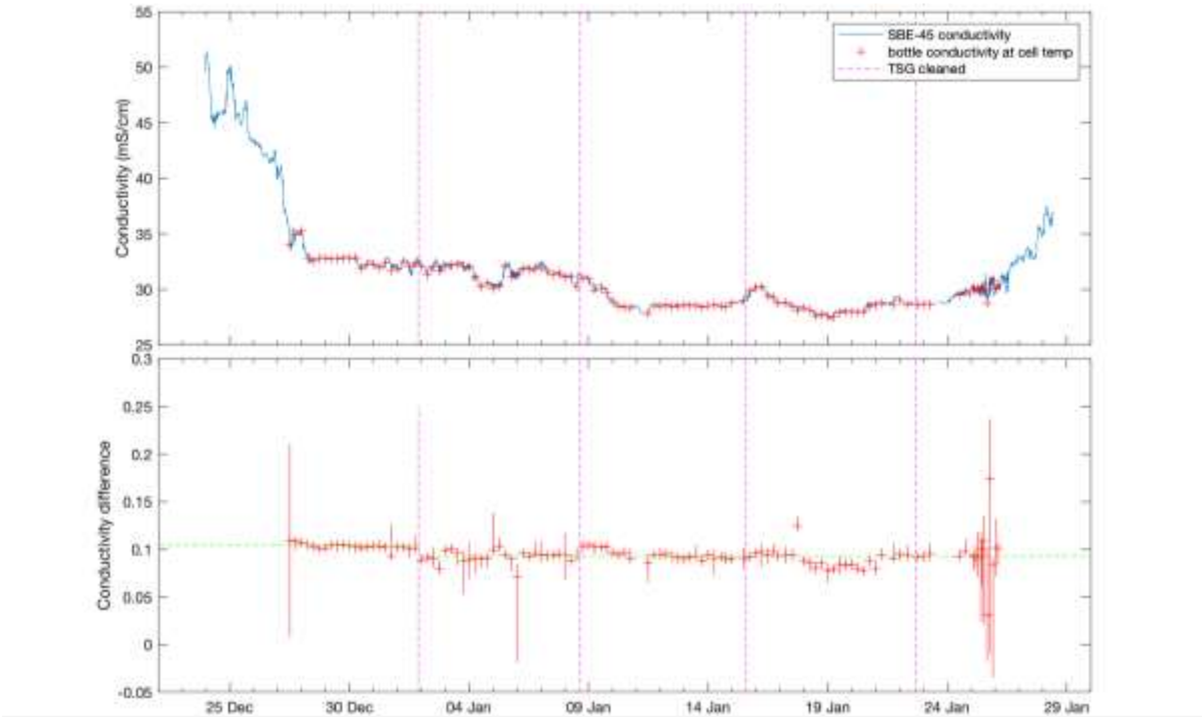


Figure 60. Offsets between uncalibrated SBE-45 conductivity and conductivity calculated from salinity samples. The vertical red lines in the lower panel indicate the range of values one minute before and after the time stamp of the sample collection.

A small shift in conductivity was observed after the first of four cleaning events during the cruise. Subsequently, a conductivity offset of 0.104 mS/cm was subtracted from the TSG conductivity before 21:12:24 on 1 Jan 2023. After this time, 0.093 mS/cm was subtracted.

The recalculated salinity offsets exhibited a linear relationship with the measured salinity, as shown in Figure 61. A linear regression was performed, disregarding outliers of >±0.04 mS/cm. This regression was then applied to the salinities, and conductivity and speed of sound was recalculated.

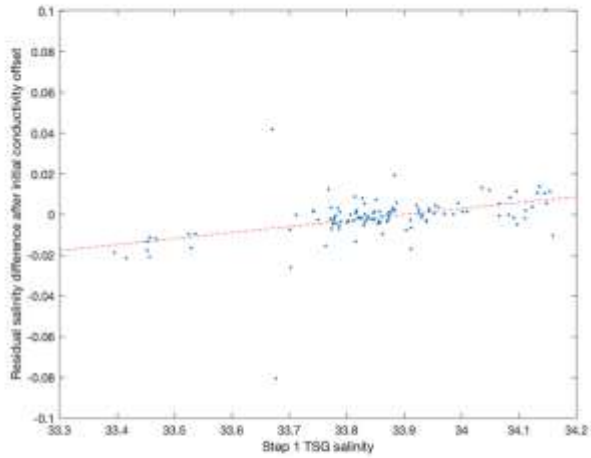


Figure 61. Regression between intermediate salinities and the difference between intermediate TSG and bottle salinities. The regression equation is y=0.029460*x-0.998686.

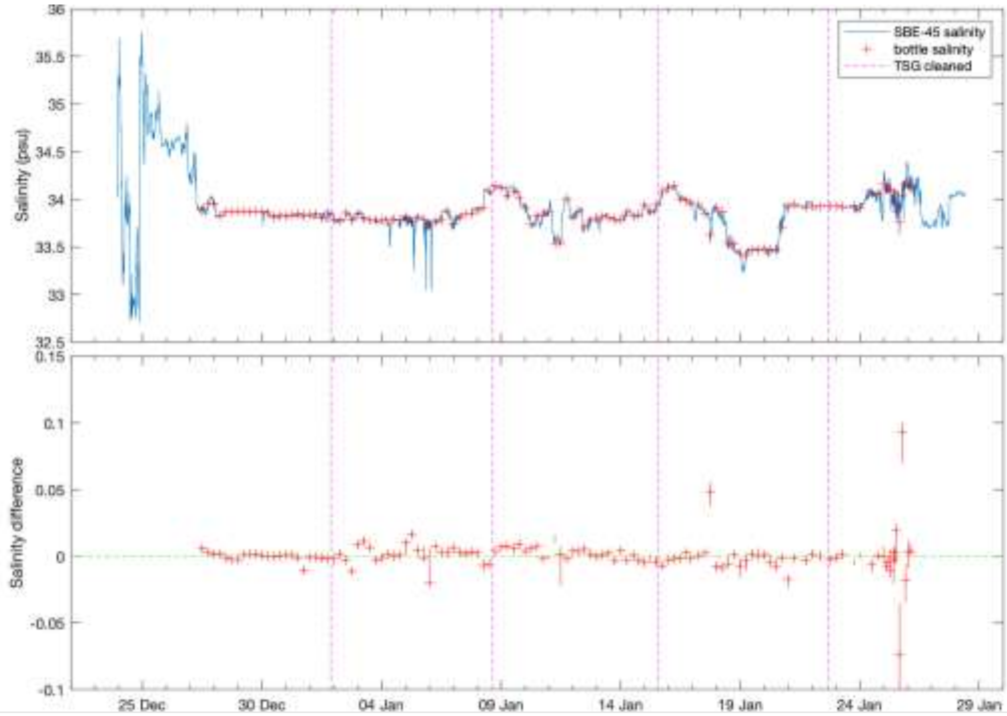


Figure 62. Final differences between calibrated TSG salinities and bottle salinities.

The calibration was also verified by comparing the underway temperatures and salinities against CTD casts. The 1-Hz calibrated CTD data files were scanned to find any time the CTD was at 5.5±1 dbar pressure, with the pumps on. Within each time window, the standard deviation of the temperature and salinity was calculated and plotted against the corresponding temperatures from the pump room (SBE-45 “remote” temperature) and drop keel, and the calibrated TSG salinity. On DY113 a large offset between the pump room temperature and CTD was observed, and attributed to the varying thermal mass of the water tank that the intake pipe passes through without insulation before reaching the SBE-38 sensor in the pump room. This remains the case here, with an offset of 0.1 °C from the drop keel temperature sensor, which is much closer to the CTD temperatures. The offsets between the remote and drop keel temperature increased as the ship was in colder waters.

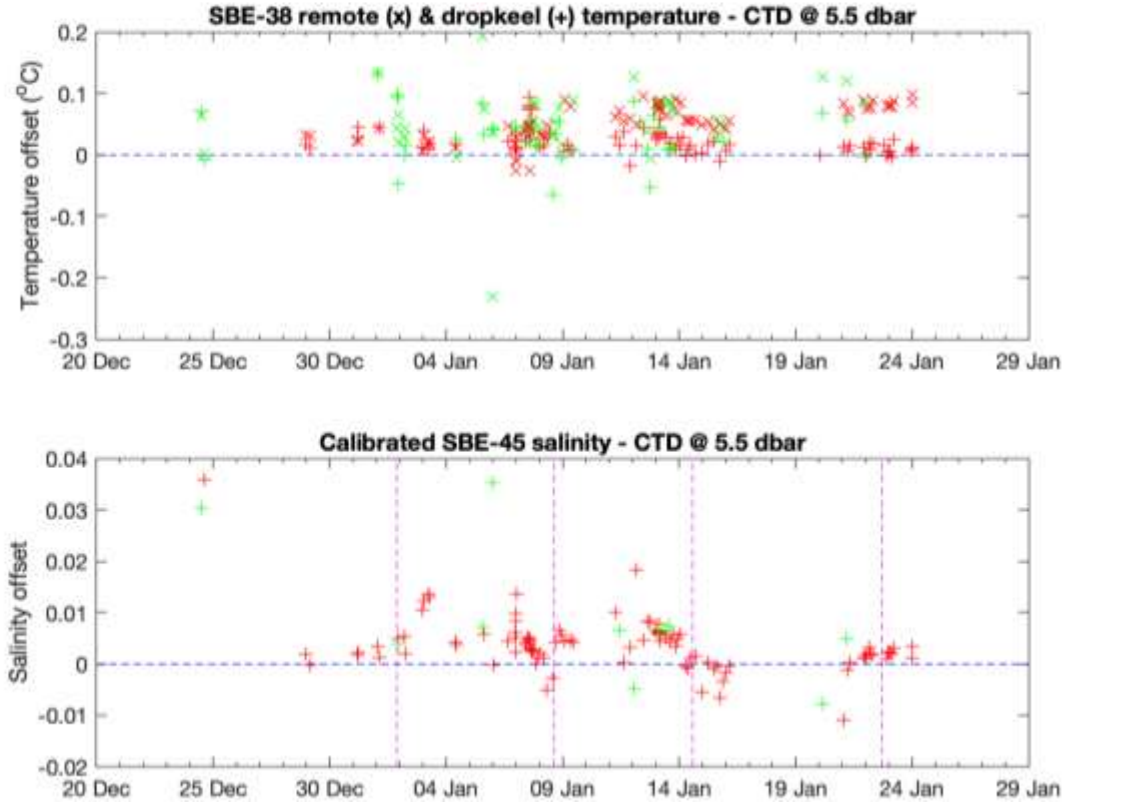


Figure 63. Offset between CTD values at 5.5±1 dbar, and underway temperature and salinity measurements. Red values indicate a standard deviation of <0.0025°C in the upper panel and <0.001 psu in the lower panel.

While there is still a difference between the CTD casts and TSG, there is no systematic offset in salinity, and little difference to the drop keel temperatures. There is a varying, uncorrectable, offset to the remote (pump room/tank top) temperature.

Bathymetry data

On RRS *Discovery* RVDAS is set up to log the EA640 single-beam bathymetric sonar and the centre-beam depth from the EM122 deep multi-beam sonar. Unlike SDA, the centre-beam depth from the EM712 shallow multi-beam is not logged. On DY, the EA640 transmits a DPT NMEA sentence, which includes both the depth below transducer and the offset from the surface to the transducer (from the Kongsberg SeaPath 330 GPS/motion system). The scripts are set up to allow for different sentences, which may or may not include depth offsets and speed of sound corrections (usually multi-beam systems will be corrected using a speed of sound profile while single-beam echo sounders typically use a fixed speed of sound of 1500 m/s). For uncorrected data, a correction can be applied using the echo sounder correction tables from Carter (1980, UK Hydrographic Office) using a Matlab version of the Fortran scripts and data files available from the BODC website at https://www.bodc.ac.uk/resources/products/software/carters_tables/.

Daily files are edited using a visual editor, originally written by Mike Meredith and subsequently updated by Hugh Venables, Povl Abrahamsen, and others, which lets the user select polygons around points to be removed. Once the user has finished editing the time series, an overview of all bathymetry data streams is shown, including corrections for any streams that are not corrected from a speed of sound profile. Since we did not use the EM122 on DY158, only the EA640 stream is available for this cruise.

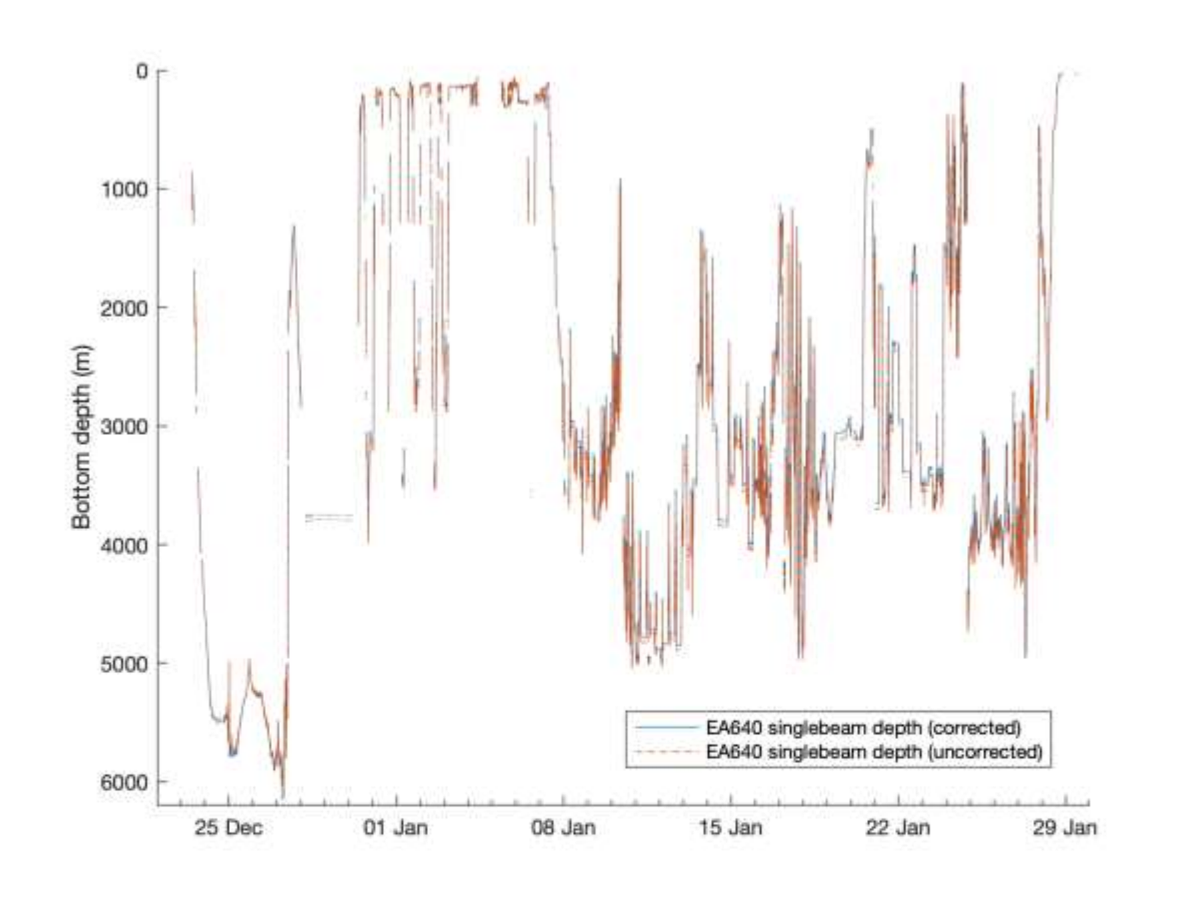


Figure 64. Edited EA640 bottom depths, with and without echo sounder corrections applied.

Appendix: Underway processing parameters from DY158

```
%SET_UNDERWAY_PARAMS Set up underway variable names for the current cruise
%
%  Sets the variable names used for underway processing. These structures
%  should be flexible to accommodate a wide range of RVDAS configurations.
%
%  This particular script is set up for RRS Discovery cruise DY158
%
%  version 1.0 - 20230109 - Povl Abrahamsen, DY158 - initial version

cruisename='dy158';
cruise_netcdf_metadata=struct(...
   'platform_type','ship',...
   'platform_identifier','RRS Discovery',...
   'title','Underway dataset from cruise DY158',...
   'institution','British Antarctic Survey',...
   'source','observation',...
   'references','Cruise report at https://www.bodc.ac.uk/resources/inventories/cruise_inventory/report/dy158.pdf',...
   'history',sprintf('Generated on RRS Discovery at %s',datestr(now))...
   );

nav_tables={'seapathpos_ingga','seapathpos_invtg','seapathatt_psxn23',...
   'posmv_gpgga','posmv_gpvtg','posmv_gphdt','posmv_pashr',...
   'phins_hehdt','phins_pixseatitud'};

nav_convert_positions=false; % convert positions from DDMMM.mmm to DDD.ddd
   % this should be set to "false" on ships where RVDAS does the
   % conversion before we do (e.g. Discovery)!

nav_sensor_sets=[...
   struct('set_name','SeaPath',...      % RRS Discovery SeaPath 330
      'gga_table','seapathpos_ingga',... % GGA contains latitude and longitude
         'gga_lat_field','latitude',...
         'gga_lon_field','longitude',...
      'vtg_table','seapathpos_invtg',... % VTG contains course/speed over ground
         'vtg_cog_field','courseoverground',...
         'vtg_sog_field','speedknots',...
      'hdt_table','phins_hehdt',...      % HDT contains true heading
         'hdt_hdg_field','headingtrue',...
      'file_add','_seapath'),...
   struct('set_name','PosMV',...        % RRS Discovery PosMV
      'gga_table','posmv_gpgga',...
         'gga_lat_field','latitude',...
         'gga_lon_field','longitude',...
      'vtg_table','posmv_gpvtg',...
         'vtg_cog_field','coursetrue',...
         'vtg_sog_field','speedknots',...
      'hdt_table','phins_hehdt',...
         'hdt_hdg_field','headingtrue',...
      'file_add','_posmv'),...
   ];

nav_sensor_set_best=2; % our main nav dataset - PosMV

hpr_sensor_sets=[...
   struct('set_name','SeaPath',...
      'hpr_table','seapathatt_psxn23',...
         'hpr_heading_field','heading',...
         'hpr_heave_field','heave','hpr_heave_orientation','up',...
         'hpr_pitch_field','pitch','hpr_pitch_orientation','fore_up',...
         'hpr_roll_field','roll','hpr_roll_orientation','starboard_down'),...
   struct('set_name','PosMV',...
      'hpr_table','posmv_pashr',...
         'hpr_heading_field','heading',...
         'hpr_heave_field','heave','hpr_heave_orientation','up',...
         'hpr_pitch_field','pitch','hpr_pitch_orientation','fore_up',...
         'hpr_roll_field','roll','hpr_roll_orientation','starboard_down'),...
   struct('set_name','Phins',...
      'hpr_table','phins_pixseatitud',...
         'hpr_heading_field','',...
         'hpr_heave_field','','hpr_heave_orientation','down',...
         'hpr_pitch_field','pitch','hpr_pitch_orientation','fore_down',...
         'hpr_roll_field','roll','hpr_roll_orientation','starboard_down'),...
   struct('set_name','Phins',...
      'hpr_table','phins_hehdt',...
```

```
        'hpr_heading_field','headingtrue',...
        'hpr_heave_field','','hpr_heave_orientation','down',...
        'hpr_pitch_field','','hpr_pitch_orientation','fore_down',...
        'hpr_roll_field','','hpr_roll_orientation','starboard_down'),...
  ];

ocl_tables={'surfmet_gpxsm','sbe45_nanan'};

% the fields in ocl_sensors are:
%   1: RVDAS table
%   2: RVDAS variable name
%   3: our (short) variable name for Matlab and NetCDF file
%   4: units
%   5: long/display variable name
%   6: CF standard variable name
%   7: calibration function for uncalibrated sensors

ocl_sensors=struct(...
  'ocl_flow',{{{'surfmet_gpxsm','flow1','flow','L min-1','TSG flow rate','',[]}}},...
  'ocl_water_temp',{{{'surfmet_gpxsm','tempdk','temp_dropkeel','Celsius',...
        'Drop keel temperature','sea_surface_temperature',[]},...
     {'sbe45_nanan','remotewatertemperature','temp_pumproom','Celsius',...
        'Pump room temperature','sea_surface_temperature',[]},...
     {'sbe45_nanan','housingwatertemperature','temp_cell','Celsius',...
        'SBE45 cell temperature','temperature_of_analysis_of_sea_water',[]}}},...
  'ocl_water_cond',{{{'sbe45_nanan','conductivity','cond','mS cm-1',...
     'SBE45 conductivity','',[]}}},...
  'ocl_water_sal',{{{'sbe45_nanan','salinity','salin','1',...
     'SBE45 salinity','sea_surface_salinity',[]}}},...
  'ocl_water_svel',{{{'sbe45_nanan','soundvelocity','svel','m s-1',...
     'SBE45 sound velocity','',[]}}},...
  'ocl_water_fluor',{{{'surfmet_gpxsm','fluo','fluor','mg m-3',...
     'Chlorophyll A fluorescence','mass_concentration_of_chlorophyll_a_in_sea_water',...
     @(x) 16.2*(x-0.060)}}},... % s/n WSCHL-1526 30/3/2022
  'ocl_water_trans',{{{'surfmet_gpxsm','trans','trans','percent',...
     'beam transmittance through 25 cm of seawater','',...
     @(x) 100*(x-0.004)./(4.700-0.004)}}},... % s/n CST-1852PR 23/3/2021
  'ocl_air_temp',{{{'surfmet_gpxsm','airtemperature','airtemp','Celcius',...
     'air_temperature',[]}}},...
  'ocl_air_rel_hum',{{{'surfmet_gpxsm','humidity','humidity','percent',...
     'relative_humidity',[]}}},...
  'ocl_air_pressure',{{{'surfmet_gpxsm','airpressure','airpressure','hPa',...
     'air_pressure_at_mean_sea_level',[]}}},...
  'ocl_rad_tir',{{{'surfmet_gpxsm','tirport','tirport','W m-2','TIR port',...
        'downwelling_shortwave_flux_in_air',@(x) x.*10./11.81},... % sn 161658 6/4/2021
     {'surfmet_gpxsm','tirstarboard','tirstarboard','W m-2','TIR starboard',...
        'downwelling_shortwave_flux_in_air',@(x) x.*10./10.09}}},... % sn 962276 18/8/2021
  'ocl_rad_par',{{{'surfmet_gpxsm','parport','parport','W m-2','PAR port',...
        'downwelling_photosynthetic_radiative_flux_in_air',@(x) x.*10./8.937},... % sn 28561 7/9/2022
     {'surfmet_gpxsm','parstarboard','parstarboard','W m-2','PAR starboard',...
        'downwelling_photosynthetic_radiative_flux_in_air',@(x) x.*10./9.944}}},... % sn 28558 7/9/2022
  'ocl_wind_rel_speed',{{{'surfmet_gpxsm','windspeed','windspeed_rel','m s-1','relative wind speed',[]}}},...
  'ocl_wind_rel_dir',{{{'surfmet_gpxsm','winddirection','winddir_rel','degree','relative wind direction',[]}}}...
  );

ocl_calc_true_wind=true; % calculate true wind from relative wind
% names of true wind variables - one set for each ocl_wind_rel_speed/dir pair above:
ocl_true_wind_names={{'windspeed_abs','winddir_abs','wind_u_abs','wind_v_abs'}};

bathy_tables={'ea640_sddpt','em122_kidpt'};

bathy_sensor_sets=[...
  struct('set_name','ea640',...
     'set_name_long','EA640 singlebeam',...
     'bathy_table','ea640_sddpt',...
        'depth_below_surface_field','',...
        'depth_below_transducer_field','waterdepthmetertransducer',...
        'transducer_offset_field','transduceroffset',...
        'fixed_transducer_offset',[],...
        'depth_is_uncorrected',true),...
  struct('set_name','em122',...
     'set_name_long','EM122 multibeam',...
     'bathy_table','em122_kidpt',...
        'depth_below_surface_field','',...
        'depth_below_transducer_field','waterdepthmetre',...
        'transducer_offset_field','transduceroffset',...
```

```
    'fixed_transducer_offset',[],...
    'depth_is_uncorrected',false),...
];
```

16. Investigating biogeochemical cycles using silica isotopes

Laura Taylor, Clara Manno

CTD Water sampling

Motivation

The Southern Ocean plays a key role in the global silica cycle; however, there is much uncertainty regarding Si fluxes and cycling in the surface ocean layer (Tréguer, 2014) and the impacts of this on biological carbon export. The Scotia Sea has distinct regional differences microplankton structure and bloom dynamics, influencing carbon export from sinking of phytoplankton, and determining grazing interactions and subsequent export of faecal pellets (Korb et al., 2012). Siliceous plankton take up dissolved Si from the water column, exporting biogenic silica through sinking and in faecal pellets when eaten by zooplankton.

When analysed, samples collected on this cruise will show Si isotopic composition across abiotic and biogenic sources in conjunction with particulate organic carbon POC concentration to suggest the relationship between different Si isotope compositions across the study region and with depth, and the impact this may have on carbon cycling and export. This forms part of the PhD project 'Isotopic approaches to unravelling export and recycling processes in the Southern Ocean' (C-CLEAR DTP, University of Cambridge).

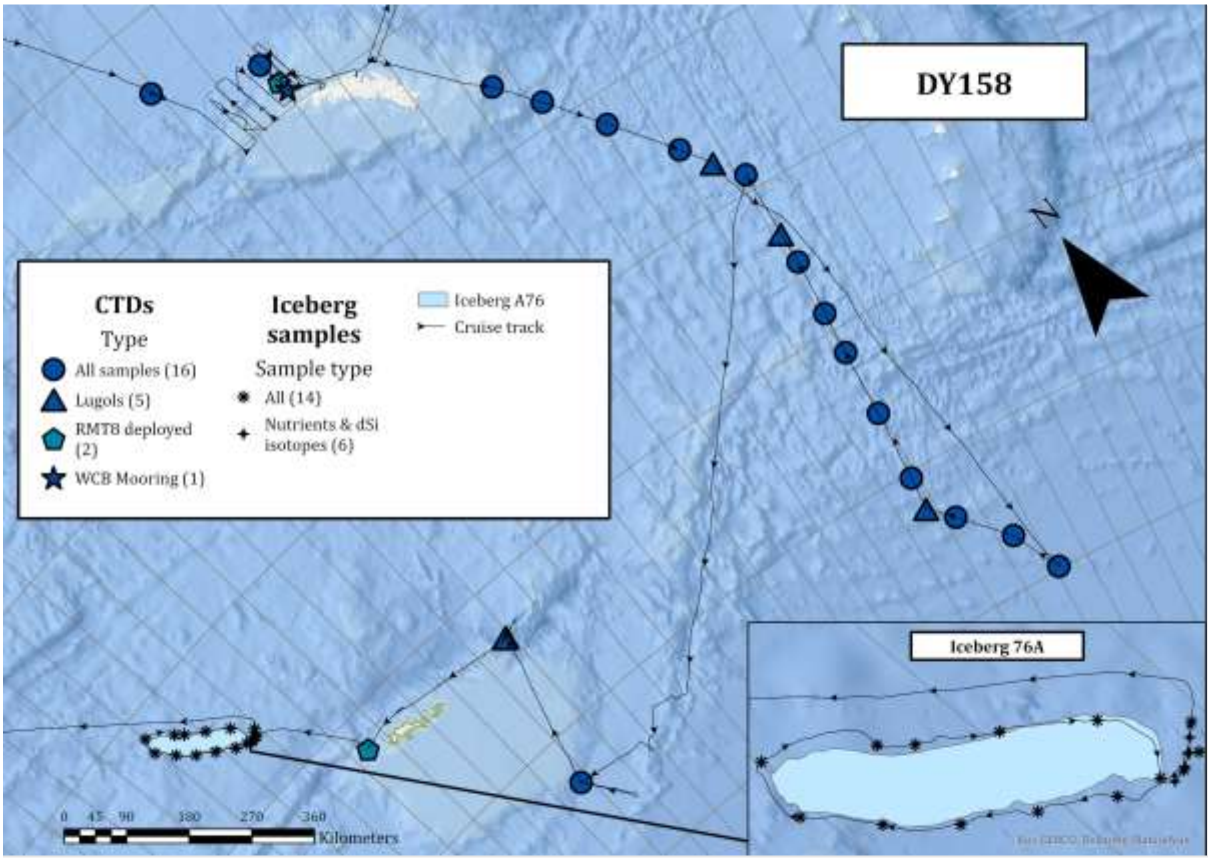


Figure 65. Map showing sample locations for CTD water sampling and RMT8 net catches for krill faecal pellet production experiments.

Locations and depths

Samples were taken along the A23 transect encompassing varying biogeochemical environments, from the more productive waters around South Georgia, to those potentially influenced by ice-edge processes in the Weddell Sea.

CTD stations were chosen where simultaneous samples for analysis of oxygen isotope composition were taken to allow comparison between the two data sets to investigate links between Si isotopes and water mass sources suggested by oxygen isotopes.

Additional samples were taken at the P3 mooring site, due to the potential for comparison with longer-term time series data, at the M2 mooring site due to proximity to sea ice. Phytoplankton composition samples only were taken at additional locations to correspond with Bongo net samples.

The sample profile chosen provides finer resolution in surface waters with typically higher variability across biogeochemical parameters. If the maximum chlorophyll concentration (chl_{max}), identified by observing CTD-mounted fluorometer plots as the CTD descends, clearly peaked at a depth not covered by existing depths, an additional set of samples was taken at the depth of the chl_{max}.

CTD water samples were taken from Niskin bottles as shown in Table 26 for dissolved nutrient concentrations, dissolved silicon isotopic composition, phytoplankton community composition, particulate silica, and particulate organic carbon and nitrogen. This range of parameters will allow biogenic and abiotic sources of silica to be identified, and their sources and sinks considered in the context of the biogeochemical environment.

Location	Event Number	Chl_{max} depth (m)	Chl_{max} samples taken?	Diss-olved Nutrients	Dissolved silicon isotopes	Phyto plankton composit-ion (Lugols)	Particulate silica	POC and PON
P3 mooring	8	30	Y	Y	Y	Y	Y	Y
WCB W3.2	27	26	**N**	**N**	**N**	Y	**N**	**N**
WCM mooring	51	17	Y	Y	Y	Y	**N**	**N**
A23-51A	63		**N**	Y	Y	Y	Y	Y
A23-49	70		Y	Y	Y	Y	Y	Y
A23-47	74	40	Y	Y	Y	Y	Y	Y
A23-45	77	50	**N**	Y	Y	Y	Y	Y
A23-44	78		**N**	**N**	**N**	Y	**N**	**N**
A23-24	80		**N**	Y	Y	Y	Y	Y
A23-25	83		**N**	Y	Y	Y	Y	Y
A23-27	86		**N**	Y	Y	Y	Y	Y
A23-28	87		**N**	**N**	**N**	Y	**N**	**N**
A23-29	90	20	**N**	Y	Y	Y	Y	Y
A23-32	95		Y	Y	Y	Y	Y	Y
A23-35	101		**N**	Y	Y	Y	Y	Y
A23-37	103	55	Y	Y	Y	Y	Y	Y
A23-40	108	20	**N**	Y	Y	Y	Y	Y
A23-41	109		**N**	**N**	**N**	Y	**N**	**N**
A23-43	115		**N**	Y	Y	Y	Y	Y
M2 mooring	117	30	**N**	Y	Y	Y	Y	Y
OP6 mooring	129		**N**	**N**	**N**	Y	**N**	**N**

OP2 mooring	138		**N**	**N**	**N**	Y	**N**	**N**
OP4 mooring	147		**N**	**N**	**N**	Y	**N**	**N**

Table 26. CTD sample locations and parameters sampled.

Sampling and preservation

Samples for analysis of dissolved nutrient concentration and dissolved silicon isotopes passed through an Acropak filter (0.8/0.45 µm) attached via tubing to the Niskin bottle when obtaining water from each depth, meaning these samples are free from particulate organic matter.

Phytoplankton composition samples were obtained by storing water from each Niskin bottle in Nalgene bottles covered in aluminium foil to prevent light from penetrating the sample. Samples were fixed with Lugol's iodine. immediately after sampling, or if this was not possible, samples were chilled at 4 °C until they were fixed.

Sample	Filtration	Depths (m)	Water volume (ml)	Vessel	Storage
Dissolved nutrients	Acropak filter (0.8/0.45 µm)	10, 20, 50, 100, 500, 1000, 2000	50	Falcon tube	Frozen -20°C
Dissolved silicon isotopes	Acropak filter (0.8/0.45µ m)	10, 20, 50	125 or 250	Nalgene bottle	Chilled 4°C
		100	250		
		500,1000,2000	500		
		chlmax	250		
Phytoplankton composition	Unfiltered	10, 20, 50	125	Nalgene bottle covered in aluminium foil	Preserved with Lugol's iodine, chilled 4°C

Table 27. Sample depths, filtration methods, and storage of water samples obtained from CTD Niskin bottles.

Particulate silica and organic carbon and nitrogen samples were obtained by filtering water onto polycarbonate (0.65 µm) and pre-ashed and weighed GF/F filters respectively. This included washing forceps and other tools used with Milli-Q between touching each filter type to avoid contamination due to filter material. Care was not taken to not touch filters directly to avoid contamination, particularly of organic carbon.

All samples were stored in petri dishes and wrapped in Parafilm for protection before storage.

Sample	Depths (m)	Volume filtered (ml)	Filter used	Storage
Particulate biogenic silica	10, 20, 50, 100	250	Polycarbonate filter (0.65 µm, 25 mm)	Frozen -20°C
	500, 1000, 2000	500		
	Chlmax	250		
Particulate organic carbon and nitrogen	10, 20, 50, 100	250	Ashed and weighed GF/F filter (25 mm)	Frozen -20°C
	500, 1000, 2000	500		
	Chlmax	250		

Table 28. Depths, volume filtered, filter type, and storage of samples for particular matter in water obtained from CTD Niskin bottles.

Figure 66. Filtration setup in the general lab.

All samples will be analysed for their respective biogeochemical parameters once they have been returned to the UK at BAS Cambridge and other institutions where necessary for isotopic analysis.

Underway sampling

Water samples were taken from the underway sampling system every 6 hours along the A23 transect for measurement of dissolved nutrients and dissolved Si isotopes. Samples were taken at the same time as oxygen isotope composition samples to allow for future comparison of the two datasets.

Water obtained from the underway sampling system passed through an Acropak filter (0.8/0.45 µm) attached with tubing to the sampling tap to remove particulate organic matter from the sample.

Figure 67. Underway sampling taps.

Krill faecal pellet production experiments

Motivation

Higher food availability for zooplankton in austral summer allows for increase in zooplankton population, and increased faecal pellet production, of which krill faecal pellets are a major contributor to biological carbon export (Gleiber et al., 2012). Collection and analysis of faecal pellets from this experiment will highlight differences in particulate n biogenic silica isotope composition and POC content between krill with and without access to food.

Methods

Krill obtained from the RMT8 net catch of event 30 (02/01/2023) were allowed to acclimatise before 8 healthy specimens were selected for this incubation experiment. These were split into two groups of four replicates, one given food over the course of the experiment and one that received no food. Krill given food were each provided with 100 µL of a food consisting primarily of dinoflagellates. Each Krill was incubated in glass beaker contained 250 ml of water.

Krill for two experiments were obtained through RMT8 net catches, the first of event 30 (02/01/2023), in the West Core Box study area, and the second of event 150 (24/01/2023), near the South Orkney islands. Krill were allowed to acclimatise before 8 healthy specimens from each catch were selected for incubation. Krill were split into groups of four replicates with each krill in an individual beaker with 250 ml of filtered seawater, where in one group each krill was given 100 µL of a food containing primarily dinoflagellates at each time interval, and one group was not provided with any food over the course of the experiment. Krill acclimatisation and experiments took place in the temperature-controlled lab at approximately 4 °C.

Beakers containing krill were fitted with a mesh covering the bottom of the beaker to prevent coprophagy (ingestion of faecal pellets), coprohexy (fragmentation of faecal pellets), and coprochaly (removal of faecal pellet membranes), allowing all faecal pellets produced by krill to be collected. Each beaker contained 250 ml of water.

Krill were incubated for a total time period of 36 hours in the dark, during which beakers were oxygenated using an air pump with diffusing stones to limit the bubbling effect of the pump in the small volume of water.

Every 12 hours (T1, T2, T3) from the start of the experiment faecal pellets were collected from each beaker using a pipette and preserved with ethanol in an Eppendorf tube, resulting in samples for each of the 8 specimens for 3 time periods. Food was supplied to the food group after faecal pellet removal. Faecal pellets were also collected from a basket in which a large number of krill acclimatised before experimentation (T0), alongside larger samples of faecal pellets from krill not being used in experiments.

At the end of the experiment (T3= 36 hours), all krill specimens were still alive. Krill were preserved by freezing for later analysis of life stage. Once samples have returned to the UK, faecal pellets will be analysed for particulate biogenic silica isotopic composition and particulate organic carbon content, and krill life stage will be determined.


Figure 68. Krill incubation beaker setup.

References

Tréguer, P.J., 2014. The Southern Ocean silica cycle. Comptes Rendus Geoscience 346, 279–286. https://doi.org/10.1016/j.crte.2014.07.003

Korb, R.E., Whitehouse, M.J., Ward, P., Gordon, M., Venables, H.J., Poulton, A.J., 2012. Regional and seasonal differences in microplankton biomass, productivity, and structure across the Scotia Sea: Implications for the export of biogenic carbon. Deep Sea Research Part II: Topical Studies in Oceanography, DISCOVERY 2010: Spatial and Temporal Variability in a Dynamic Polar Ecosystem 59–60, 67–77. https://doi.org/10.1016/j.dsr2.2011.06.006

Gleiber, M.R., Steinberg, D., Ducklow, H.W., 2012. Time series of vertical flux of zooplankton fecal pellets on the continental shelf of the western Antarctic Peninsula. Marine Ecology Progress Series 471, 23–36. https://doi.org/10.3354/meps10021

17. VMADCP

Jonathan Rosser

Data acquisition, processing, editing, and calibration

Equipment and Setup

Although two Vessel Mounted Acoustic Doppler Current Profilers (VMADCPs), 75 kHz and 150 kHz, are present on the RRS Discovery, only the 75 kHz was used for routine data collection. This was for two reasons, primarily, because the 150 kHz VMADCP interfered problematically with the fisheries echosounder and other acoustic data, but also because only 3 of the beams were active and so the data were less useful. The 75 kHz VMADCP was run in narrowband mode for most of the cruise, using UHDAS to sample and ksync to schedule pings with other acoustic sampling.

Processing

The data were processed using CODAS (http://currents.soest.hawaii.edu/adcp_doc/codas_doc/index.html). This was done by syncing the data to a laptop and processing it using the workflow below:

1. Mount relevant public drives to ensure access to raw data and ability to reupload once the data has been processed
2. Activate the pycodas environment which is supplied by CODAS
3. Download the data, place it in relevant directories and sync previous edits using versions of uhdas_01, uhdas_02 and uhdas_03 which have been adapted for the local directory structure
4. Preliminary checking and editing using dataviewer to check for and remove clear biases/ erroneous measurements. More details in the "Dataviewer" section.
5. Calibration of the data. The required parameters to calibrate the data was determined using the command "tail -20 cal/watertrk/adcpcal.out". The values for the amplitude and angle corrections were then put into the command: "quick_adcp.py –steps2rerun rotate:apply_edit:navsteps:calib –rotate_amplitude X –rotate_angle Y –auto", where X and Y are the relevant values
6. Second manual check of the data, for more detail see the "Dataviewer" section
7. Export and upload the data to the public drives using uhdas_04 and uhdas_05 adapted for local directory structures

Dataviewer

While underway, the turbulences and bubbles caused by the engines and the ship's movement sometimes led to corrupted data in the upper bins. There were also issues with consistent electrical noise during the cruise which began on 03/01/23 and affected the water in the upper 50 m and below 200 m in the water column, significantly reducing the quantity of useable data (See Issues and Problems Section). This is a known issue which UHDAS are aware of and will hopefully be resolved by rearranging some of the electrical setup supporting the VMADCP to reduce cable interference. There were also some biases due to reflecting layers in the water and reflections from the bottom of the sea.

Dataviewer in edit mode was used to remove all of the above issues by running the command "dataviewer.py -e". In this mode the relevant points were masked and then removed.

Final Calibration Values

The final calibration values for the amplitude and phase applied to the data are as follows:

Amplitude: 1.0046
Phase: 0.07

Issues and Problems

As previously mentioned, due to interference with the fisheries echosounders, the 150 kHz ADCP was not used throughout the cruise.

Also, on the 03/01/23 11:45 UTC it was observed that the depth of the good signal return had increased from ~200 m to around 400 m with the new data in the 200 m-400 m region appearing erroneous. This correlated with the time that the bottom tracking was turned on for a transect, however the error did persist after the bottom tracking was turned off. After contact with UHDAS support in Hawaii it was determined that this was likely to be due to an ongoing electrical problem which remains unresolved and would require rewiring and the changing of the cable setup to fix. This led to significant biases in the upper 50 m and below 200 m in the data and so large regions of this data had to be removed from the dataset from this point onwards. This led to a new cruise section being started and a new set of data being recorded from 03/01/23 23:45 UTC until the end of the cruise. Restarting the cruise section and the systems did seem to reduce the prevalence of the error, although large sections still had to be removed above 50 m and below 200 m.

Results

The VMADCP was switched on and recording for the majority of the cruise, with data recorded throughout the WCB, A23 Section and while retrieving moorings in the Weddell Sea and Orkney Passage. It was also running for the period of transit from Orkney Passage to the Falkland Islands.

Calibration and Correction Figures

The below figures are example reference figures showing the calibration of the amplitude and angle of the VMADCP water track and the heading correction over the final days of the cruise.

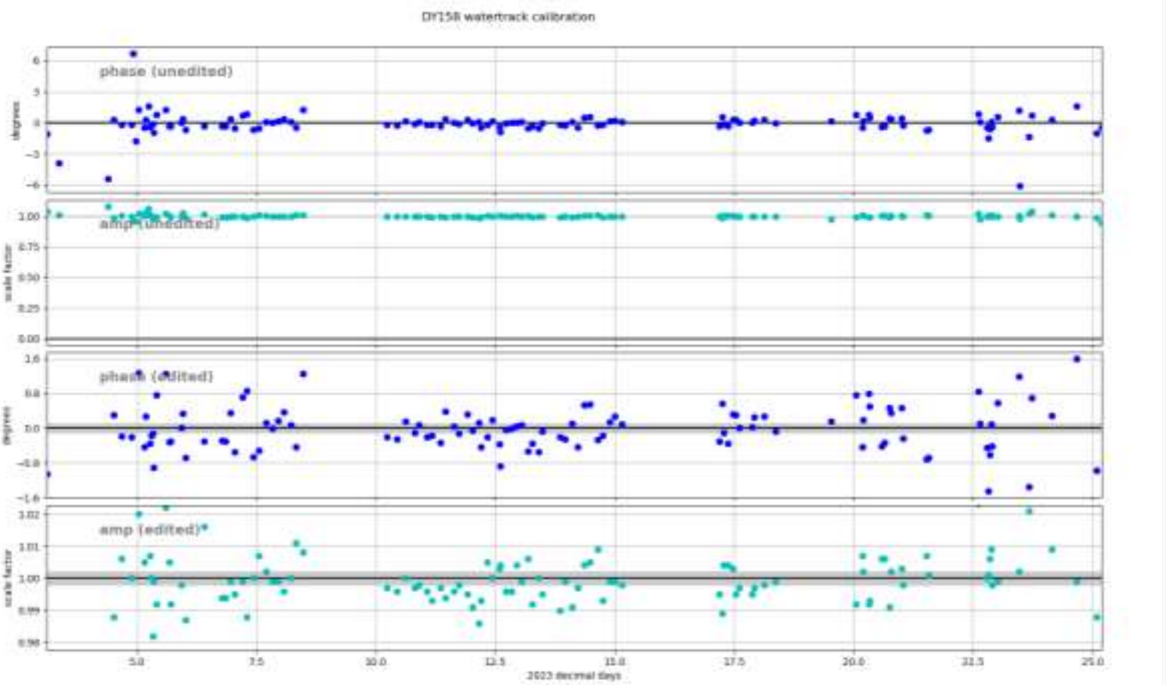


Figure 69. Water Track Calibration of the VMADCP for the amplitude and phase, for part 2 of the cruise.

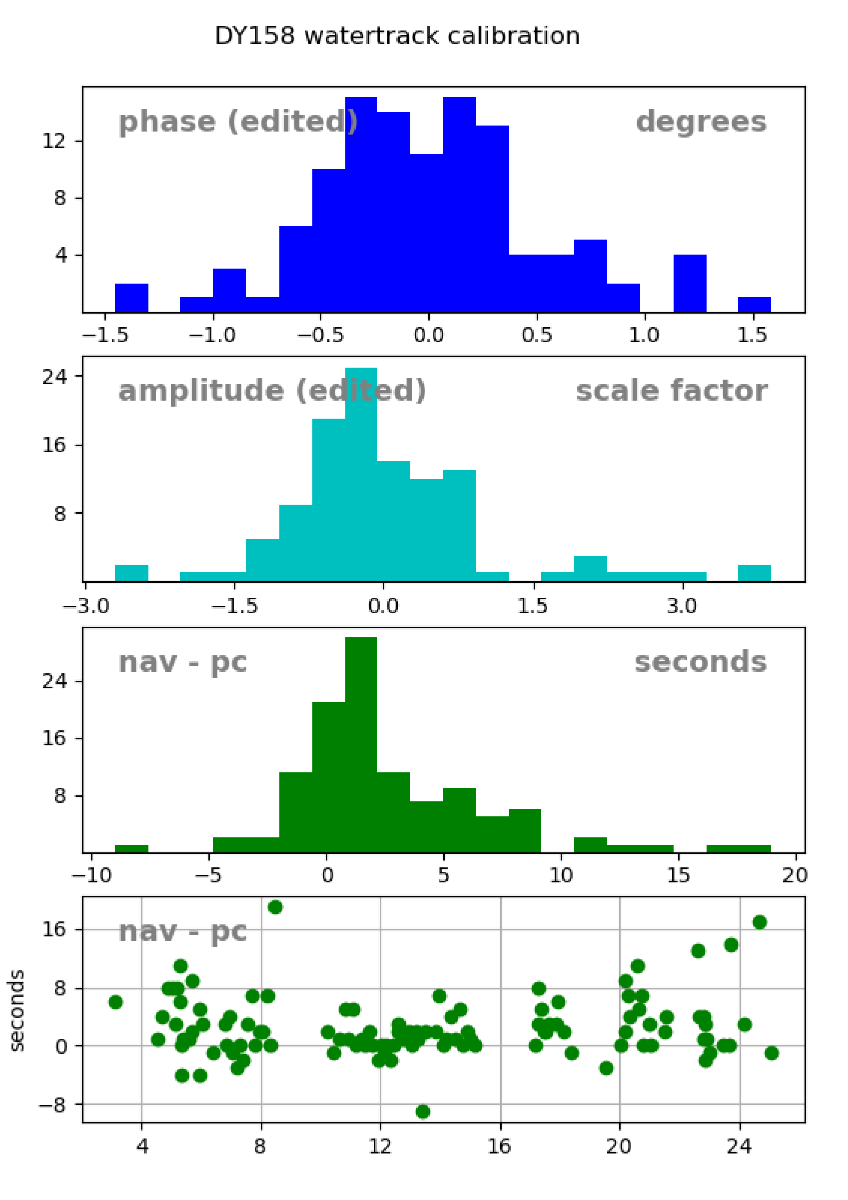


Figure 70. Histograms showing the calibration of the VMADCP watertrack for part 2 of the cruise.

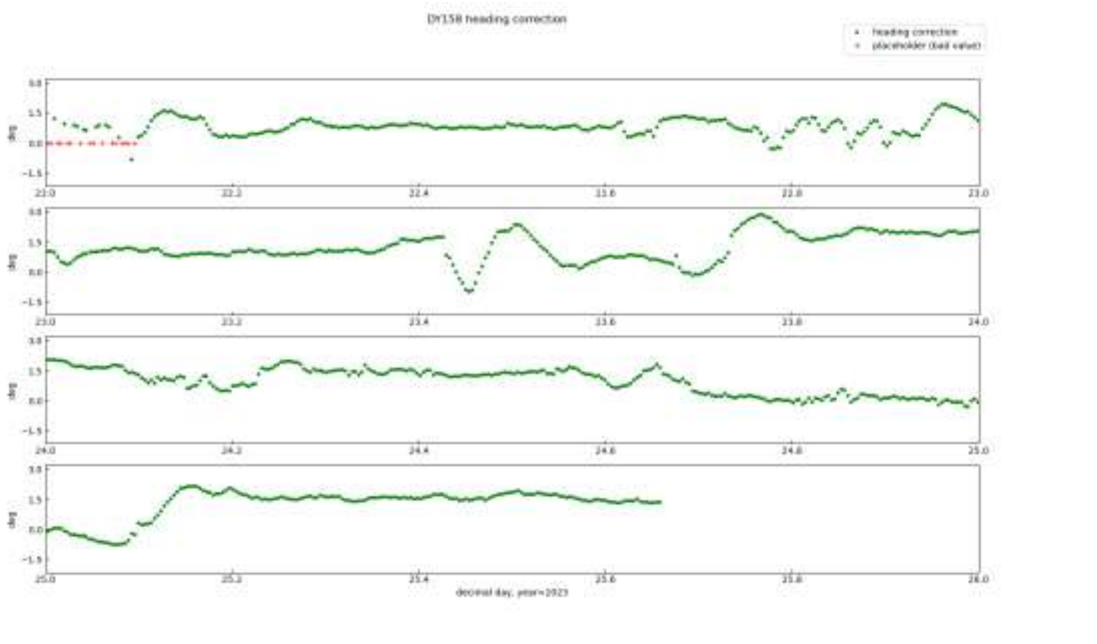


Figure 71. Heading correction for the VMADCP over the later part of the VMADCP part 2 section.

Cruise Path and Velocity Figures

The figures below show the cruise path of the ship for the two recorded sections (before and after the electrical faults) along with the calculated u and v velocities. The bias against the COG is also given. Overall, the data look reasonable in most regions, although the data below 200 m and above 50 m in the second half of the data should be treated with significant suspicion due to the possible influence of the electrical fault.

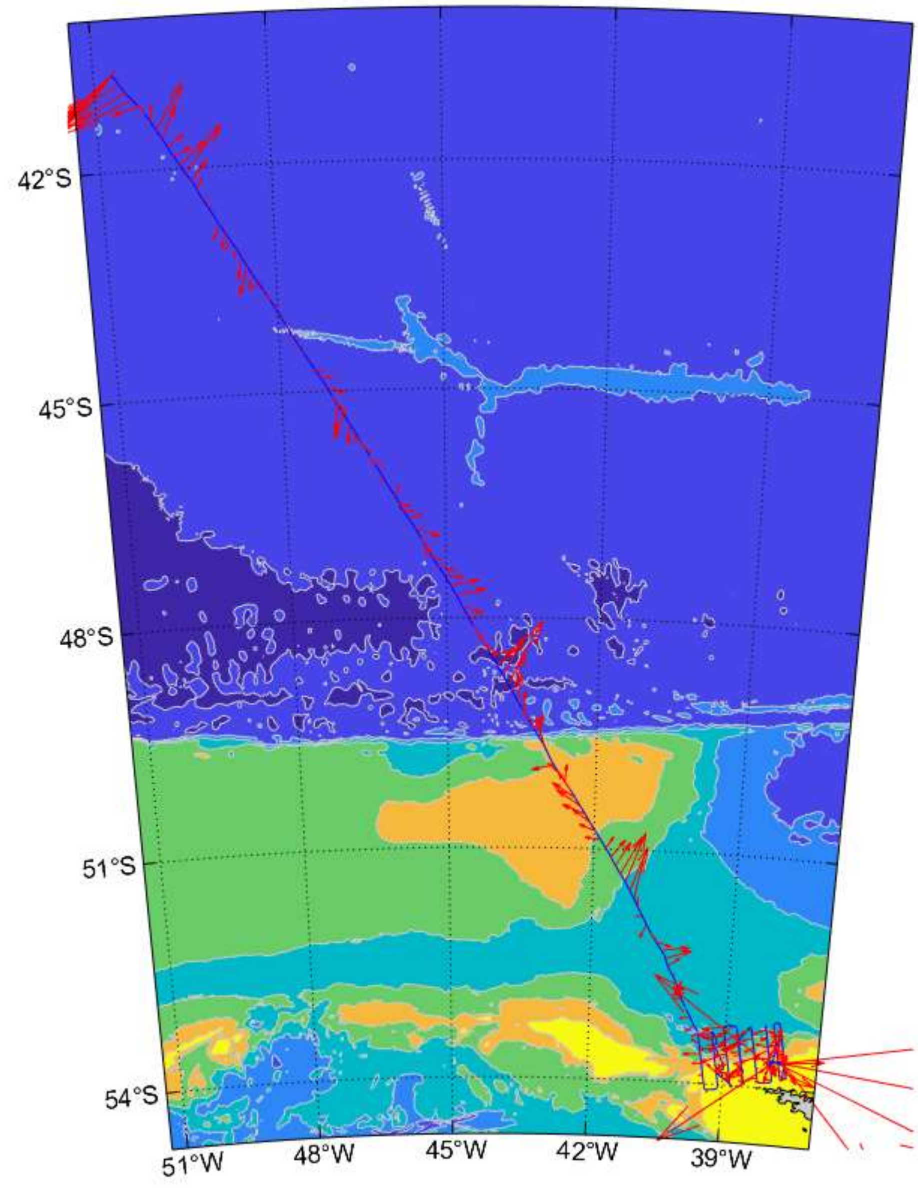


Figure 72. Cruise track and VMADCP current vectors for part 1 of the cruise.

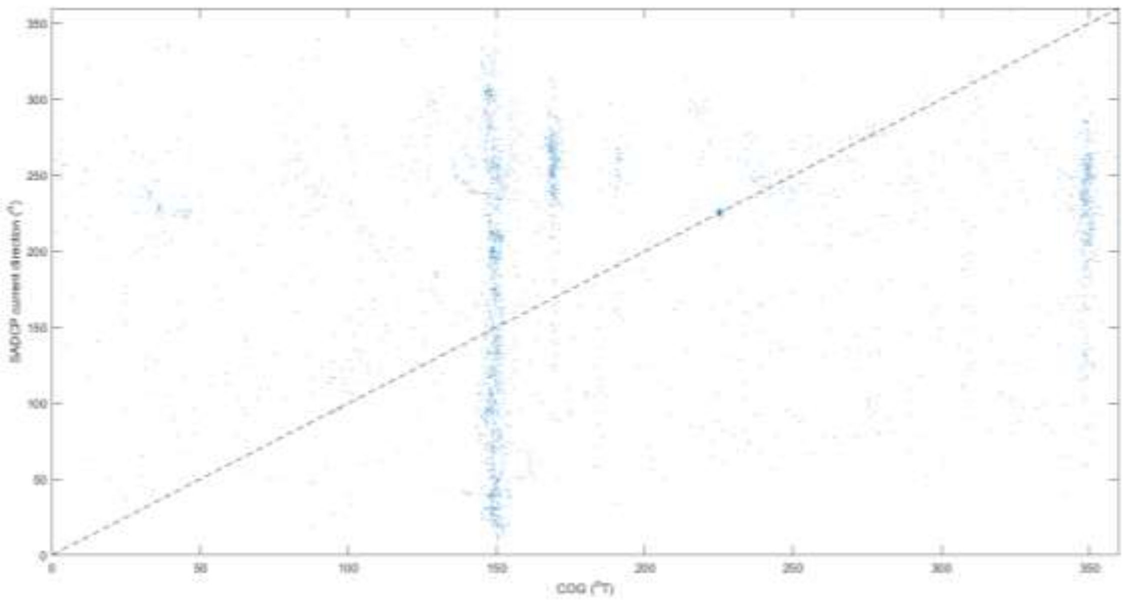


Figure 73. VMADCP Current direction vs COG for bias identification, part 1 of the cruise.

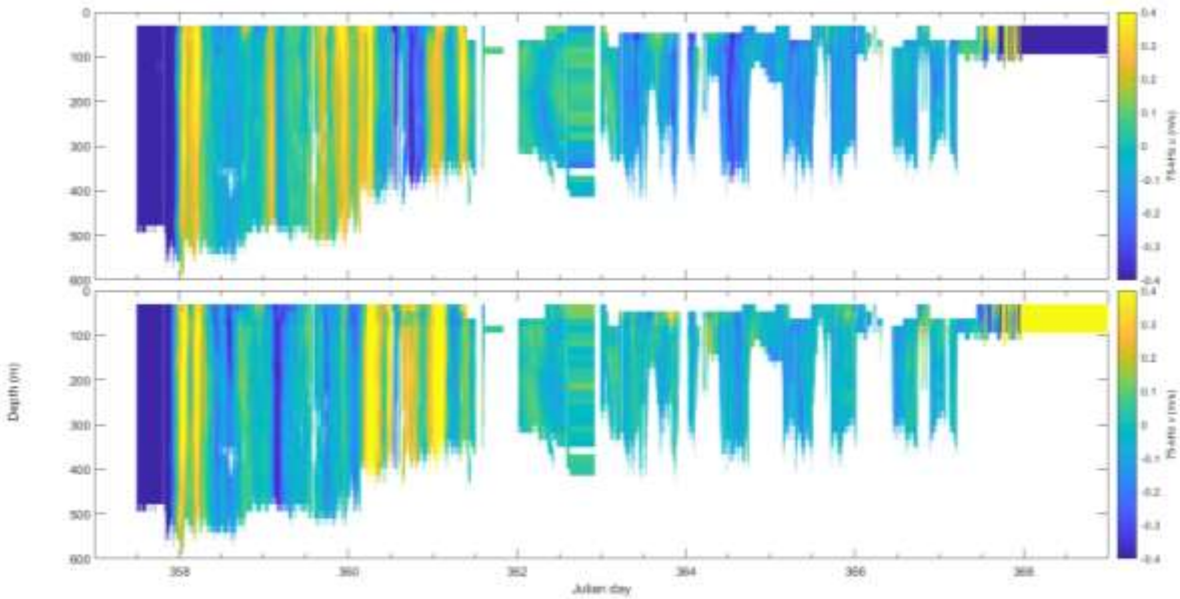


Figure 74. VMADCP u and v velocities for part 1 of the cruise.

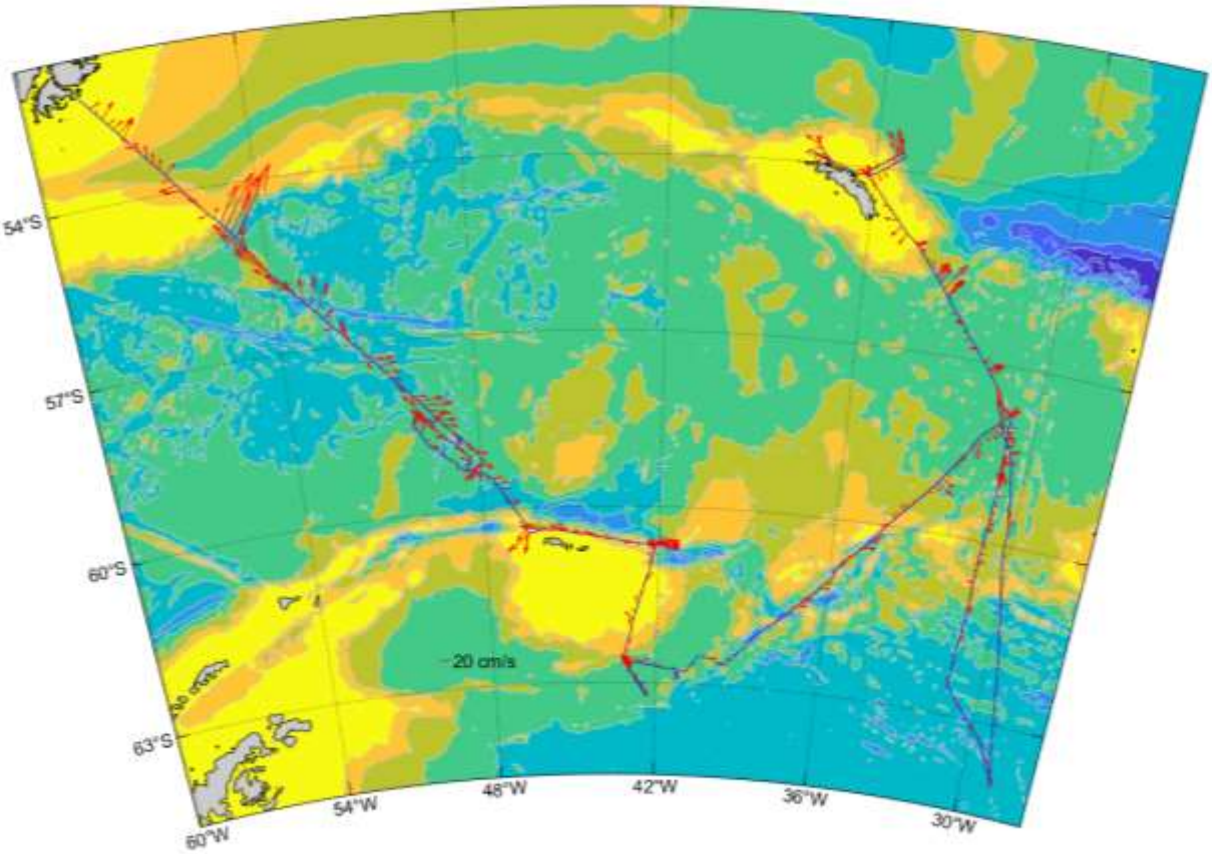


Figure 75. Cruise track and VMADCP current vectors for part 2 of the cruise.

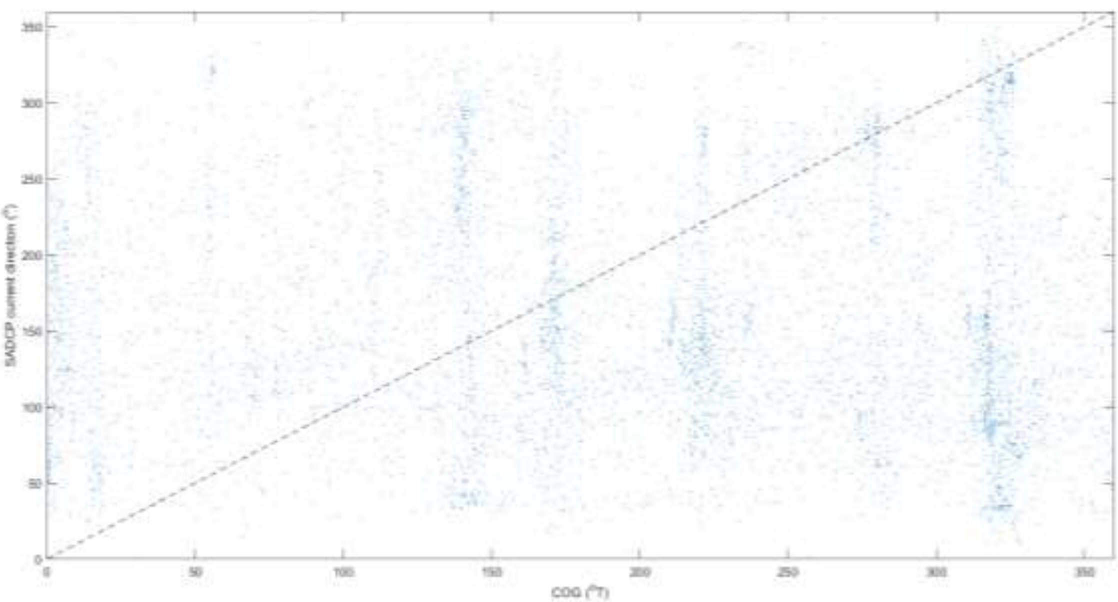


Figure 76. VMADCP Current direction vs COG for bias identification, part 2 of the cruise.

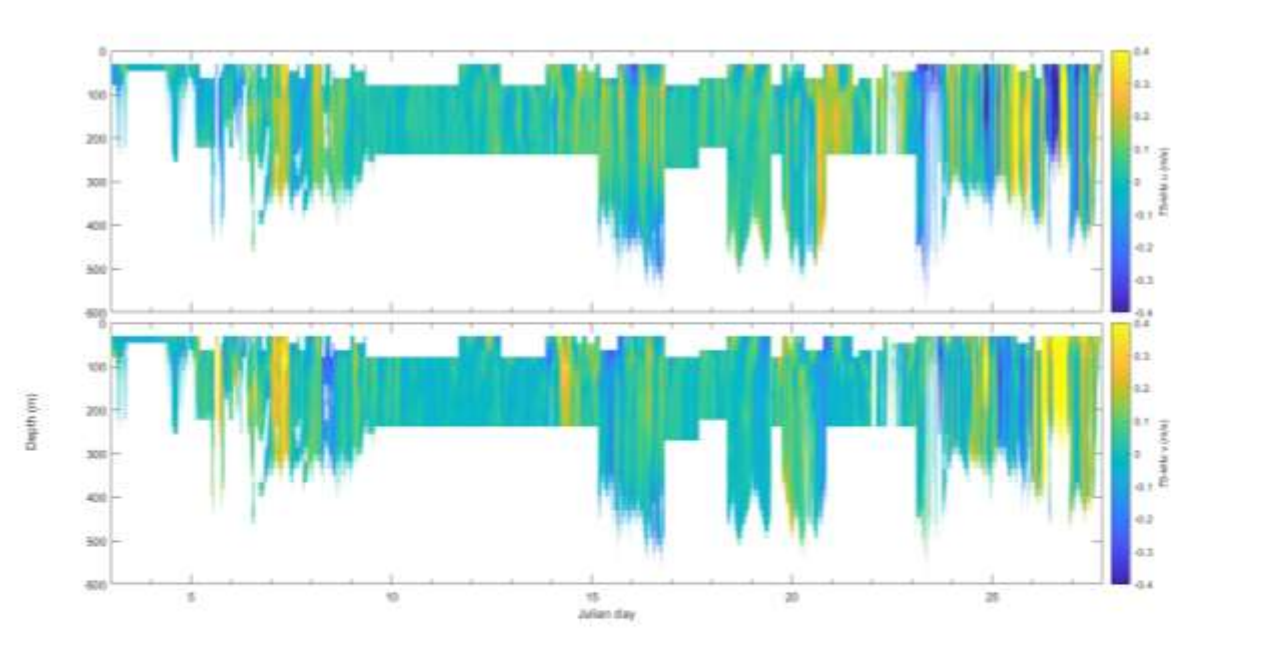


Figure 77. VMADCP u and v velocities for part 2 of the cruise.

Lowered Acoustic Doppler Profiler (LADCP)

Christopher Auckland

During the CTD casts on DY158, a pair of LADCP's were attached to the rosette to profile current. The uplooker was a 600 kHz Teledyne RDI Workhorse monitor and the downlooker was a 300 kHz Teledyne RDI Workhorse sentinel. The pair were left free pinging with a 4 m blanking distance and 25 bins. Due to the difference between the uplooker and downlooker the bin lengths were 4m and 8m respectively. The pre deployment and deployments scripts are included here alongside a description of each command.

Up Looker	Down Looker	Description
$T	$T	Set LADCP Clock to PC Time
PS0	PS0	Display System Configuration
CR1	CR1	Restore Factory Defaults
WM15	WM15	LADCP Water Mode 15
CF11101	CF11101	Disable Serial Output
	CF11211	Enable Serial Output (CRLF terminated Hex ASCII)
	CD000010000	Serial Data Outfields (status words only)
EA00000	EA00000	Zero Bean 3 Misalignment (default)
EB00000	EB00000	Zero Heading Bias (default)
EC1500	EC1500	Speed of sound 1500 m/s (default)
ED0000	ED0000	Zero Transducer Depth
ES35	ES35	Salinity 35PSU
EX00100	EX00100	Beam Coordinates, use tilts
EZ0011101	EZ0011101	Use temp, heading and tilt sensors (use EC speed of sound, ED depth, ES salinity)
TE00:00:00.6	TE00:000:00.8	0.6/0.8 Second Minimum Time Per Ensemble
TP00:00.60	TP00:00.80	0.6/0.8 Second Minimum Time Between Pings
LP00001	LP00001	1 Ping per Ensemble
LD111100000	LD111100000	Collect and Process All Data
LF0400	LF0400	LADCP 4m Blank
LN025	LN025	LADCP 25 Bins
LS0400	LS0800	LADCP 4/8 m bins
LV330	LV330	LADCP 330 cm/s Ambiguity Velocity
LJ1	LJ1	LADCP High Receiver Gain
LW1	LW1	LADCP Narrow Bandwidth
LZ30,220	LZ30,220	LADCP Default Bottom Detect and Correlation Threshold
SM0	SM0	RDS3 mode off (free-ping)
SB0	SB0	Disable Hardware Detection on Channel B
$B	$B	Send a Break
$W">",2	$W">",2	Wait up to 2 seconds for a prompt before continuing
RN UP__	RN DOWN__	Set file name to UP__/DOWN__
CK	CK	Save as User Defaults
CS	CS	Start Pinging

Table 29. Pre-deployment and deployment scripts.

After each cast the instruments were downloaded and logged before being transferred to the local directory.

There is no LADCP data for cast 041 as this was repeated due to winch issues. The LADCP was not running on casts 050, 051, and 052 due to issues with the power supply for the LADCP.

Data Processing

The data was initially analysed using the LADCP_w v2.2 software developed by Andreas Thurnherr at Columbia LDEO to calculate the vertical velocity and vertical turbulent kinetic energy. Our initial analysis only included vertical velocity with further analysis of VKE once back at BAS, Cambridge. Following this all data was process using MATLAB code LDEO_IX_15beta developed by Martin Visbeck and maintained by Andreas Thurnherr. This software incorporates data from the CTD as well as the Vessell Mounted ADCP (VMADCP) to calculate horizontal velocity based on shear and inversion methods.

The details of all the cruise specific parameterisations are contained within the set_cast_params.m MATLAB code including the changes to bin length and changes to the bottom track method in cases where the CTD cast was not within range of the bottom. Further modifications to the code were made in the backscatter estimates. This was to update the estimated target strength from Deines 1999 to the Mullison 2017 method to correct for backscatter estimation in low signal environments. This data will also be used to look at biological backscatter (Chawarski 2022).

Due to issues apparent in the VMADCP data each cast was run with and without incorporating this data into the velocity calculations. It was found that whilst the use of the VMADCP data provides a good constraint the calculations without this data are also of use. Calculating the mismatch in the surface VMADCP data with the LADCP shows almost all casts have a deviation less than 0.08m/s indicating good qualtity data. For the purpose of this metric we considered surface to be between 49-149 m as the quality of the VMADCP data rapidly decayed beyond this.

Results

Presented below are examples of the output from both the LDEO_w and LDEO_IX_15beta codes for the CTD cast at Orkney Passage Mooring 2, cast 053 in Figure 78 and Figure 79. As expected for this station, we find strong flow in the NW direction below 1000 m. This captures the northward transport of Antarctic Bottom Water through the mooring region. The vertical velocity profiles show are relatively weak for this CTD cast showing minimal up and downwelling in the cast.

Also presented are the horizontal velocity profiles for the A23 section in Figure 78.

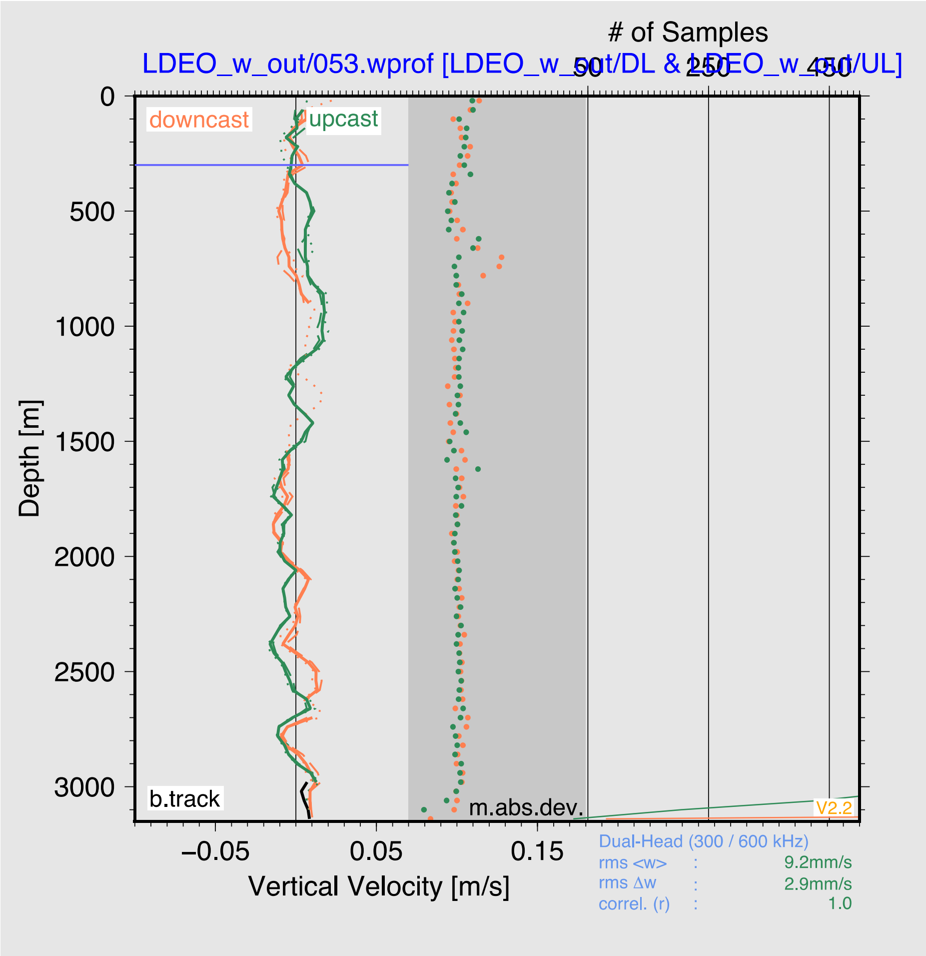


Figure 78. Output of LDEO_w codes for CTD 053 in A23 section.

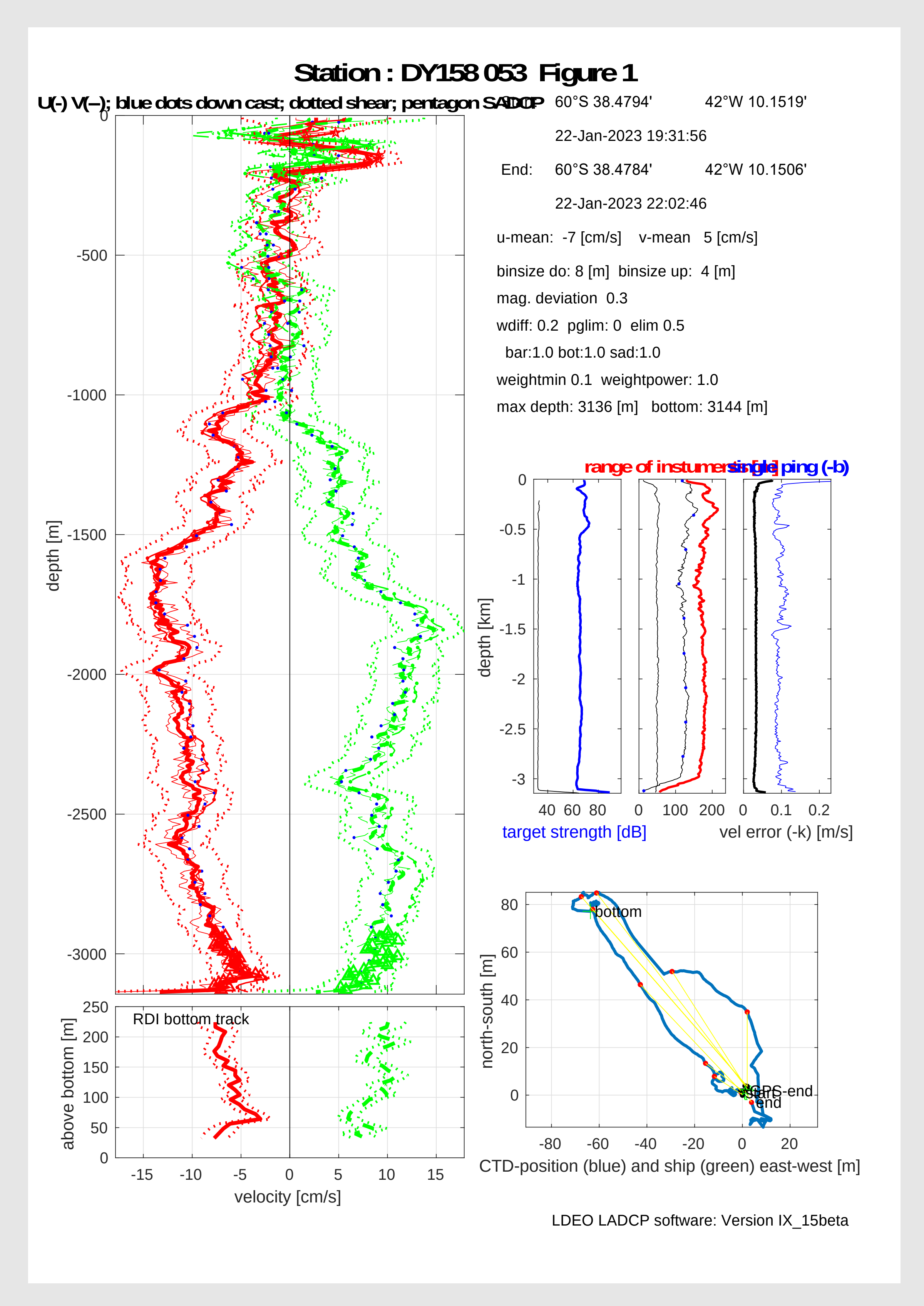


Figure 79. LDEO_IX_15beta codes for CTD 053 in A23 station.

18. Moorings (Polar Oceans)

Povl Abrahamsen (BAS)

During DY158, seven moorings were recovered and five redeployed for the BAS Polar Oceans group. These moorings have been part of BAS long-term monitoring and survey since 2005, and were included in the ORCHESTRA/ENCORE programmes in 2016-2022, currently forming part of the BIOPOLE project, with strong links to other projects including Horizon 2020 project SO-CHIC and Horizon Europe project OCEAN:ICE. Additional funding for moorings M2, M3, and nominally one OP mooring has also been provided by project partners at Lamont-Doherty Earth Observatory, Columbia University, through NOAA's Climate Program Office's Ocean Observing and Monitoring Division (Fund Ref 100007298) via PIs Arnold Gordon and Bruce Huber. Sadly, this funding is now being discontinued, but the instrumentation has been redeployed with BAS NC funding for the next two years.

All the moorings that we recovered on DY158 were deployed on RRS *James Clark Ross* cruise JR18004, in 2019. The original plan was to recover them in 2021, but because of the pandemic ship time was not available on an ice-strengthened ship, and they were not included on cruise JC211. In the following season there were plans for a barter cruise to turn over the moorings, but this fell through because of technical problems with the engines on the barter vessel following a refit. Thus, the moorings were deployed for four years rather than two. The ship was unable to reach one mooring, M3, because of sea ice. At the end of the cruise, equipment was transferred to RRS *Sir David Attenborough* to attempt recovery and redeployment of this mooring on cruise SD025 (polar water science trials).

Five moorings were re-deployed on DY158, with the intention of recovering these on the second BIOPOLE cruise, scheduled in Jan 2025 on RRS *Sir David Attenborough*. The triangulated positions of the moorings are given in the table below; the times indicate the anchor drop for deployments, or release time for recoveries.

Mooring	Deployment	Recovery	Latitude	Longitude	Depth (m)
M2 (1923)	13/01/19 19:11	19/01/23 18:26	62° 36.798' S	043° 14.384' W	3052
M3 (19XX)	26/01/19 20:19	not recovered	63° 31.945' S	041° 46.146' W	4560
OP1 (1923)	10/02/19 14:03	21/01/23 08:18	60° 37.594' S	042° 05.467' W	3620
OP2 (1923)	28/01/19 21:19 (23/03/19 22:50)	(23/03/19 22:40) 21/01/23 11:40	60° 38.512' S	042° 10.255' W	3131/ **3145**
OP3 (1923)	10/02/19 16:51	22/01/23 13:44	60° 39.368' S	042° 13.776' W	1728
OP4 (1923)	09/02/19 16:15	21/01/23 15:54	60° 35.417' S	041° 49.764' W	2948
OP5 (1923)	09/02/19 17:56 (June 2019) (May 2022)	 (April 2021) 22/01/23 10:59	60° 36.420' S	041° 58.628' W	3397- **3402**- 3408
OP6 (1923)	09/02/19 12:28	21/01/23 19:02	60° 33.851' S	041° 37.994' W	2309
M2 (23XX)	20/01/23 10:47		62° 36.925' S	043° 14.526' W	3046
OP1 (23XX)	23/01/23 11:31		60° 37.698' S	042° 05.497' W	3639
OP2 (23XX)	23/01/23 14:27		60° 38.504' S	042° 10.190' W	3113
OP3 (23XX)	22/01/23 17:37		60° 39.389' S	042° 13.639' W	1769

Table 30. Summary of mooring locations and dates for recovery and redeployment.

The bottom depths for the recovered moorings have been updated from the mooring pressure records. OP2 had a sudden shift between 22:40 and 22:50 on 23 Mar 2019, moving from 3131 m to 3145 m depth. OP5 had a more gradual shift from 3397 m depth to 3402 m depth between February and June 2019, remaining at this depth until April 2021, and then gradually deepening to 3408 m until May 2022, remaining at this depth until recovery. The bathymetry in Orkney Passage is very steep in places, and it is not unlikely that the mooring anchors have slipped down the slopes at these times. Looking back at previous mooring records, similar shifts also occurred at OP2 in 2017-2019.

Narrative

A brief description of the mooring operations is given below, with details for each mooring as required. Mooring recoveries and deployments were done using the NMF double-barrel mooring winch with a reeler with interchangeable drums. All of the mooring deployments were performed buoy first (anchor last).

After completing the A23 transect, the ship attempted to reach mooring M3. However, because of sea ice the ship was unable to reach the mooring from E/NE, and instead proceeded to M2 on the afternoon of 19 Jan. Here, the mooring was interrogated and indicated that the releases were upright and not released. However, when a release command was sent the mooring did not rise. Both releases were released multiple times and indicated that they had released. As the evening was approaching, the ship steamed away toward M3 from the north, with strict instructions to be back at M2 in early morning of 20 Jan for a dragging attempt, if M3 could not be reached. In the early hours of morning the ship turned around after encountering the ice edge 25 miles from M3.

The ship then set up for dragging, with a sinker weight deployed on 250 m of wire, followed by a Gifford grapnel on a length of chain, another 500 m of wire, another grapnel, and 250 m of wire leading to another weight, a weak link, which was attached to the ship's trawl wire. This was lowered onto the seabed 355 m from the mooring location, and the ship then laid out the wire in a semi-circle of radius 250 m around the mooring. The ship stopped 344 m from the mooring position, and then started hauling on the wire. After ~50 minutes, shortly after the second weight had been lifted off the seabed, the ranges started to decrease faster than the wire was being hauled. The mooring surfaced directly off the stern of the ship, with the top floats wrapped around the ship's trawl wire. The mooring was disentangled from the wire and the dragging gear recovered, before the ship proceeded to recover the mooring. Apart from some minor scuffs to instrument housings and slight distortion of one plastic hardhat on a mooring float, all equipment was successfully recovered. The mooring was redeployed the following morning, 20 Jan.

The releases on the mooring were in good condition, with some remaining metal on the anodes. The tandem chain surfaced in the jaws of one release. Clearly there was too much friction in the release mechanism to allow the releases to surface without a small nudge from the trawl wire. But nothing further could be determined, also because one of the NMF technicians opened the jaws of the second release before we could investigate it more closely. After servicing, the releases operated perfectly on the bench, with instant release of the hook.

After steaming to Orkney Passage during the afternoon of 20 Jan, CTD casts were undertaken overnight, and moorings OP1, OP2, OP4, and OP6 were all recovered on 21 Jan. All surfaced and were recovered without incident. On 22 Jan, OP5 and OP3 were recovered, and OP3 was redeployed. On 23 Jan, OP1, OP2, and OP5 were redeployed.

All instrument data were downloaded as soon as possible after recovery. All Microcats (SBE-37s) were deployed on the CTD rosette for a calibration cast using aluminium/Delrin brackets from NMF, which could hold two Microcats in place of one Niskin bottle. The instruments were set up with a 10-s sampling interval, and downloaded immediately after the cast. Four bottle stops were extended to five minutes, to get further data at a variety of depths and conditions. This allows for improved calibration of the data between factory recalibrations. Batteries were replaced in all instruments, o-rings cleaned and replaced if necessary. Instruments were redeployed with the same settings as on the previous deployments (15 minute intervals at M2, 10 minute intervals in OP).

All mooring releases and rangings were performed with EdgeTech 8011M s/n 34541, connected to the ship's hull-mounted transducer using a home-made adapter, in the main lab. The turnaround time on the deck unit was set to 20 ms for IxBlue AR861 releases and 13 ms for EdgeTech 8242xs releases; a speed of sound of 1500 m/s was used throughout (and corrected in software using CTD casts).

Initially, an IxBlue TT-801 s/n 010 from NMF was attempted, but this did not respond to replies from the releases on P3, while the 8011M picked these up immediately.

After the moorings were redeployed, they were triangulated together on the evening of 23 Jan, before a final CTD cast west of OP3, with calibration of the final three Microcats. The survey is shown in the figure below, with the ship's track in red and ranges to OP3, OP2, OP1, and OP5 in purple, dark green, yellow, and light green, respectively.

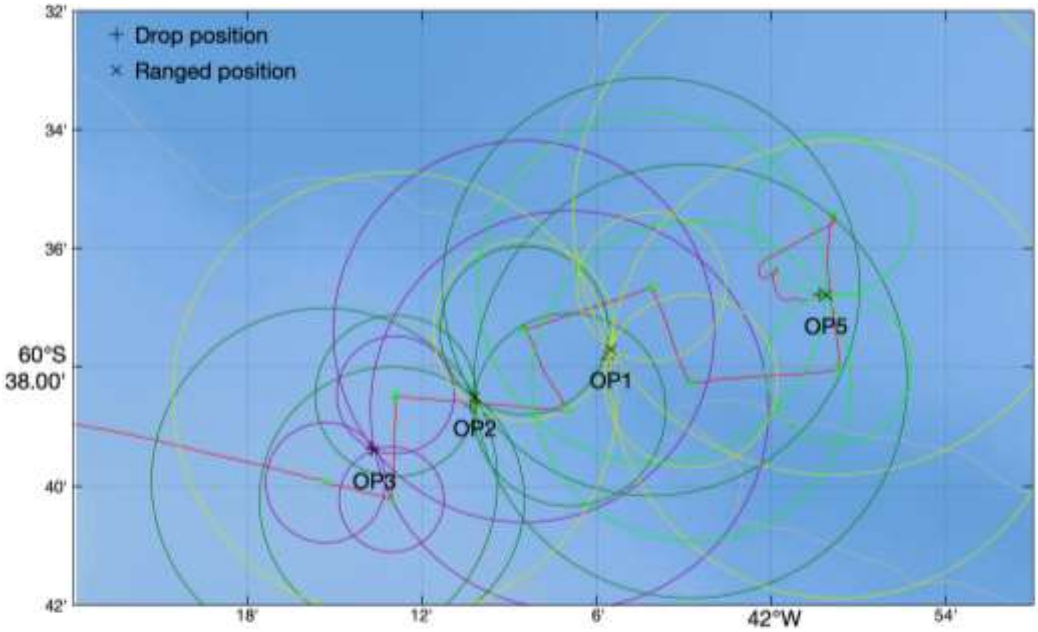


Figure 80. Orkney Passage ship track and ranges to moorings.

Hardware

The Orkney Passage and M2/M3 moorings all use 3/16" (5 mm) 3x19 plastic-jacketed galvanized wire, supplied by Mooring Systems Inc. (MSI), with an outer diameter of 6.5 mm, and swaged sockets to fit 1/2" shackles. Buoyancy on M2 (and M3) consists of Benthos 17-inch glass spheres, shackled onto 10-mm grade 30 galvanized chain using 5/16" safety bolt shackles (screw pins could be used in the future). Buoyancy on the OP moorings consists of Benthos and Vitrovex 17-inch glass spheres attached to Kevlar ropes using the Vitrovex's Eddygrip swivel system.

1/2" safety bolt shackles were used on the wire and Eddygrip ropes. Most of these were Van Beest Green Pin shackles; however, the eyes on some of the Eddygrip ropes are too small for these shackles, and Crosby or blue pin shackles were used instead, where required. 5/8" shackles were used on the acoustic releases and anchors, with 3/4" shackles used on the tandem release rings for the IxBlue tandem releases. The (super duplex) top link of the IxBlue tandem kits was wrapped in Scotch 33+ vinyl tape for insulation. For single releases, a Crosby S-643 7/8" x 5½" weldless ring was used as the release link, again, wrapped in Scotch 33+ tape for insulation. For the IxBlue tandem kits, a 2 m length of 12 mm long link chain was attached to IxBlue super duplex release links using 1/2" chain (dee) shackles. This chain was led through a Crosby S-643 1-1/8" x 6" weldless ring. For the 8242xs releases, tandem kits from MSI were used, with 2 m of chain attached to EdgeTech release links, led through a Crosby S-643 7/8" x 5½" weldless ring. The chain used on the moorings was 12 mm grade 30 galvanised long link chain.

All of the instrumentation deployed on the OP and M moorings was clamped onto the mooring wire. The table below gives an overview of the instrument types deployed, and the tools required to remove them from the mooring wire.

Model	Parameters	Tools required	Connector	Serial nos.
SBE-39	T & P	3/8" socket	internal	All M2/M3 except 0229 (M2)
SBE-39	T only	3/8" socket	internal	0083 (OP5) and 0229 (M2)
SBE-39	T & P	3/16" Allen key	internal	1239 (OP3)
SBE-39	T only	3/16" Allen key	4-pin XSG / internal	Remaining OP instruments
SBE-37SM	T, C, P	3/8" socket	3-pin XSG	2707 (OP2) and 2956 (OP5)
SBE-37SM	T, C (no P!)	3/8" socket	4-pin XSG	8267 (OP3)
SBE-37SM	T, C, P	3/8" socket	4-pin XSG	Remaining OP instruments
SBE-37SMP	T, C, P	3/8" socket	4-pin XSG	M2/M3 instruments
Aquadopp DW (6000 m)	U, V, W, T, P	9/16" socket & spanner	Round	9380 (M2)
Aquadopp DW (6000 m)	U, V, W, T, P	9/16" socket & spanner	Square	All remaining instruments on M2/M3
Aquadopp DW (6000 m)	U, V, W, T, P	17 mm socket & spanner	Round	Instruments on OP1, OP2, and OP5
Aquadopp DW (6000 m)	U, V, W, T, P	13 mm socket & spanner	Square	5424 (OP3)

Table 31. Mooring hardware details.

The times in the tables below are relative to GPS time. On the deployment cruise, clocks were synchronized with server “jrlb.jcr.nerc-bas.ac.uk”, which is accessible on the JCR’s public network. In turn, this machine is synchronized with the ship’s Galleon NTP-4000 GPS time server, which is on the data network only. Similarly, on Discovery, the clocks were synchronized with “times.discovery.local”, which in turn is synchronized to a Galleon server.

Recoveries:

M2 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
532	2520	Novatech RF-700A1 U08-058 VHF radio beacon (159.480 MHz)					On triangular McLane top float.
532	2520	Novatech ST-400A V08-057 Xenon flash beacon					Switch not working on flash beacon.
511	2541	Aquadopp 2807	U, V, W, T, P	30	13/01/2019 17:00:00 19/01/2023 19:52:27	+00:05:19	13/01/2019 20:00:00 12/10/2022 23:10:02 – low battery
466	2586	SBE-37SM 6557	T, C, P	15	13/01/2019 17:00:01 22/12/2020 09:15:01	-00:00:52	13/01/2019 20:00:01 22/12/2020 09:15:01 – low battery
341	2711	SBE-39 1311	T, P	15	13/01/2019 17:00:00 24/11/2021 00:45:00	clock reset	13/01/2019 20:00:00 24/11/2021 00:45:00 – low battery
239	2813	SBE-39 1232	T, P	15	13/01/2019 17:00:00 10/01/2021 16:45:01	clock reset	13/01/2019 20:00:00 10/01/2021 16:45:01 – low battery
164	2888	SBE-39 0229	T	15	13/01/2019 17:00:00 20/01/2023 00:55:00	-00:04:37	13/01/2019 19:59:59 19/01/2023 18:15:00
19	3033	SBE-37SMP 14765	T, C, P	15	13/01/2019 17:00:01 19/01/2023 23:30:40	+00:00:26	13/01/2019 20:00:01 19/01/2023 18:15:01
16	3036	Aquadopp 9380	U, V, W, T, P	30	19/01/2019 17:00:00 20/01/2023 00:23:41	+00:05:02	13/01/2019 20:00:00 19/01/2023 17:30:00
8	3044	Releases: Edgetech 8242xs 31512 & 33152					Did not release properly!

Table 32. Mooring recoveries, including depth, instrumentation, parameters measured, sampling intervals, and relevant datetime parameters.

OP1 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
1839	1781	Novatech RF-700A1 Y07-009 VHF radio beacon (160.725 MHz)					On top float with Trimsyn TS2 syntactic foam float
1839	1781	Novatech ST-400A Y07-011 Xenon flash beacon (daylight off disabled)					
1823	1797	Six orange Vitrovex floats on 5-m Eddygrip rope					
1817	1803	Aquadopp 5993	U, V, W, T, P	10	10/02/2019 00:00:00 21/01/2023 15:19:42	+00:01:22	10/02/2019 14:50:00 31/10/2021 14:01:25 – low battery
1816	1804	SBE-39 4409	T	10	10/02/2019 00:00:00 21/01/2023 15:32:18	+00:03:25	10/02/2019 14:50:00 21/01/2023 08:20:00
1483	2137	Aquadopp 6000	U, V, W, T, P	10	10/02/2019 00:00:00 21/01/2023 17:35:40	+00:02:54	10/02/2019 14:50:00 21/11/2021 21:37:47 – low battery
1482	2138	SBE-37SM 7380	T, C, P	10	08/02/2019 00:00:01 21/01/2023 14:09:17	+00:01:48	10/02/2019 14:50:01 21/01/2023 08:20:01
1467	2153	Four orange Vitrovex floats on 5-m Eddygrip rope					
1114	2506	Three orange Vitrovex floats on 3-m Eddygrip rope					
1064	2556	SBE-39 4413	T	10	08/02/2019 00:00:00 21/01/2023 15:47:10	+00:05:11	10/02/2019 14:50:00 21/01/2023 08:20:00
760	2860	Three yellow Benthos floats on 3-m Eddygrip rope					
710	2910	Aquadopp 6112	U, V, W, T, P	10	10/02/2019 00:00:00 21/01/2023 17:06:00	+00:02:37	10/02/2019 14:50:00 10/12/2021 01:45:47 – low battery
709	2911	SBE-37SM 7381	T, C, P	10	08/02/2019 00:00:01 21/01/2023 14:16:25	+00:02:02	10/02/2019 14:50:01 21/01/2023 08:20:01
407	3213	Three orange Vitrovex floats on 3-m Eddygrip rope					
53	3567	Three orange Vitrovex floats on 3-m Eddygrip rope					
47	3573	Aquadopp 6180	U, V, W, T, P	10	10/02/2019 00:00:00 21/01/2023 17:55:00	+00:02:06	10/02/2019 14:50:00 04/02/2022 00:45:09 – low battery
19	3601	SBE-37SM 7382	T, C, P	10	08/02/2019 00:00:01 21/01/2023 14:20:50	+00:00:54	10/02/2019 14:50:01 21/01/2023 08:10:01
9	3611	Three orange Vitrovex floats on 3-m Eddygrip rope					

7	3613	Releases: IxBlue AR861 564 & 1616					

Table 33. OP1 Instrumentation, previous deployment, and recovery information.

OP2 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
1543	1602	Novatech RF-700A1 Y07-010 VHF radio beacon (160.725 MHz)					On rectangular McLane top float
1543	1602	Novatech ST-400A Y07-012 Xenon flash beacon (daylight off disabled)					
1527	1618	Six yellow Benthos floats on 5-m Eddygrip rope					
1520	1625	SBE-37SM 7383	T, C, P	10	28/01/2019 19:30:00 21/01/2023 14:29:33	+00:00:40	28/01/2019 21:50:01 21/01/2023 11:40:01
1421	1724	Six orange Vitrovex floats on 5-m Eddygrip rope					
1415	1730	Aquadopp 6198	U, V, W, T, P	10	28/01/2019 19:30:00 21/01/2023 18:20:20	+00:02:06	28/01/2019 21:50:00 28/11/2021 17:49:59 – low battery
1121	2024	SBE-39 0083	T	10	28/01/2019 19:30:00 22/01/2023 00:37:53	-00:04:37	28/01/2019 21:50:00 21/01/2023 11:30:00
727	2418	Aquadopp 6226	U, V, W, T, P	10	28/01/2019 19:30:00 21/01/2023 19:10:10	+00:03:41	28/01/2019 21:50:00 25/11/2021 04:55:57 – low battery
726	2419	SBE-37SM 7385	T, C, P	10	28/01/2019 19:30:00 21/01/2023 14:35:33	+00:00:53	28/01/2019 21:50:01 21/01/2023 11:40:01
715	2430	Six orange Vitrovex floats on 5-m Eddygrip rope					
65	3080	Aquadopp 6236	U, V, W, T, P	10	28/01/2019 19:30:00 21/01/2023 18:44:30	+00:01:53	28/01/2019 21:50:00 20/12/2021 10:36:46 – low battery
21	3124	SBE-37SM 7386	T, C, P	10	28/01/2019 19:30:00 21/01/2023 15:09:40	+00:00:57	28/01/2019 21:50:01 21/01/2023 11:40:01
10	3135	Four yellow Benthos floats on 5-m Eddygrip rope					
7	3138	Releases: EdgeTech 8242xs 33147 & 33614					

Table 34. OP2 Instrumentation, previous deployment, and recovery information.

OP3 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
530	1198	Novatech RF-700A1 W02-086 VHF radio beacon (160.725 MHz)					On triangular McLane top float
530	1198	Novatech ST-400A W02-087 Xenon flash beacon (daylight off disabled)					
514	1214	Four yellow Benthos floats on 5-m Eddygrip rope					
508	1220	SBE-39 1239	T, P	10	08/02/2019 00:00:00 22/01/2023 18:37:00	-00:14:41	10/02/2019 17:09:59 21/07/2021 08:59:59 – low battery
308	1420	Four orange Vitrovex floats on 5-m Eddygrip rope					
300	1428	Aquadopp 5424	U, V, W, T, P	10	08/02/2019 00:00:00 22/01/2023 19:16:20	clock invalid	10/02/2019 17:10:00 21/11/2021 16:30:00 – low battery
299	1429	SBE-37SM 8540	T, C, P	10	08/02/2019 00:00:00 22/01/2023 16:26:55	+00:01:45	10/02/2019 17:10:01 22/01/2023 13:40:01
53	1675	Four yellow Benthos floats on 5-m Eddygrip rope					
47	1681	Aquadopp 8556	U, V, W, T, P	20	08/02/2019 00:00:00 22/01/2023 20:11:53	clock invalid	10/02/2019 17:20:00 03/02/2022 17:43:26 – low battery
19	1709	SBE-37SM 8541	T, C, P	10	08/02/2019 00:00:00 22/01/2023 17:22:40	+00:00:47	10/02/2019 17:10:01 22/01/2023 13:40:01
9	1719	Two yellow Benthos floats on 3-m Eddygrip rope					
7	1721	Release: IxBlue AR861 1942					

Table 35. OP3 Instrumentation, previous deployment, and recovery information.

OP4 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
1130	1818	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)					On top float with Trimsyn TS2 syntactic foam float
1130	1818	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)					
1114	1834	Four orange Vitrovex floats on 5-m Eddygrip rope					
1108	1840	Aquadopp 6263	U, V, W, T, P	10	08/02/2019 00:00:00 21/01/2023 20:35:10	+00:00:44	09/02/2019 16:40:00 22/01/2022 07:37:13 – low battery
1107	1841	SBE-39 4418	T, C, P	10	08/02/2019 00:00:00 21/01/2023 18:29:15	+00:02:17	09/02/2019 16:40:00 21/01/2023 15:50:00
759	2189	Four yellow Benthos floats on 5-m Eddygrip rope					
750	2198	Aquadopp 9250	U, V, W, T, P	10	08/02/2019 00:00:00 21/01/2023 21:12:15	+00:03:41	09/02/2019 16:40:00 22/01/2022 07:37:13 – low battery
749	2199	SBE-39 4713	T, C, P	10	08/02/2019 00:00:00 21/01/2023 18:53:10	+00:06:28	09/02/2019 16:40:00 21/01/2023 15:50:00
53	2895	Four yellow Benthos floats on 5-m Eddygrip rope					
47	2901	Aquadopp 9264	U, V, W, T, P	10	08/02/2019 00:00:00 21/01/2023 20:14:10	+00:02:47	09/02/2019 16:40:00 14/04/2022 16:55:09 – low battery
19	2929	SBE-37SM 2956	T, C, P	10	08/02/2019 00:00:00 22/01/2023 20:22:25	+00:09:16	09/02/2019 16:40:00 23/09/2022 22:50:02 – out of memory
9	2939	Three yellow Benthos floats on 3-m Eddygrip rope					
7	2941	Releases: Ixsea AR861 565 & 1615					Weak transmit on release 565

Table 36. OP4 Instrumentation, previous deployment, and recovery information.

OP5 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
424	2978	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)					On rectangular McLane top float

424	2978	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)					
408	2994	Four orange Vitrovex floats on 5-m Eddygrip rope					
400	3002	Aquadopp 12010	U, V, W, T, P	10	08/02/2019 00:00:00 22/01/2023 19:49:17	+00:02:54	09/02/2019 19:10:00 28/04/2022 12:39:03 – low battery
399	3003	SBE-39 4716	T	10	08/02/2019 00:00:00 22/01/2023 13:32:40	+00:04:13	09/02/2019 19:10:00 22/01/2023 11:00:00
53	3349	Four orange Vitrovex floats on 5-m Eddygrip rope					
46	3356	Aquadopp 12016	U, V, W, T, P	10	08/02/2019 00:00:00 22/01/2023 18:35:40	+00:01:37	09/02/2019 19:10:00 23/05/2022 06:08:42 – low battery
18	3384	SBE-37SM 7387	T, C, P	10	08/02/2019 00:00:00 22/01/2023 12:50:50	+00:00:36	09/02/2019 19:10:01 22/01/2023 10:50:01
9	3393	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2A)					
7	3395	Release: Ixsea AR861 1618					

Table 37. OP5 Instrumentation and deployment information.

OP6 (2019-2023)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start/stop time, UTC (dd/mm/yyyy hh:mm:ss)	Clock drift (hh:mm:ss)	First good/Last good record/comments (times are instrument times – uncorrected for drift)
424	1885	Novatech RF-700A1 V08-056 VHF radio beacon (159.480 MHz)					On triangular McLane top float
408	1901	Four floats on 5-m Eddygrip rope					
400	1909	Aquadopp 12020	U, V, W, T, P	10	08/02/2019 00:00:00 21/01/2023 23:06:30	+00:03:24	09/02/2019 13:10:00 15/04/2022 04:10:31 – low battery
53	2256	Four floats on 5-m Eddygrip rope					
46	2263	Aquadopp 12053	U, V, W, T, P	10	08/02/2019 00:00:00 21/01/2023 23:48:00	+00:04:18	09/02/2019 13:10:00 18/05/2022 04:39:38 – low battery
18	2291	SBE-37SM 2707	T, C, P	10	08/02/2019 00:00:00 22/01/2023 00:51:50	+00:08:50	09/02/2019 13:10:00 18/05/2022 04:39:38 – low battery
9	2300	Two floats on 3-m Eddygrip rope					
7	2302	Release: Ixsea AR861 1356					

Table 38. OP6 Instrumentation and deployment information.

Deployments:

M2 (2023-)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
532	2514	Novatech ST-400A U08-059 Xenon flash beacon				On triangular McLane top float
518	2528	Four yellow Benthos floats on 4 m of 10-mm chain				
511	2535	Aquadopp 2807	U, V, W, T, P	30	20/01/2023 09:00:00	
466	2580	SBE-37SMP 6557	T, C, P	15	20/01/2023 09:00:00	
341	2705	SBE-39 1311	T, P	15	20/01/2023 09:00:00	
265	2781	Two orange Vitrovex floats on 2 m of 10-mm chain				
239	2807	SBE-39 1232	T, P	15	20/01/2023 09:00:00	
164	2882	SBE-39 0229	T	15	20/01/2023 09:00:00	
19	3027	SBE-37SMP 14765	T, C, P	15	20/01/2023 09:00:00	
17	3029	Aquadopp 9380	U, V, W, T, P	30	20/01/2023 09:00:00	
12	3034	Four yellow Benthos floats on 4 m of 10-mm chain				
8	3038	Releases: EdgeTech 8242xs 31512 & 33152				

Table 39. M2 Instrumentation and redeployment details.

OP1 (2023-)

Height above bottom (m)	Nominal Depth (m)	Instrument/ sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
1839	1800	Novatech RF-700A1 W02-086 VHF radio beacon (160.725 MHz)				On top float with Trimsyn TS2 syntactic foam float
1839	1800	Novatech ST-400A Y07-011 Xenon flash beacon (daylight off disabled)				
1823	1816	Six orange Vitrovex floats on 5-m Eddygrip rope				
1817	1822	Aquadopp 5993	U, V, W, T, P	10	23/01/2023 09:00:00	
1816	1823	SBE-39 4409	T	10	23/01/2023 09:00:00	
1483	2156	Aquadopp 6000	U, V, W, T, P	10	23/01/2023 09:00:00	
1482	2157	SBE-37SM 7381	T, C, P	10	23/01/2023 09:00:00	
1467	2172	Four yellow Benthos floats on 5-m Eddygrip rope				
1114	2525	Three orange Vitrovex floats on 3-m Eddygrip rope				
1064	2575	SBE-39 4418	T	10	23/01/2023 09:00:00	
760	2879	Three orange Vitrovex floats on 3-m Eddygrip rope				
710	2929	Aquadopp 6112	U, V, W, T, P	10	23/01/2023 09:00:00	
709	2930	SBE-37SM 7382	T, C, P	10	23/01/2023 09:00:00	
407	3232	Three orange Vitrovex floats on 3-m Eddygrip rope				
53	3586	Three orange Vitrovex floats on 3-m Eddygrip rope				
47	3592	Aquadopp 6180	U, V, W, T, P	10	23/01/2023 09:00:00	
19	3620	SBE-37SM 7383	T, C, P	10	23/01/2023 09:00:00	
10	3629	Three orange Vitrovex floats on 3-m Eddygrip rope				
8	3631	Releases: IxBlue AR861 1616 & 3046				

Table 40. OP1 Instrumentation and redeployment details.

OP2 (2023-)

Height above bottom (m)	Nominal Depth (m)	Instrument/ sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
1543	1570	Novatech RF-700A1 V08-056 VHF radio beacon (159.480 MHz)				On rectangular McLane top float
1543	1570	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)				
1527	1586	Six yellow Benthos floats on 5-m Eddygrip rope				
1521	1592	SBE-37SM 2707	T, C, P	10	23/01/2023 09:00:00	3500 m depth rating
1421	1692	Six orange Vitrovex floats on 5-m Eddygrip rope				
1415	1698	Aquadopp 6198	U, V, W, T, P	10	23/01/2023 09:00:00	
1121	1992	SBE-39 4713	T	10	23/01/2023 09:00:00	
727	2386	Aquadopp 6226	U, V, W, T, P	10	23/01/2023 09:00:00	
726	2387	SBE-37SM 22337	T, C, P	10	23/01/2023 09:00:00	
715	2398	Six orange Vitrovex floats on 5-m Eddygrip rope				
65	3048	Aquadopp 6236	U, V, W, T, P	10	23/01/2023 09:00:00	
21	3092	SBE-37SM 22338	T, C, P	10	23/01/2023 09:00:00	
10	3103	Four orange Vitrovex floats on 5-m Eddygrip rope				
8	3105	Releases: EdgeTech 8242xs 33147 & 33614				

Table 41. OP2 Instrumentation and redeployment details.

OP3 (2023-)

Height above bottom (m)	Nominal Depth (m)	Instrument/ sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
534	1235	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)				On triangular McLane top float
534	1235	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)				
518	1251	Five yellow Benthos floats on 5-m Eddygrip rope				

512	1257	SBE-39 1239	T, P	10	22/01/2023 16:00:00	
300	1469	Aquadopp 9250	U, V, W, T, P	10	22/01/2023 16:00:00	
299	1470	SBE-37SM 7380	T, C, P	10	22/01/2023 16:00:00	
263	1506	Five orange Vitrovex floats on 5-m Eddygrip rope				
47	1722	Aquadopp 9264	U, V, W, T, P	10	22/01/2023 16:00:00	
19	1750	SBE-37SM 8267	T, C	10	22/01/2023 16:00:00	No pressure sensor
10	1759	Three yellow Benthos floats on 3-m Eddygrip rope				
8	1761	Releases: IxBlue AR861 1356 & 3045				

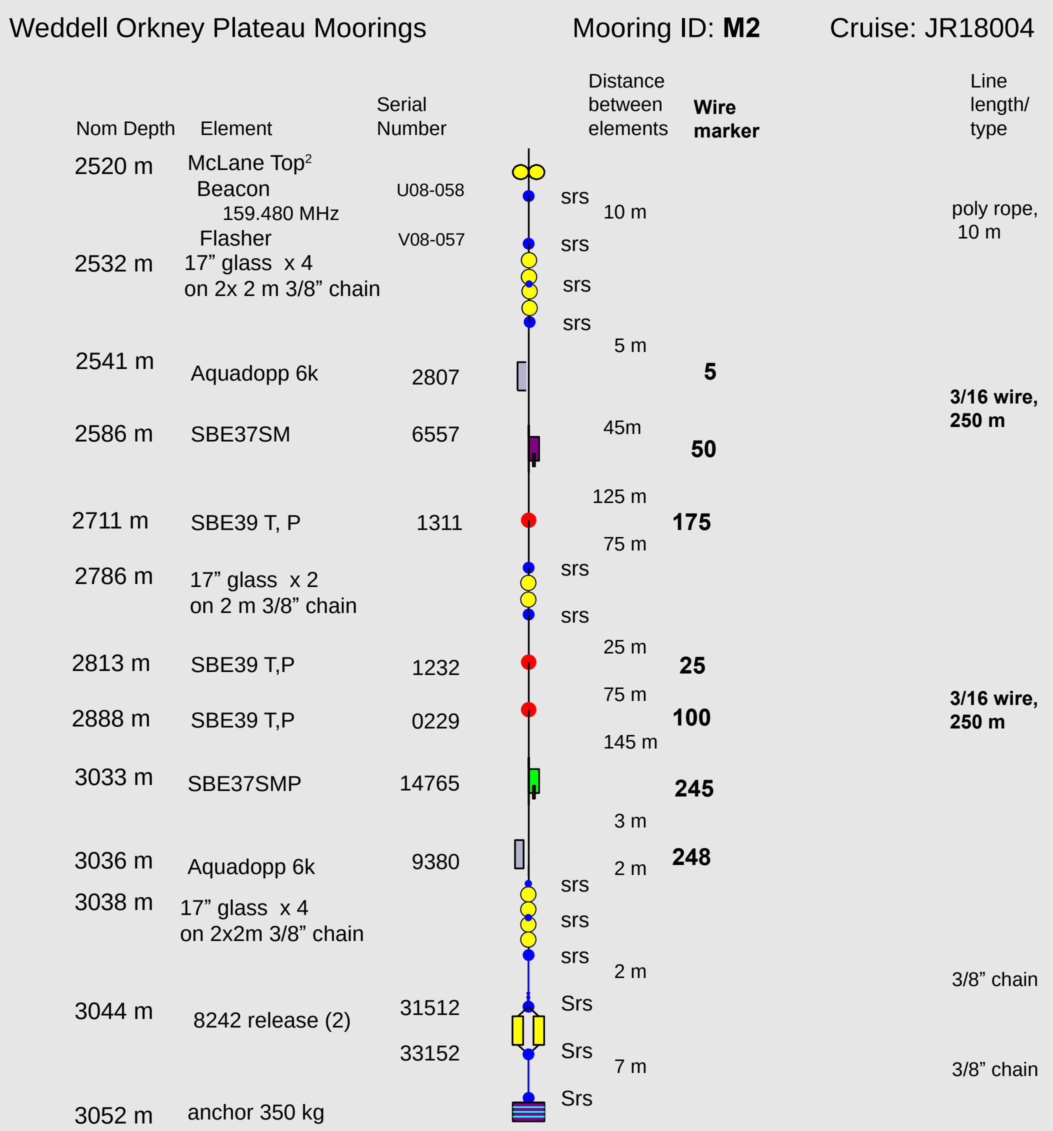
Table 42. OP3 Instrumentation and redeployment details.

OP5 (2023-)

Height above bottom (m)	Nominal Depth (m)	Instrument/ sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
424	2985	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)				On triangular McLane top float
424	2985	Novatech ST-400A W02-087 Xenon flash beacon (daylight off disabled)				
408	3001	Four orange Vitrovex floats on 5-m Eddygrip rope				
400	3009	Aquadopp 8556	U, V, W, T, P	20	23/01/2023 09:00:00	Has 13mm clamp; 1 battery
399	3010	SBE-39 0083	T	10	23/01/2023 15:30:00	
53	3356	Four orange Vitrovex floats on 5-m Eddygrip rope				
46	3363	Aquadopp 5424	U, V, W, T, P	10	23/01/2023 15:30:00	Has 13mm clamp; 2 batteries
18	3391	SBE-37SM 2956	T, C, P	10	23/01/2023 09:00:00	
9	3400	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2A)				
7	3402	Release: IxBlue AR861 1942				

Table 43. OP5 Instrumentation and redeployment details.

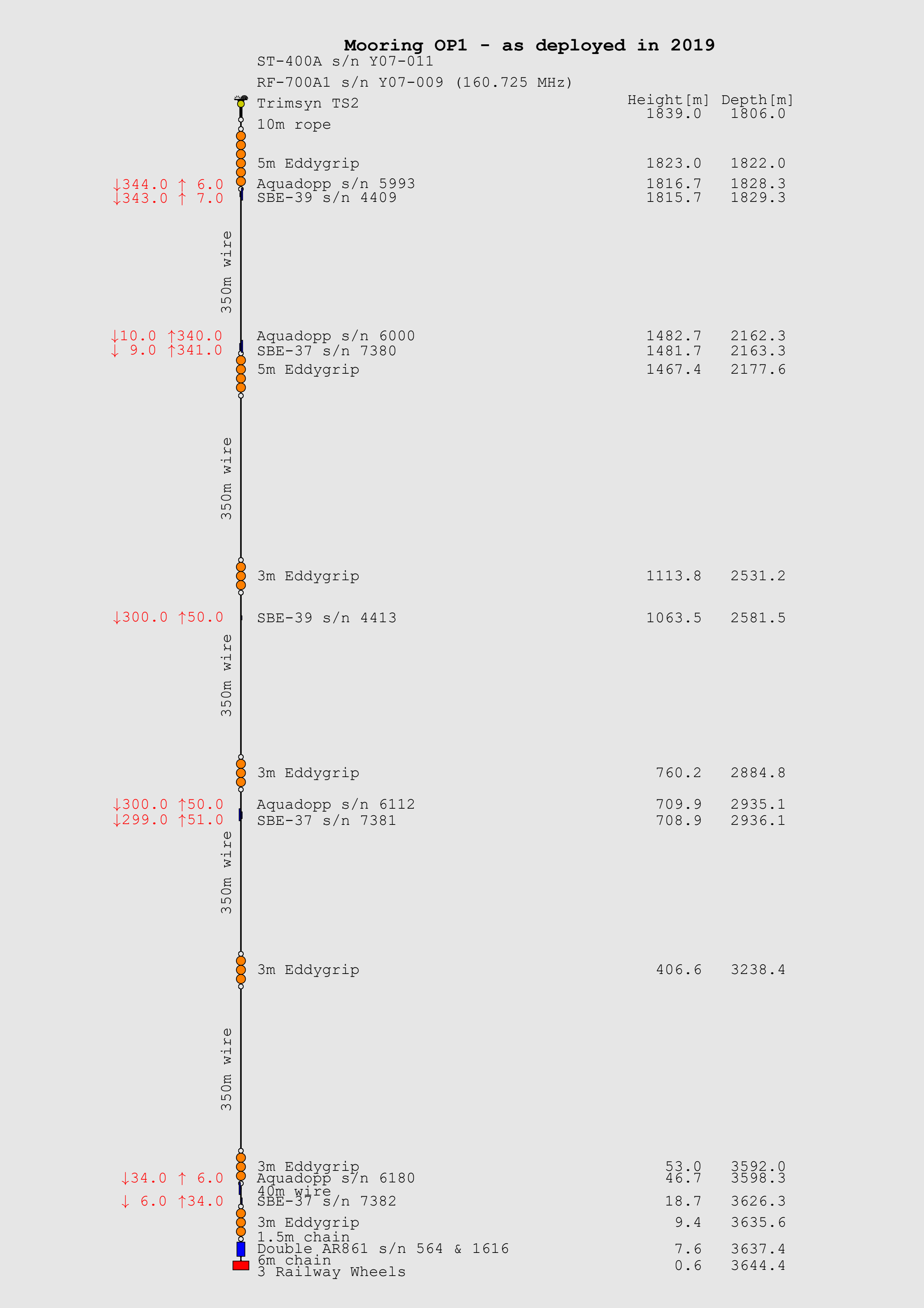
Diagrams: recovered moorings:



Target Position: Lat S 62 36.924’ Lon W 043 14.618’ Target Depth 3049m

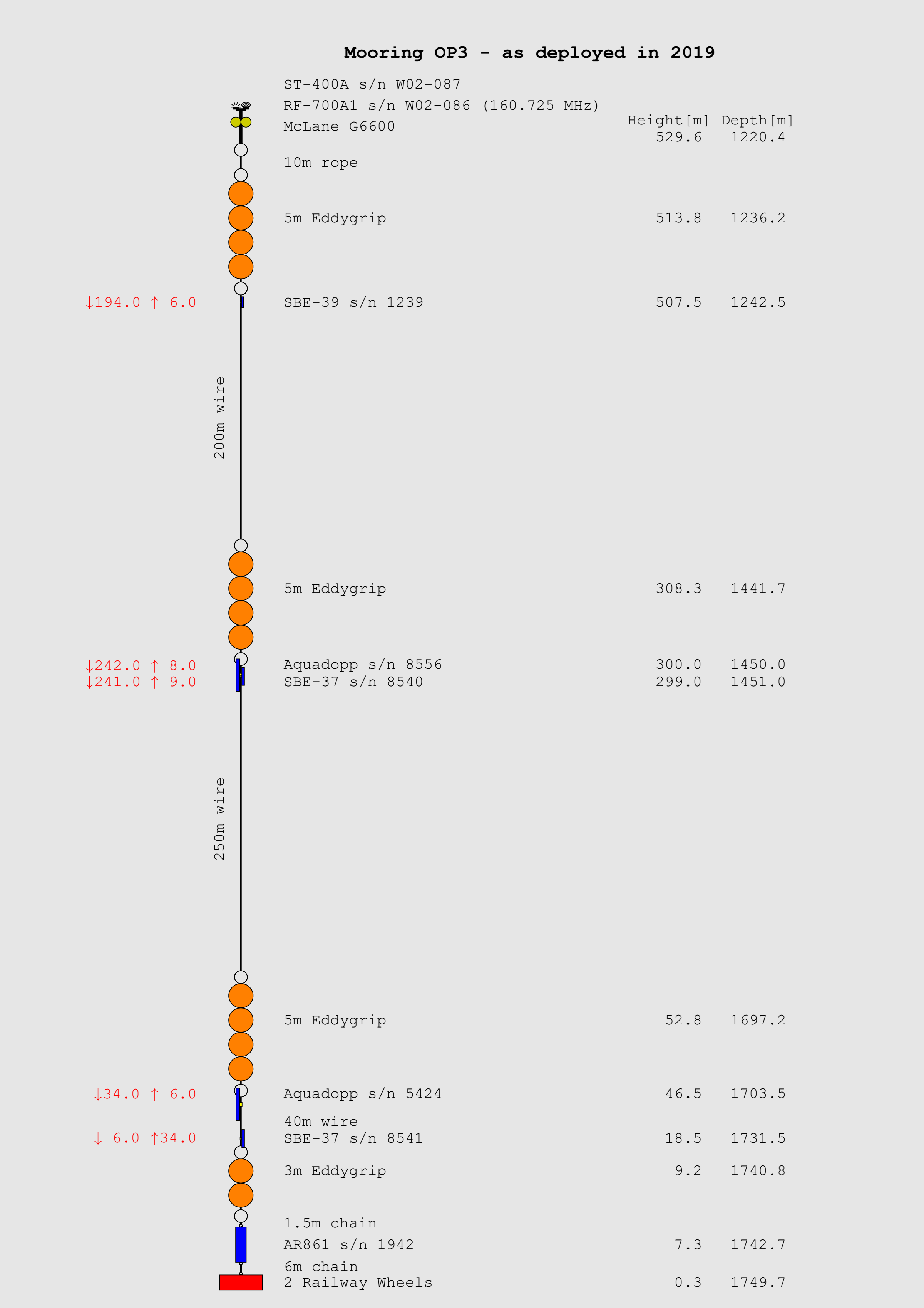
Anchor Drop: Lat S 62 36.924’ Lon W 043 14.618’ 13 Jan 2019 19:11:30

Triangulated Pos: Lat S 62 36.798’ Lon W 043 14.384’ Depth 3052 m



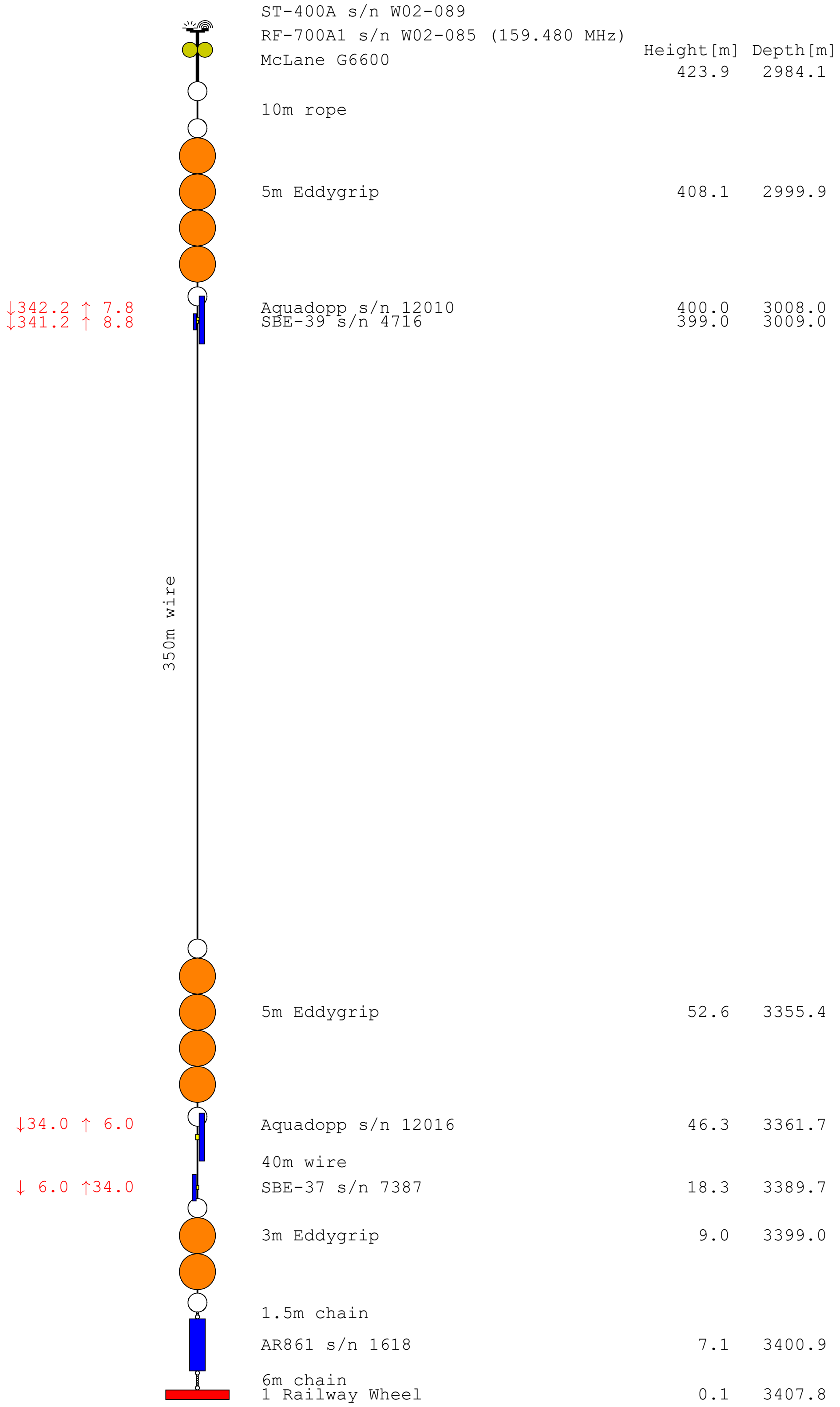
Mooring OP1 - as deployed in 2019
ST-400A s/n Y07-011
RF-700A1 s/n Y07-009 (160.725 MHz)
Height[m] Depth[m]
Trimsyn TS2 1839.0 1806.0
10m rope
5m Eddygrip 1823.0 1822.0
↓344.0 ↑ 6.0 Aquadopp s/n 5993 1816.7 1828.3
↓343.0 ↑ 7.0 SBE-39 s/n 4409 1815.7 1829.3
350m wire
↓10.0 ↑340.0 Aquadopp s/n 6000 1482.7 2162.3
↓ 9.0 ↑341.0 SBE-37 s/n 7380 1481.7 2163.3
5m Eddygrip 1467.4 2177.6
350m wire
3m Eddygrip 1113.8 2531.2
↓300.0 ↑50.0 SBE-39 s/n 4413 1063.5 2581.5
350m wire
3m Eddygrip 760.2 2884.8
↓300.0 ↑50.0 Aquadopp s/n 6112 709.9 2935.1
↓299.0 ↑51.0 SBE-37 s/n 7381 708.9 2936.1
350m wire
3m Eddygrip 406.6 3238.4
350m wire
3m Eddygrip 53.0 3592.0
↓34.0 ↑ 6.0 Aquadopp s/n 6180 46.7 3598.3
40m wire
↓ 6.0 ↑34.0 SBE-37 s/n 7382 18.7 3626.3
3m Eddygrip 9.4 3635.6
1.5m chain
Double AR861 s/n 564 & 1616 7.6 3637.4
6m chain
3 Railway Wheels 0.6 3644.4

Mooring OP2 - as deployed in 2019
ST-400A s/n Y07-012
RF-700A1 s/n Y07-010 (160.725 MHz)
Height[m] Depth[m]
McLane G8800 1542.7 1559.3
10m rope
5m Eddygrip 1526.8 1575.2
↓94.0 ↑ 6.0
SBE-37 s/n 7383 1520.5 1581.5
100m wire
5m Eddygrip 1421.2 1680.8
↓344.0 ↑ 6.0
Aquadopp s/n 6198 1414.9 1687.1
350m wire
↓50.0 ↑300.0
SBE-39 s/n 0083 1120.9 1981.1
350m wire
↓ 6.0 ↑344.0
Aquadopp s/n 6226 726.6 2375.4
↓ 5.0 ↑345.0
SBE-37 s/n 7385 725.6 2376.4
5m Eddygrip 715.3 2386.7
350m wire
350m wire
↓50.0 ↑300.0
Aquadopp s/n 6236 64.7 3037.3
↓ 6.0 ↑344.0
SBE-37 s/n 7368 20.7 3081.3
5m Eddygrip 9.5 3092.5
1.5m chain
double 8242 s/n 33147 & 33614 7.6 3094.4
6m chain
3 Railway Wheels 0.6 3101.4

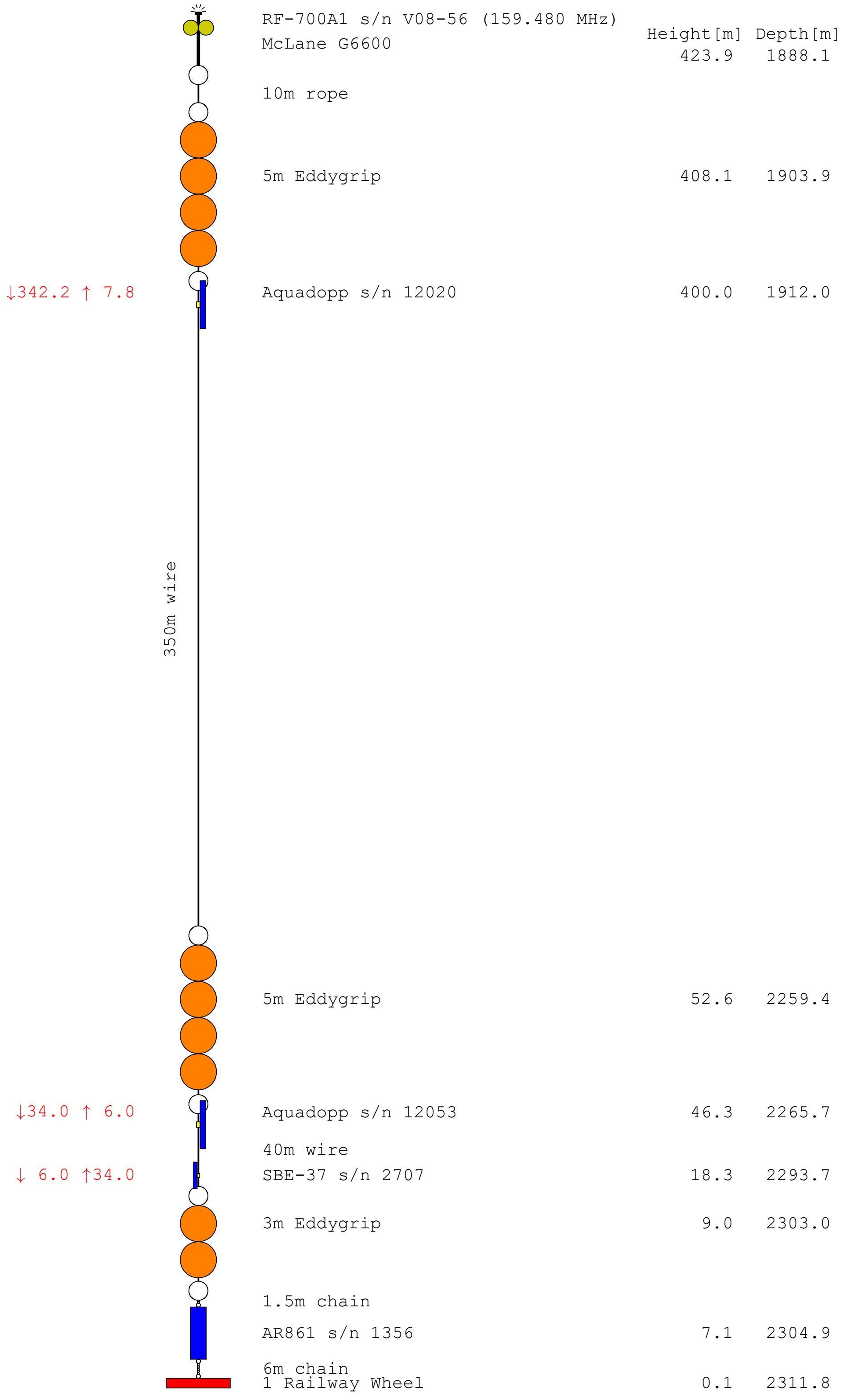

Mooring OP3 - as deployed in 2019
ST-400A s/n W02-087
RF-700A1 s/n W02-086 (160.725 MHz)
McLane G6600
Height[m] Depth[m]
529.6 1220.4
10m rope
5m Eddygrip 513.8 1236.2
↓194.0 ↑ 6.0
SBE-39 s/n 1239 507.5 1242.5
200m wire
5m Eddygrip 308.3 1441.7
↓242.0 ↑ 8.0
↓241.0 ↑ 9.0
Aquadopp s/n 8556 300.0 1450.0
SBE-37 s/n 8540 299.0 1451.0
250m wire
5m Eddygrip 52.8 1697.2
↓34.0 ↑ 6.0
Aquadopp s/n 5424 46.5 1703.5
40m wire
↓ 6.0 ↑34.0
SBE-37 s/n 8541 18.5 1731.5
3m Eddygrip 9.2 1740.8
1.5m chain
AR861 s/n 1942 7.3 1742.7
6m chain
2 Railway Wheels 0.3 1749.7


Mooring OP4 - as deployed in 2019
ST-400A s/n W02-088
RF-700A1 s/n W02-084 (154.585 MHz)
Trimsyn TS2
Height[m] Depth[m]
1130.1 1821.9
10m rope
5m Eddygrip 1114.1 1837.9
↓344.0 ↑ 6.0
↓343.0 ↑ 7.0
Aquadopp s/n 6263 1107.8 1844.2
SBE-39 s/n 4418 1106.8 1845.2
350m wire
5m Eddygrip 758.6 2193.4
↓341.7 ↑ 8.3
↓340.7 ↑ 9.3
Aquadopp s/n 9250 750.0 2202.0
SBE-39 s/n 4713 749.0 2203.0
350m wire
350m wire
5m Eddygrip 52.8 2899.2
↓34.0 ↑ 6.0
↓ 6.0 ↑34.0
Aquadopp s/n 9264 46.5 2905.5
40m wire
SBE-37 s/n 2956 18.5 2933.5
3m Eddygrip 9.2 2942.8
1.5m chain
Double AR861 s/n 565 & 1615 7.4 2944.6
6m chain
2 Railway Wheels 0.3 2951.7

Mooring OP5 - as deployed in 2019



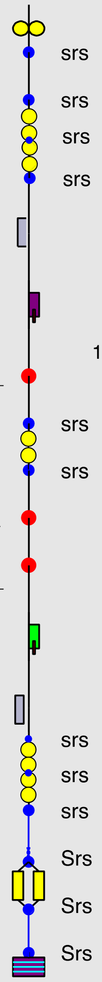
Mooring OP6 - as deployed in 2019



Diagrams: deployed moorings:

Weddell Orkney Plateau Moorings — Mooring ID: **M2** — Cruise: DY158

Nom Depth	Element	Serial Number	Distance between elements	**Wire marker**	Line length/ type
2492 m	McLane Top² Beacon 159.480 MHz Flasher	U08-058 V08-057	10 m		poly rope, 10 m
2504 m	17" glass x 4 on 2x 2 m 3/8" chain		5m		
2513 m	Aquadopp 6k	2807	45m	**5**	**3/16 wire, 250 m**
2558 m	SBE37SM	6557	125 m	**50**	
2683 m	SBE39 T, P	________	75 m	**175**	
2758 m	17" glass x 2 on 2 m 3/8" chain		25 m		
2785 m	SBE39 T,P	________	75 m	**25**	**3/16 wire, 250 m**
2860 m	SBE39 T,P	________	145 m	**100**	
3005 m	SBE37SMP	14765	3 m	**245**	
3008 m	Aquadopp 6k	9380	2 m	**248**	
3010 m	17" glass x 4 on 2x2m 3/8" chain		2 m		3/8" chain
3016 m	8242 release (2)	31512 33152	7 m		3/8" chain
3024 m	anchor 350 kg				

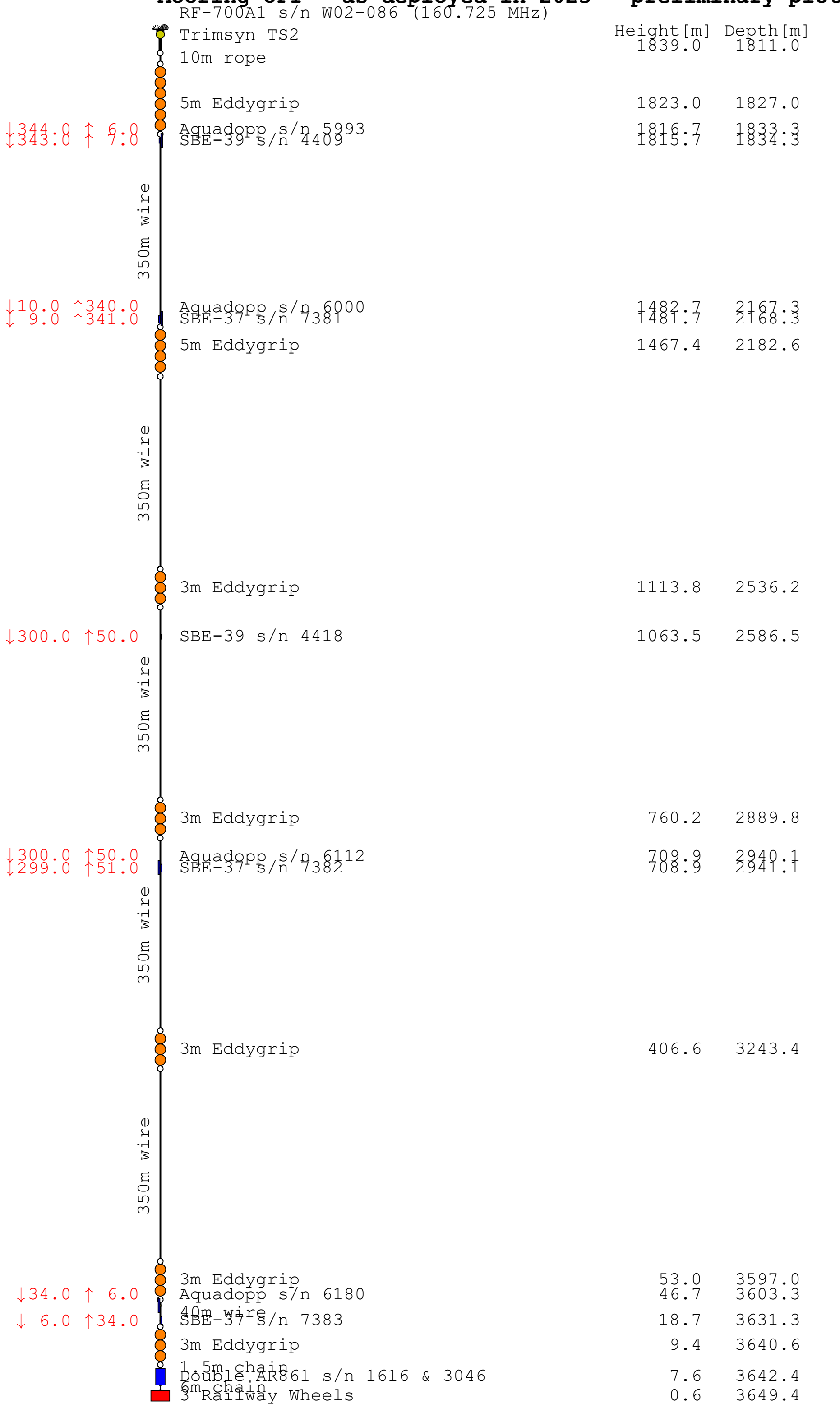


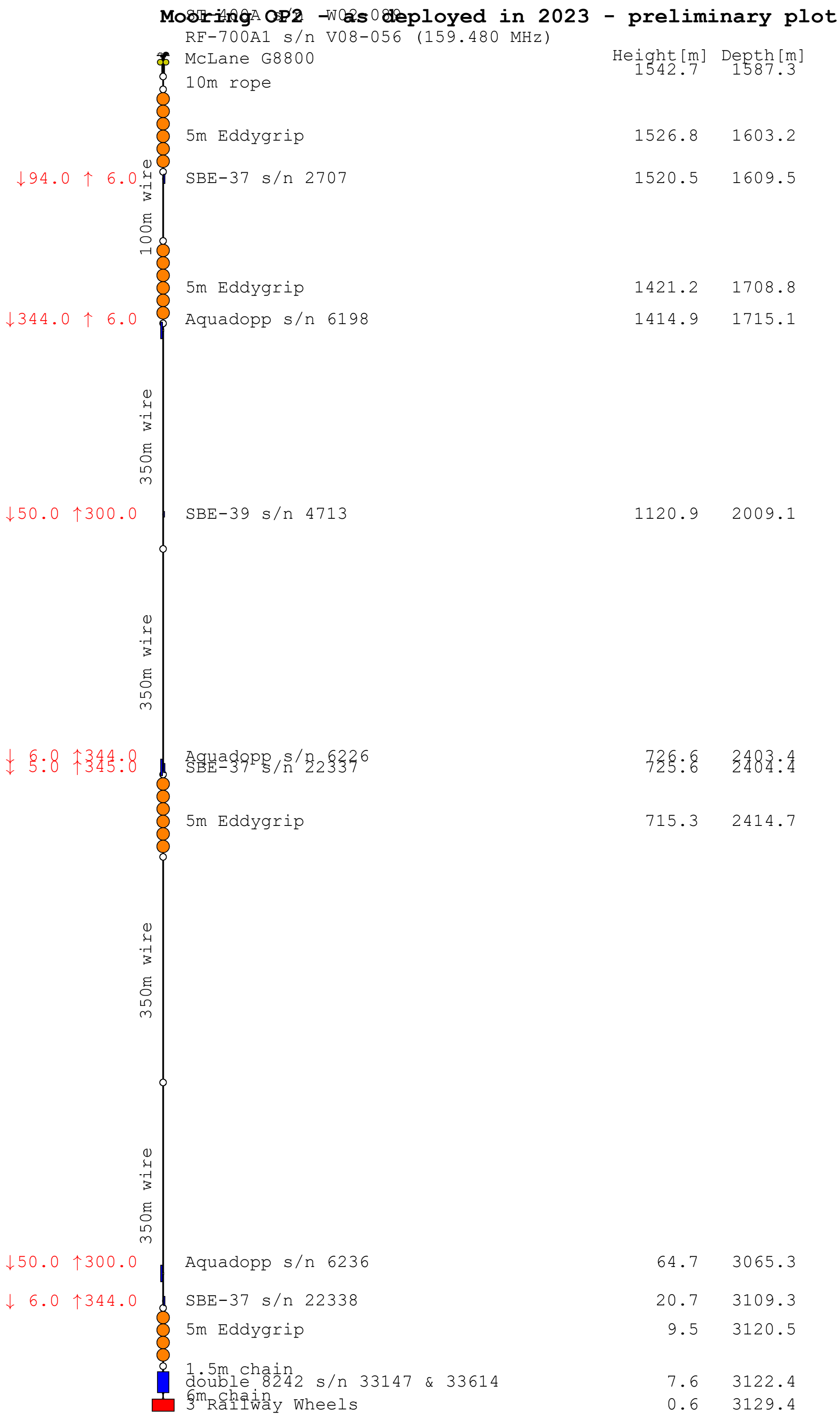
Target Position: Lat S 62 36.924' Lon W 043 14.618' Target Depth 3049m

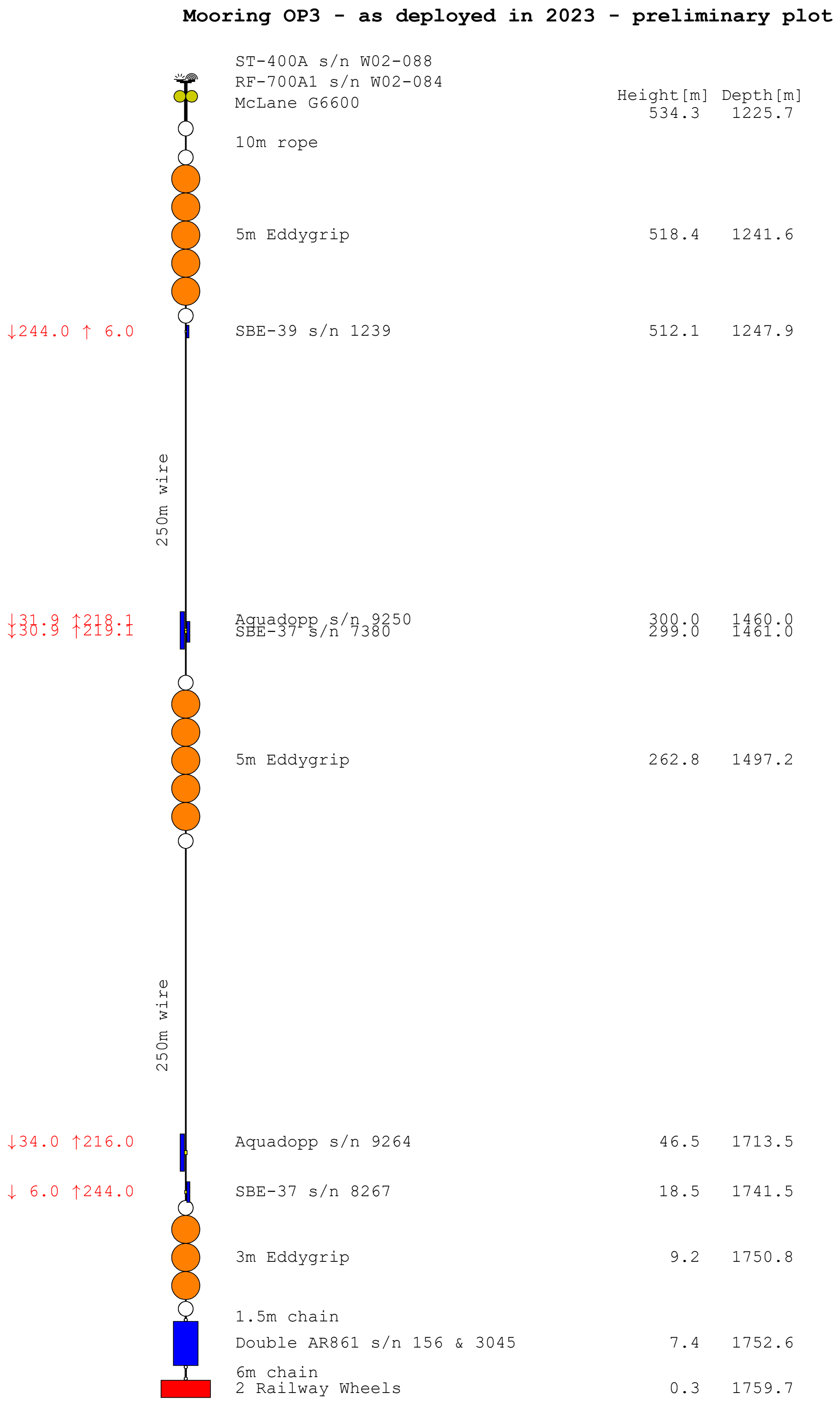
Anchor Drop:

Triangulated Pos:

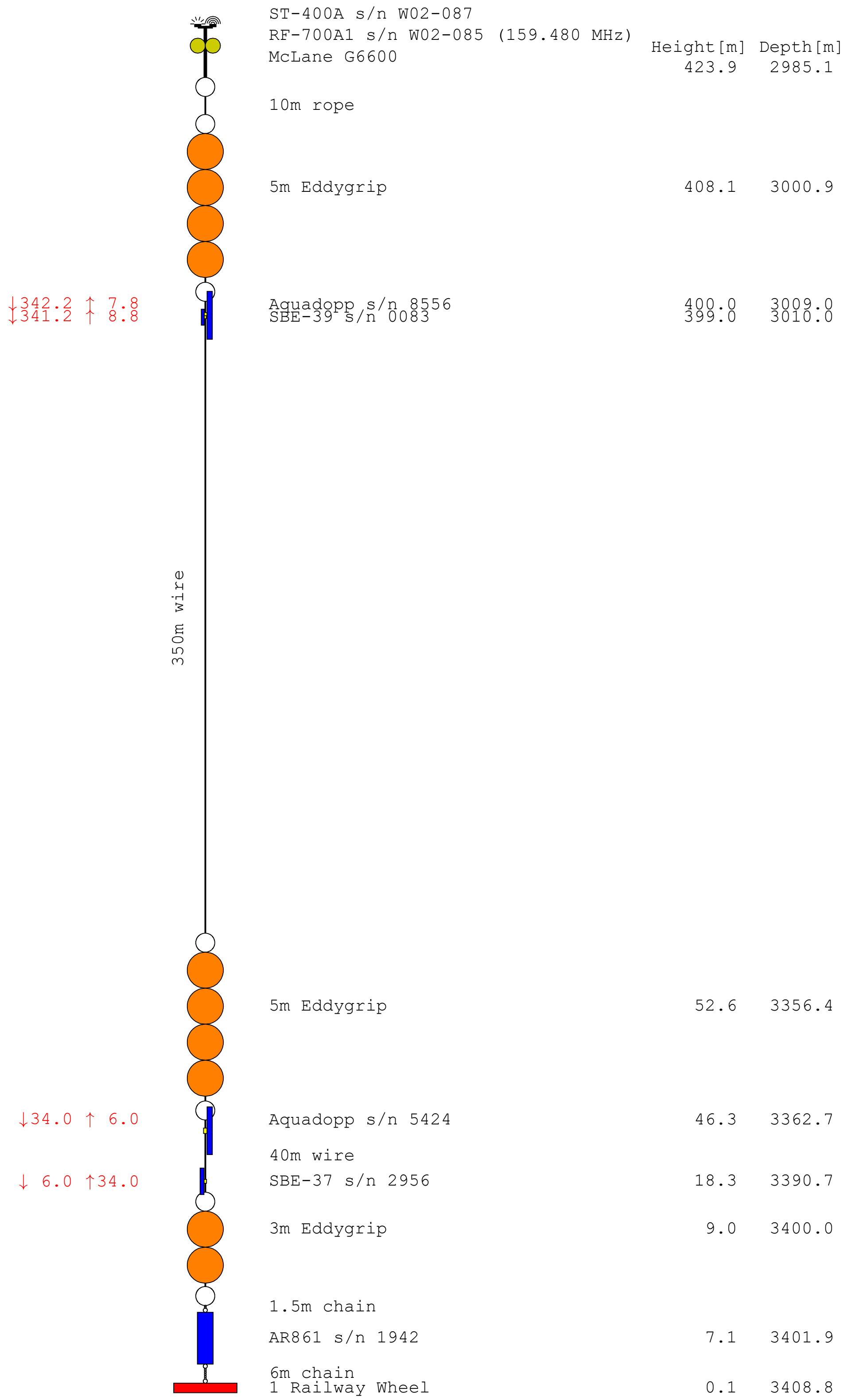
Mooring OP1 - as deployed in 2023 - preliminary plot




Mooring OP2 - as deployed in 2023 - preliminary plot
ST-400A s/n W02-08
RF-700A1 s/n V08-056 (159.480 MHz)
Height[m] Depth[m]
McLane G8800 1542.7 1587.3
10m rope
5m Eddygrip 1526.8 1603.2
↓94.0 ↑ 6.0
SBE-37 s/n 2707 1520.5 1609.5
100m wire
5m Eddygrip 1421.2 1708.8
↓344.0 ↑ 6.0
Aquadopp s/n 6198 1414.9 1715.1
350m wire
↓50.0 ↑300.0
SBE-39 s/n 4713 1120.9 2009.1
350m wire
↓ 6.0 ↑344.0
Aquadopp s/n 6226 726.6 2403.4
↓ 5.0 ↑345.0
SBE-37 s/n 22337 725.6 2404.4
5m Eddygrip 715.3 2414.7
350m wire
350m wire
↓50.0 ↑300.0
Aquadopp s/n 6236 64.7 3065.3
↓ 6.0 ↑344.0
SBE-37 s/n 22338 20.7 3109.3
5m Eddygrip 9.5 3120.5
1.5m chain
double 8242 s/n 33147 & 33614 7.6 3122.4
6m chain
3 Railway Wheels 0.6 3129.4


Mooring OP3 - as deployed in 2023 - preliminary plot
ST-400A s/n W02-088
RF-700A1 s/n W02-084
McLane G6600
Height[m] Depth[m]
534.3 1225.7
10m rope
5m Eddygrip 518.4 1241.6
↓244.0 ↑ 6.0
SBE-39 s/n 1239 512.1 1247.9
250m wire
↓31.9 ↑218.1
↓30.9 ↑219.1
Aquadopp s/n 9250 300.0 1460.0
SBE-37 s/n 7380 299.0 1461.0
5m Eddygrip 262.8 1497.2
250m wire
↓34.0 ↑216.0
Aquadopp s/n 9264 46.5 1713.5
↓ 6.0 ↑244.0
SBE-37 s/n 8267 18.5 1741.5
3m Eddygrip 9.2 1750.8
1.5m chain
Double AR861 s/n 156 & 3045 7.4 1752.6
6m chain
2 Railway Wheels 0.3 1759.7

Mooring OP5 - as deployed in 2023 - preliminary plot



19. Ship Scientific Systems Report

Andrew Moore and Daniel Phillips

Cruise overview

Cruise	Departure	Arrival	Technician(s)
DY158	22/12/22 14:00	29/01/23	Andrew Moore Dr Daniel Phillips

Table 44. Scientific Systems Cruise overview.

Ship Scientific Systems (SSS) is responsible for operating and managing the Ship's scientific information technology infrastructure, data acquisition, compilation and delivery, and the suite of ship-fitted scientific instruments and sensors in support of the Marine Facilities Programme (MFP).

The work site was South Georgia and the South Sandwich Islands, the Western Core Box, the A23 mooring array and the Orkney Passage Moorings.

The main objectives for SSS in the service of the science party on this cruise were:

1. Acquire underway data and metadata, including sea-surface, meteorological, position and attitude, depth and multibeam swath.
2. Provide services for recording metadata and events and monitoring data streams.
3. Provide basic IT support.

All times in this report are in UTC.

1.1. Summary

A summary of the progress made against objectives is shown below.

[X] Objectives, [X] completed, [X] partially completed, [X] not completed.

Target	Outcomes	Objective met?
Acquire underway data and metadata, including sea-surface, meteorological, position and attitude, depth and multibeam swath.	Data collected and given to PI and data manager.	Yes.
Provide services for recording metadata and events and monitoring data streams.	Event logger operational and used throughout.	Yes.
Provide expertise for the operation and calibration of the EK-80 transducers. Subsequently, calibrate the transducers as required.	Two box surveys and multiple continuous transects of EK-80 measurements. Transducers calibrated 04/01/23.	Yes.

Provide basic IT support.	Provided.	Yes.

Table 45. Summary of progress made against objectives.

Scientific computer systems

Underway data acquisition

Data from the suite of ship-fitted scientific instrumentation was aggregated onto a network drive on the ship's file server. This was available throughout the voyage in read-only mode to permit scientists to work with the data as it was acquired. A Public network folder was also available for scientists to share files.

A copy of these two drives are written to the end-of-cruise disks that are provided to the Principal Scientist and the British Oceanographic Data Centre (BODC).

List of logged ship-fitted scientific systems:

/Cruise_Reports/DY158_Ship_fitted_information_sheet.docx

The data acquisition systems used on this cruise are detailed in the table below. The data and data description documents are filed per system in the *Data* and *Documentation* directories respectively within Ship Systems folder on the cruise data disk.

Data acquisition system	Usage	Data products	Directory system name
Ifremer TechSAS	Continuous.	NetCDF ASCII pseudo-NMEA	/TechSAS/
NMF RVDAS	Continuous.	ASCII Raw NMEA SeaDataNet NetCDF (Testing)	/RVDAS/
Kongsberg SIS (EM710)	Discrete.	Kongsberg .all	/Acoustics/EM-710/
Kongsberg EA640	Continuous.	None, redirected to Techsas/RVDAS RAM	/Acoustics/EA-640/
Kongsberg EK80	Continuous/ Discrete.		/Acoustics/EK-80/
UHDAS (ADCPs)	Continuous.	ASCII raw, RBIN, GBIN, CODAS files	/Acoustics/ADCP/
Sonardyne Ranger2	Discrete.	None, redirected to Techsas/RVDAS RAM	/Acoustics/USBL/

Table 46. Data acquisition systems used on this cruise.

Data description documents per system:

/Ship_Systems/Documentation/TechSAS/Data_Description/

Data directories per system:

/Ship_Systems/Data/

Significant acquisition events and gaps

On this cruise, the NMF Event Logger/BAS Event Logger was used with CSV records of events saved to the cruise data directory.

Path and pattern to event log CSV files:

/Ship_Systems/Documentation/EventLogs/current_csv_logs/[logName]/*.csv

Date	Time start*	Time end*	Event
22/12/2022	11:15:02	-	Start of DY158 data acquisition (Techsas/RAM)
22/12/2022	16:30:00	-	Vessel departure from Montevideo, Uruguay
04/01/2023	10:00	18:00	EK80 transducer calibration in Rosita Bay, South Georgia.
29/01/2023	10:30	-	Vessel arrival into Mare Harbour, Falkland Islands
29/01/2023	14:00:23	-	End of DY158 acquisition (Techsas/RAM)

Table 47. Summary of main events.

Summary of data gaps

Event log entries contain information for any data gaps.

Path and pattern to event log CSV files:

/Ship_Systems/Documentation/EventLogs/current_csv_logs/techlogs/Data_acquisition.csv

Internet provision

Satellite communications were provided with both the VSat and Fleet Broadband systems.
The ship operated with bandwidth controls to prioritise business use.

Instrumentation

Coordinate reference

Path to ship survey files:

/Ship_Systems/Documentation/Vessel_Survey

Origin (RRS Discovery)

The ship's survey (Parker Maritime, 2013) defines two systems of reference point using two different central reference points (CRPs):

1. (0,0,0) at Frame 0 (aft-most frame, 6m forward from stern), centreline (centre of keel), baseline (ship's bottom-most longitudinal).
2. (0,0,0) at ship's centre of gravity (CG), Frame 44 (26.4 m forward from Frame 0 at 0.6 m framespacing), centreline (centre of keel), main deck (7.4 m up from baseline).

The survey coordinate sense is X is positive forward, Y positive starboard, and Z positive down. The coordinate order in the survey is (Y,X,Z), but unless otherwise noted, all coordinates are given elsewhere as (X,Y,Z).
For all scientific purposes, unless otherwise stated, the coordinate system is referenced using the second system, with the CRP at the CG.

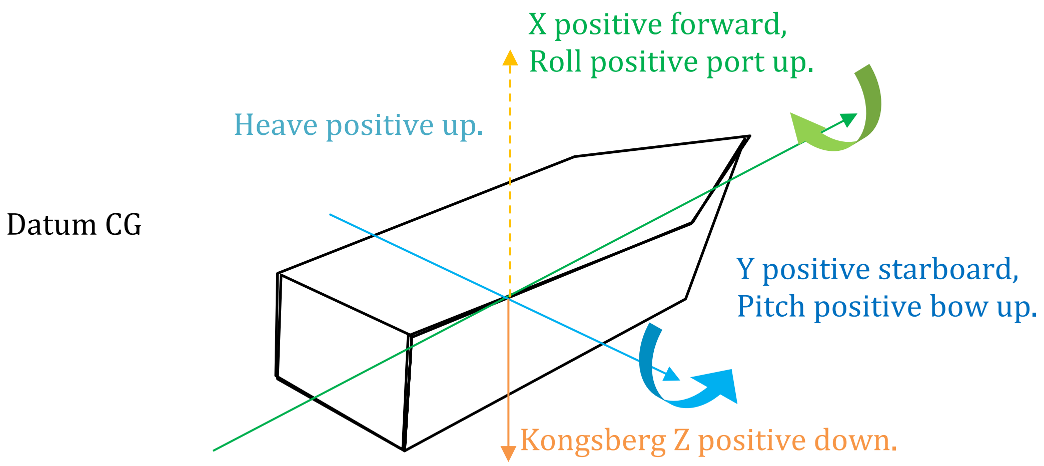


Figure 81. Conventions used for position and attitude. On the Discovery, the Datum is the CRP at the CG.

Multibeam

The Kongsberg axes reference conventions are (see Figure 81) as follows:

1. X positive forward,
2. Y positive starboard,
3. Z positive downward.

The rotational sense for the multibeam systems and Seapath is set to follow the convention of Applanix PosMV (the primary scientific position and attitude system), as per Figure 81.

Primary scientific position and attitude system

The translations and rotations provided by this system (Applanix PosMV) have the following convention:

1. Roll positive port up;
2. Pitch positive bow up;
3. Heading true positive to starboard;

4. Heave positive up.

Position, attitude and time

System	Navigation (Position, attitude, time)		
Statement of Capability	/Ship_Systems/Documentation/GPS_and_Attitude		
Data product(s)	NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/ Raw NMEA: /Ship_Systems/Data/RAM/ CSV: /Ship_Systems/Data/RAM/CSV		
Data description	/Ship_Systems/Documentation/TechSAS /Ship_Systems/Documentation/RVDAS		
Other documentation	/Ship_Systems/Documentation/GPS_and_Attitude		
Component	Purpose	Outputs	Headline Specifications
Applanix PosMV	Primary GPS and attitude.	Serial NMEA to acquisition systems and multibeam	Positional accuracy within 2 m.
Kongsberg Seapath 330	Secondary GPS and attitude.	Serial and UDP NMEA to acquisition systems and multibeam	Positional accuracy within 1 m.
Oceaneering CNav 3050	Correction service for primary and secondary GPS and dynamic positioning.	RTCM to primary and secondary GPS	Positional accuracy within 0.15 m.
Fugro Seastar / MarineStar	Correction service for primary and secondary GPS and dynamic positioning.	Corrections to primary and secondary GPS	Positional accuracy within 0.15 m.
Meinberg NTP Clock	Provide network time	NTP protocol over the local network.	

Table 48. Scientific systems and their details.

Significant position, attitude or time events or losses

> *Path and pattern to event log CSV files:*
>
> /Ship_Systems/Documentation/EventLogs/current_csv_logs/techlogs/GPS.csv

Ocean and atmosphere monitoring systems

SURFMET

> *Fitted Sensors Configuration sheet (Instrument serial numbers & calibration dates):*
>
> /Ship_Systems/Documentation/Surfmet/DY158_Surfmet_sensor_information_sheet.pdf
>
> *Sensor Calibration Certificates Location:*
>
> /Ship_Systems/Documentation/Surfmet/Calibration_Files/Fitted/

System	SURFMET (Surface water and atmospheric monitoring)
Statement of Capability	/Ship_Systems/Documentation/Surfmet
Data product(s)	NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/ Raw NMEA: /Ship_Systems/Data/RAM/ CSV: /Ship_Systems/Data/RAM/CSV
Data description	/Ship_Systems/Documentation/TechSAS /Ship_Systems/Documentation/RVDAS
Other documentation	/Ship_Systems/Documentation/Surfmet
Calibration information	See Ship Fitted Sensor sheet for calibration information for each sensor.

Table 49. SURFMET documentation, data and calibration details.

Component	Purpose	Outputs
Inlet temperature probe (SBE38)	Measure temperature of water at hull inlet.	Serial to Interface Box.
Drop keel temperature probe (SBE38)	Measure temperature of water in drop keel space.	Serial to Interface Box.
Thermosalinograph (SBE45)	Measure temp. and conductivity at sampling board. Salinity is calculated.	Serial to Interface Box.
Interface Box (SBE90402)	Signals management.	Serial to Moxa.
Debubbler	Reduces bubbles through instruments.	None.

Transmissometer (CST)	Measure of transmittance.	Analogue to NUDAM.
Fluorometer (WS3S)	Measure of fluorescence.	Analogue to NUDAM.
Air temperature and humidity probe (HMP155)	Temperature and humidity at met. platform.	Analogue to NUDAM.
Ambient light sensors (PAR, SKE510; TIR, CMP6)	Ambient light at met. platform.	Analogue to NUDAM.
Barometer (PTB210)	Atmospheric pressure at met. platform.	Analogue to NUDAM.
Anemometer (Windsonic)	Wind speed and direction at met. platform.	Serial to Moxa.
NUDAM	A/D converter.	Serial NMEA to Moxa.
Moxa	Serial to UDP converter.	UDP NMEA to Surfmet VM.
Surfmet Virtual Machine	Data management.	UDP NMEA to TechSAS, RVDAS.

Table 50. SBE38 components, their purpose and outputs.

Component	Calibrated product steps
SBE38: **Temperature (°C)**	No calibration to apply, residuals below uncertainty.
SBE45: Temperature (°C)	No calibration to apply, residuals below uncertainty.
SBE45: Conductivity (S m^{-1})	No calibration to apply, residuals below uncertainty.
CST: Transmission (%)	1. Product $= (\text{Data} - V_{\text{dark}})/(V_{\text{ref}} - V_{\text{dark}})$. Here product has units % and data, V_{dark} and V_{ref} have units V.
WS3S: Fluorescence (µg L^{-1})	1. Product $= \text{Coefficient} \times (\text{Data} - \text{Offset})$. Here product has units µg L^{-1}, coefficient has units µg L^{-1} V^{-1}, and data and offset have units V.
HMP45A / HMP155: Temperature (°C)	No calibration to apply, residuals below uncertainty.
HMP45A / HMP155: Relative humidity (%)	No calibration to apply, residuals below uncertainty.

PTB110 / PTB210: Pressure (hPa)	No calibration to apply, residuals below uncertainty.
SKE510: PAR (W m^{-2})	1. Product $=$ Data $\times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2, data has units 10^{-5} V, the 10^6 scalar has units µV V^{-1}, and coefficient has units µV m^2 W^{-1}.
CMP6: TIR (W m^{-2})	1. Product $=$ Data $\times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2, data has units 10^{-5} V, the 10^6 scalar has units µV V^{-1}, and coefficient has units µV m^2 W^{-1}.
Windsonic: Wind speed (m s^{-1})	No calibration to apply.
Windsonic: Wind direction (m s^{-1})	No calibration to apply.

Table 51. Systems, their purpose, output and calibration requirements.

Note that while the residuals (difference of reference and measured) are below uncertainty and the output is considered calibrated for the SBE38, SBE45, HMP45A, HMP155, PTB110 and PTB210 instruments, a regression could still be made between the reference and measured data (see the calibration certificate) if desired. Follow the steps below:

1. Calculate $y = Bx + A$ from calibration data, where x is reference data.
2. Product $=$ (Data $- A)/B$.

The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port, and whilst alongside. Please see the separate information sheet for details of the sensors used and whether their recorded data have calibrations applied or not.

Surface water sampling board maintenance

Path and pattern to event log CSV files:

/Ship_Systems/Documentation/EventLogs/current_csv_logs/techlogs/[logName]/Underway_Events.csv

The system was cleaned prior to the cruise.

Wave radar

System	WAMOS Wave Radar
Statement of Capability	/Ship_Systems/Documentation/Wamos
Data product(s)	NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/ Raw NMEA: /Ship_Systems/Data/RAM/

	CSV: /Ship_Systems/Data/RAM/CSV Raw: /Ship_Systems/Data/Wamos/	
Data description	/Ship_Systems/Documentation/TechSAS /Ship_Systems/Documentation/RVDAS	
Other documentation	/Ship_Systems/Documentation/Wamos	
Statement of Capability	/Ship_Systems/Documentation/Wamos	
Component	Purpose	Outputs
Rutter OceanWaves WAMOS	Measure wave height, direction, period and spectra.	Summary statistics in NMEA to TechSAS and RVDAS. Spectra files.
RsAqua Rex2 Wave Height Sensor	Measure wave height at bow to provide calibration reference dataset.	Wave height NMEA, UDP to TechSAS, RVDAS.
Furuno Radar	Measures radar reflection on sea surface.	Radar data to WAMOS.

Table 52. Wave radar, its components' purpose and outputs.

Hydroacoustic systems

System	Acoustics	
Statement of Capability	/Ship_Systems/Documentation/Acoustics	
Data product(s)	Raw: /Ship_Systems/Data/Acoustics NetCDF (EA640, EM122cb): /Ship_Systems/Data/TechSAS NMEA (EA640, EM122cb): /Ship_Systems/Data/RVDAS CSV: /Ship_Systems/Data/RAM/CSV	
Data description	/Ship_Systems/Documentation/Acoustics	
Other documentation	/Ship_Systems/Documentation/Acoustics	
Component	Purpose	Operation and Outputs
10 kHz Single beam (Kongsberg EA-640)	Primary depth sounder	Continuous, free running/Discrete. NMEA over serial, raw files
12 kHz Multibeam (Kongsberg EM-122)	Full-ocean-depth multibeam swath.	Discrete.

		Binary swath, centre-beam NMEA, *.all files, optional water column data
70 kHz Multibeam (Kongsberg EM-710)	Coastal/shallow multibeam swath.	Discrete. Binary swath, centre-beam NMEA, *.all files.
EK80 (Simrad/Kongsberg)	Fisheries echo sounder	Continuous, k-sync (2sec)
Drop keel sound velocity sensor	Provide sound velocity at transducer depth.	Continuous, free running. Value over serial to Kongsberg SIS.
Sound velocity profilers (Valeport Midas, Lockheed XBT)	Direct measurement of sound velocity in water column.	Discrete. ASCII pressure vs sound velocity files. Manually loaded into Kongsberg SIS or Sonardyne Ranger2.
75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler.	Continuous, k-sync (4sec) /Discrete. (via UHDAS).
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler.	Unused. (via UHDAS).
USBL (Sonardyne Ranger2)	Underwater positioning system to track deployed packages or vehicles.	Discrete. NMEA over serial.

Table 53. Hydroacoustic systems, their components, purpose and outputs.

Marine Mammal Protection

NMF policy is to follow JNCC guidelines for marine mammal observations before operating any equipment which causes significant acoustic disturbance in the water column. Such equipment includes the deep-water multibeam and sub-bottom profiler. For these systems, an MMO procedure is followed, which, in summary, involves a 60-minute bridge observation with a ramped start 45 minutes into the observation.

Path to Marine Mammal Observations logs:

/Ship_Systems/Documentation/Acoustics/MMOs

A member of the scientific party was responsible for carrying out and recording MMO activities.

Date	System	Obs. Start Time	Sys. Start Time	Notes (inc. any observations or actions)
04/01/23	EM710	04:00	05:00	Undertaken by Povl Abrahamsen. No comments.
05/01/23	EM710	04:00	05:00	Undertaken by Povl Abrahamsen. No comments.

Table 54. Marine mammal observations.

Sound velocity profiles

Sound velocity profiles were measured directly with a Midas SVP, derived from CTD or calculated from the WOA13 model using Ifremer DORIS.

Path of sound velocity profile data on the cruise datastore:

/Ship_Systems/Data/Acoustics/Sound_Velocity

Details of when sound velocity profiles were taken and applied are in the event log:

Path and pattern to event log CSV files:

/Ship_Systems/Documentation/EventLogs/current_csv_logs/techlogs/Acoustics.csv

Equipment-specific comments

ADCPs

Path of ADCP data on the cruise datastore:

/Ship_Systems/Data/Acoustics/ADCP

Attribute	Value
Acquisition software	UHDAS
Frequencies used	150 kHz only.
Running mode	K-sync (triggered as slave), 4-sec ping rate

Table 55. ADCP acquisition software, frequencies used and running mode.

EK-80 Configuration and Surveys

Path of EK-80 data on the cruise datastore:

/Ship_Systems/Data/Acoustics/EK-80

Attribute	Value
Number of surveys	Run near-continuously (2 sec ping except during calibration at 1sec)
Calibration environmental variables	Water temperature: 1.8 °C. Water salinity: 33.8 PSU. Water pH: 8. Depth: 10 m. Latitude: 53 °.
Offsets	(see table below)

Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
18 kHz transducer	23.15	0.90	7.49
38 kHz transducer	24.02	0.91	7.49
70 kHz transducer	23.62	0.70	7.49
120 kHz transducer	23.53	1.16	7.49
200 kHz transducer	23.76	1.15	7.49
333 kHz transducer	23.67	0.98	7.49

Table 56. EK80 number of surveys, calibration, offsets.

Drop Keel – The drop keel was not used during DY158. All data collection was with the transducers flush to the vessel baseline.

Draft – Vessel draft at the start of the cruise was 6.5 m. A waterline level ('Installation → Sensor Configuration → Sensor → Water Level') of 1 m was applied to the system to match the 'distance from transducer to waterline' to the known (6.5 m) draft. This was achieved by temporarily outputting a DTP NMEA message from the EK-80, which contains 'offset rel. to transducer'. With a 1 m 'Waterline' applied, the DTP 'offset rel. to transducer' was confirmed as 6.52 m.

Pulse Type – All frequencies were run throughout with **CW** Pulse Type. During the calibration activity on 4-JAN-23 the 38 kHz frequency was occasionally put into 'Wide' mode (option exists for the ES38-7 only, within the Installation menu) to assist with locating the calibration sphere. **'Fast' ramping** was used throughout for all frequencies.

Synchronisation – K-sync used for OS75 and EK-80 through (except during EK-80 calibration). EA-640 was not set to run on K-sync due to it not being able to run as a slave and still allow EK-80 to achieve 2 sec ping rate. This appears to be a wiring issue as the transmit pulse is appearing approx. 6 seconds *after* the trigger pulse (and therefore meaning the EA-640 State in K-sync will go to standby after three pings are not detected). Later in the trip it was identified that on a previous cruise (DY098) the EA-640 was able to run on K-sync by disabling the 'Signal is available' option in the 'Transmitting' section of the Installation Settings of K-sync. This should not need to be done – it appears to potentially be a wiring issue from build. Usually this is not apparent due to EA-640 often being used as master, or the K-sync system not being used.

- *K-sync groups:* 1,3,5 (OS74 & EK-80); 2,4,6 (EK-80 only).

Raw Data Collection & Output – Raw data was collected mainly to 1100 m depth. Early on some was collected to 1200 m. 100 MB file size was set throughout. Due to the size of the data (800-900 GB) produced two data directories were set up to assist in synchronisation. These exist in the cruise data directory:

'DY158' – From start of EK80 acquisition to 1246 7-JAN-2023
'DY158_2' – From 12:46 7-JAN-2023 (Noted in event logger) to end of EK80 acquisition

Transducer Documentation & Incorrect ES120-7 Serial Number – Simrad manufacturer reference sheets are included in the EK-80 directory. Later in the cruise it was identified that the EK-80 installation for the ES120-7 transducer has the incorrect serial number. The incorrect number S/N:890 exists on any cruise screenshots of the EK-80 software and also the original 'CalibrationDataFile' (see below for calibration info) for the ES120-7 transducer. This was discussed with the EK-80 scientist. The **correct serial number is S/N:2250** and will be changed to the EK-80 vessel installation following completion of acquisition/refit. The serial number error does not impact the raw data, and no manufacturer data sheet values were used in the EK-80 configuration due to the existence of the recent history of calibrations. This transducer change was completed in early 2022 (JAN-FEB).

Other EK80 Files:

> *Path of additional EK-80 data on the cruise datastore:*
>
> /Ship_Systems/Data/Acoustics/EK80_CalibrationFiles_transducerDataSheets

- ***Calibration Output Files:*** *.xml files from the 5 frequency calibrations. The serial number for ES120-7 has been updated here, so there is a '*CORRECT_SN2250' file (which was modified from the '*INCORRECT_890' which has only had the filename altered). Acquisition PC location: *'C:/Users/Public/Public Documents/Simrad/Calibration/DY158'*
- ***RAW Calibration Files***: *raw and *.idx files from D202230104 T165357 to T202510 are duplicated in this directory. These are the files from the Rosita Calibration, so can be easily replayed.
- ***DY_Current_Transducers***: as discussed, *.pdfs of the SIMRAD transducer datasheets
- ***ConfigSettings_25-JAN-2023***: The *.xml files for the EK-80 software (located on acquisition PC at *'C:/ProgramData/Simrad/EK80/ConfigSettings'*).

Calibration – The 18, 38, 70, 120 & 200 kHz frequencies were calibrated at Rosita Bay, South Georgia on 4-JAN 2023 (1000 to 2100). Water depth of 59 m. A CTD was completed prior to calibration in order to obtain the correct EK-80 environment variables for temperature (1.8 °C) and salinity (33.8 PSU). These were applied prior to calibration.
Ping rate during calibration was 1 second, with a raw data collection reduced to 200 m. Calibration completed using a 38.1mm tungsten carbide sphere and a fishing weight of approx. 0.5 kg 10 m below the sphere. Sphere depth was approx. 24 m. Initial control of the calibration sphere's movement was very limited. A line/shackle from the forecastle was added to improve the portside position of the sphere, however the sphere was still rarely visible and unresponsive. Additional weight (2 medium shackles) was added and resolved the control issue. All 5 required calibrations were then performed. As requested by the scientist, all transducer frequencies were 'active' during the entire calibration.
The 'Acoustics.csv' event log file contains additional information for the events during the calibration.

200KHz Noise – On power up of the EK-80 during the initial transit from Montevideo (23-JAN-2023) noise was noted to be present on the 200 kHz frequency. This had also been noted throughout the previous DY159 cruise (which also used/calibrated the EK-80 system). It had been suspected during DY159 that the cause was the bridge's 200 kHz Skipperlog. Turning this (and the bridge port echo-sounder) off did not remove/alter the noise artefact. With no other acoustics operating, the noise was still present. The frequency was swapped back onto the previous historical EK-60 GPT which was still installed and available for testing. This initially appeared to have reduced the noise, but was revealed to not be so, as the effective depths were similar (the EK-80 'resolution' seemingly shows the noise more obviously in the EK-80), with the TVG saturating everything >100 m for the GPT installation. During the GPT/WBT investigations, the ship was on station (in order to limit lost passage data). It was decided that switching back to the original WBT config would be preferred – this was completed the morning of 24-JAN (during CTD/nets test deployments). Following the return to the original WBT 200 kHz configuration, the previously observed noise was no longer present. No further investigations of this 200 kHz noise were conducted – but it appears to have been related to the cable/connector (although seems strange the fault was present when first moved to the GPT, but then disappeared when being returned to the WBT). The only other minor change was that some of the cable ties for the mains power cable (to the GPTs) were removed/freed, but doubtful how this would make a difference to when the transducer was connected to the WBT.

120KHz Noise - During 23/24-JAN transit, acoustic testing showed noise on the 120 kHz. This was caused by ADCPs. Scientists decided to not use the 150 kHz OS150 ADCP in order to remove this artefact.

Transducer/Transceiver Information (Post-Calibration):

Variable	18 kHz	38 kHz	70 kHz	120 kHz	200 kHz	333 kHz
Transducer type	ES18-11	ES38-7	ES70-7C	ES120-7C	ES200-7C	ES333-7C
Transducer serial no.	2111	350	258	2250 (890*)	533	135
Transducer depth to waterline (m)	6.5	6.5	6.5	6.5	6.5	6.5
Transceiver Type	GPT	WBT	WBT	WBT	WBT	GPT
Transceiver serial no.	00907206 dc83	767751	400250	400256	998652	00907206 d0a4
Transmit power (W)	1600	2000	750	250	150	50
Pulse length (us)	1024	1024	1024	1024	1024	256 (1024)*

Transducer gain (dB)	22.99	26.91	27.83	26.15	26.66	25.0
Sa correction (dB)	-0.68	-0.11	0.01	-0.16	-0.15	0
3dB beam along (°)	10.09	6.68	6.55	6.65	6.58	7
3dB beam athwart (°)	10.18	6.68	6.50	6.74	6.60	7
Along offset (°)	-0.22	0	0.03	-0.07	-0.34	0
Athwart offset (°)	-0.18	-0.02	-0.02	-0.05	0.11	0
RMS Error (dB) [Calibration]	0.06	0.07	0.08	0.15	0.20	N/A
Calibration Applied (Time/Date)	04-01-23 20:25	04-01-23 17:34	04-01-23 19:47	04-01-23 19:11	04-01-23^ 12:21	N/A

Table 57. Transducer/Transceiver Information (Post-Calibration). ES333-7C not calibrated. Grey cell values are from EK80 software defaults for this transducer type ^ The 200 kHz calibration applied several days later following several replays of data to review the RMS error with the EK-80 scientist (by applying different Ts deviations prior to each replay).

EM-710 Configuration and Surveys

Path of Multibeam data on the cruise datastore:

/Ship_Systems/Data/Acoustics/EM-710

Path of EM710 CARIS Vessel Configuration File:

/Ship_Systems/Data/Acoustics/EM-710/CARIS_Processed/VesselConfig

Attribute	Value
Number of surveys	2 (South Georgia)
Date of patch test	Not undertaken.
Offsets and rotations	

Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
Tx transducer	37.570	-1.994	7.425
Rx transducer	36.819	-2.051	7.427

Item	Roll (deg)	Pitch (deg)	Yaw (deg)
Tx transducer	-0.07	0.33	0.22
Rx transducer	0.01	0.12	359.97

Post-processing undertaken	None.

Table 58. EM-710 Configuration and Surveys.

Other systems

Cable Logging and Monitoring

Winch activity is monitored and logged using the CLAM system.

20. Ship-fitted Systems Information Sheet (Discovery)

Ship-fitted instruments:

The following table lists the logging status of ship-fitted instrumentation and suites.

Manufacturer	Model	Function/data types	Logged? (Y/N)	Comments
Meinberg	M300	GPS network time server (NTP)	N	Not logged but feeds times to other systems
Applanix	POS MV320 V5	Position/attitude	Y	Primary scientific GPS
C-Nav	3050	DGNSS	Y	DGNSS (for Applanix)
Kongsberg Seatex	Seapath 330	Position/attitude	Y	Secondary scientific GPS
Fugro	Fugro 9205 DGNSS Seastar	DGNSS	Y	DGNSS (for Seapath330)
iXSea	PHINSIII	Inertial Navigation System	Y	
Sonardyne	Fusion USBL	USBL	Y	
Sperry Marine	NAVITVIN IV	Ship gyrocompasses x 3	Y	
Kongsberg Maritime	Simrad EA640	Single beam echo sounder (STDB Drop-Keel)	Y	10KHz
Kongsberg Maritime	Simrad EM122	Multibeam echo sounder (deep)	N	
Kongsberg Maritime	Simrad EM710	Multibeam echo sounder (shallow)	Y	2 short surveys around S. Georgia
Kongsberg Maritime	Simrad SBP27	Sub bottom profiler	N	
Kongsberg Maritime	Simrad EK80	Scientific echo sounder (fisheries)	Y	
NMFSS	CLAM	CLAM system winch log	Y	
NMFSS	Surfmet	Meteorology suite	Y	
NMFSS	Surfmet	Surface hydrography suite	Y	
SKIPPER	DL850	Skipper log (ship's velocity)	Y	
Rutter Inc	WaMoS II Sigma S6	Wave Radar	Y (non calibrated)	
RSAQUA	REX2 Waveradar	Wave Recorder	Y	
Teledyne RD Instruments	Ocean Observer 75 kHz	VM-ADCP	Y	UHDAS BT in shallow
Teledyne RD Instruments	Ocean Observer 150 kHz	VM-ADCP	Y	UHDAS BT in shallow
Microg Lacoste	Air-Sea System II	Gravity	N	Not onboard

Table 59. Ship-fitted systems instrumentation and suites.

21. Data management

Sarah Manthorpe

Data storage:

There were two network drives set up on the on-board server, the first containing files relating to ship instrumentation as 'current_cruise' and the second relating to scientific data produced 'Public'.

All data recorded by the instrumentation within the ship's network were stored in their relevant folders under \ship_fitted_scientific_systems within the current_cruise area of the drive. The core data on the cruise was logged using the TechSAS data acquisition system, as NetCDF and ASCII output data files. The format for logged data is described under the relevant folder within \current_cruise\Ship_Systems\Documentation. Data collected regarding CTDs can also be found here, under \current_cruise\Sensors_and_Moorings\CTD\DY158\Data.

Data and other work created by scientists were stored under \DY158\Scientific Work Area, separated into folders by the scientists themselves. These data were backed up every half an hour to the 'current_cruise' directory. The pathname for transfer into the BAS Storage Area Network (SAN) will be data/cruises/dy/dy158.

Site identifiers:

Specific codes were assigned to workstations in accordance with previous surveys in these respective areas. These are the following:

P3	WCB Mooring	19. A23-48	28. A23-39	37. A23-29	46. OP2
WCB1.1 N/S	ECB1.1 N/S	20. A23-47	29. A23-37	38. A23-28	47. OP3
WCB1.2 N/S	ECB1.2 N/S	21. A23-46	30. A23-36	39. A23-27	48. OP4
WCB2.1 N/S	13. A23-52	22. A23-45	31. A23-35	40. A23-26	49. OP5
WCB2.2 N/S	14. A23-15A	23. A23-44	32. A23-34	41. A23-25	50. OP6
WCB3.1 N/S	15. A23-51A	24. A23-43	33. A23-33	42. A23-24	51. OPCTD4
WCB3.2 N/S	16. A23-50A	25. A23-42	34. A23-32	43. M3*	52. OPCTD8
WCB4.1 N/S	17. A23-50	26. A23-41	35. A23-31	44. M2	53. OP11
WCB4.2 N/S	18. A23-49	27. A23-40	36. A23-30	45. OP1	54. OP12

Table 60. Code index for workstations on DY158 cruise.

*M3 had too much ice coverage and recovery was unsuccessful.

Event logs:

Event numbers were assigned to equipment deployments sequentially officers on watch at the bridge. These were stored in the bridge event log. 151 events were recorded, with the final event being assigned to underway sampling at the A76A iceberg, rather than to a scientific deployment. Alongside the bridge event log, scientific event logs were created and maintained for separate deployment types, and occasionally for sampling or recording equipment. Copies of these logs were downloaded as csv files throughout the cruise, with the final copy saves in the 'Public' network, under 'Public\DY158\event_logs\Downloaded' Digital Event Logs. Event logs were created for the following:

1. RMT8 net deployments
2. CTDs
3. Bongo nets
4. Floating Sediment Trap
5. Underway sampling
6. Argo float deployments

7. WCB Acoustic Transects
8. ECB Acoustic Transects
9. Mooring recoveries and deployments
10. Mammoth Net
11. VMADCP

Data was collected to support the research of the following scientists:

1. Gabi Stowasser
2. Tracey Dornan
3. Nadine Johnston
4. Geraint Taring
5. Alison Cleary
6. Emily Rowland
7. Angelika Slomska
8. Clara Manno
9. Laura Taylor
10. Philippa Birchenall
11. Evelyn Workman
12. Povl Abrahamsen
13. Michael Meredith
14. Jon Rosser
15. Chris Auckland

Cruise data deposit:

The read-only 'current_cruise' and public 'Public' scratch drive were both combined at the end of the cruise, and copied to discs for the PSCO, BAS Polar Data Centre (PDC), and BODC. All data are archived for storage with the BAS PDC. For cruise participants internal to BAS, the data has been saved on the UNIX drive under data/cruise/dy/dy158. Cruise participants external to BAS or any other external party who would like copies of the data can contact the PDC at PDCServiceDesk@bas.ac.uk.

Equipment/Activity	Number of recoveries/deployments
Bongo nets	41
RMT8	14
Floating Sediment trap	3
CTD	56
Mammoth	3
EK80 WCB + ECB acoustic transects	12
Air Sampling	79
Underway samples taken	458
VMADCP	Continuous readings
LADCP	52
Atmospheric mast-fitted loggers	Continuous
P3 Mooring	1
WCB	1
ECB	1
Argo floats	3
M2 Mooring	
OP1	1
OP2	1

OP3	1
OP4	1
OP5	1
OP6	1

Table 61. Summary of deployments and recoveries of scientific equipment on DY158.

Data sets' descriptions:

Dataset/Activity	Bongo
Instruments	Bongo net, mesh size 100 µm s + 200 µm
Description	Bongo deployments were carried out to collect Antarctic krill, copepods, and meso-zooplankton for incubation experiments on respiration (NJ, GT), community, diversity and abundance (GT). In addition, salps were collected for genetic analysis (AS).
Metadata	\Public\DY158\Scientific Work Area\Bongo
Digital data	\Public\DY158\Copepod Resp Experiments
Physical samples	The primary repository for physical samples will the BAS biological store, where samples will be further examined, described and analysed post-cruise. For samples on community, diversity and abundance, stored in 4% formaldehyde For copepod respiration, samples were -80 °C freezer. Salps were stored in the -80 °C freezer
Long-term data management	Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC) at BAS.
Users of the data	Geraint Tarling, Nadine Jonston, Clara Massa, Angelika Slomska, Emily Rowland, Laura Tarling, Pip Birchenall, Alison Cleary.

Table 62. Description of Bongo nets on DY158.

Dataset/Activity	RMT8
Instruments	Rectangular Midwater Trawl 8 opening and closing nets (8 m), mesh size 5 mm. Two nets per event.
Description	RMT8 were deployed as targeted hauls for Antarctic krill Euphausia superba, and as oblique trawls for macrozooplankton and necton. Krill were collected for respiration and environmental samples (AC), taxonomic composition (GS), BAS legacy samples (GS), salp population composition (AS), respiration experiments (AC), faecal pellet production (ER,LT), microplastic incubation experiments (PB), nanoplastic incubation (PB)
Metadata	Paper logs and their scanned copies
Digital data	\DY158\Scientific Work Area\RMT8
Physical samples	The primary repository for physical samples will the BAS biological store, where samples will be further examined, described and analysed post-cruise. Biological samples were also sorted after the RMT8 was recovered and a record made of (rough) taxonomy, weight and number of individuals. Physical samples were stored as the following: Oblique tow: one complete sample (200 m) was preserved in 4% formaldehyde

	Targeted tow: frozen Antarctic krill and various other microzooplankton and nekton in -80 °C freezers. Opportunistic samples for incubation were stored at -20 °C. Faecal pellets were stored in ethanol (LT) Plastics filters were stored at -20 °C (PB)
Long-term data management	Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC) at BAS.
Users of the data	Geraint Tarling, Nadine Jonston, Clara Manno, Angelika Slomska, Emily Rowland, Laura Tarling, Pip Birchenall, Alison Cleary.

Table 63. Description of RMT8 nets on DY158.

Dataset/Activity	Floating sediment trap*
Instruments	Four Perspex tube on a stainless steel frame
Description	Samples were to be analysed for Dissolved Organic Carbon (DOC), microplastics, ETC WHAT ELSE
Metadata	Digital event log: '\Public\DY158\Scientific Work Area\Floating_sediment_trap'
Physical samples	None – failure on recovery
Long-term management	None – failure on recovery
Users of the data	None – failure

Table 64. Description of Floating sediment trap on DY158.

Dataset/Activity	CTD
Instruments	Dual Temperature, Conductivity, Dissolved O2, single Digiquartz Pressure, Chlorophyll Fluorimeter, Altimeter, Backscatter, Transmissometer, 22 20 L water samplers, 2 10 L water samplers, LADCP (upward, downward)
Description	CTD deployments recorded measurements of temperature, salinity, pressure, dissolved oxygen, fluorescence, altitude over the sea bed, and also data from two lowered LADCPs. Niskin bottle seawater samples were taken for oxygen isotope samples (Polar Oceans), salinity (Polar Oceans) analysed on-board, methane sampling (EW), microplastics composition (PB), lugols (LT), dissolved nutrients (LT), DSi isotopes (LT), phytoplankton composition (LT), particulate biogenic silica (LT), particulate organic carbon and nitrogen (LT), and Particulate Organic Matter (POM) for stable isotope analysis (GS) analyses to be carried out back in Cambridge.
Metadata	Paper logs and their scanned copies: '\current_cruise\Sensors_and_Moorings\CTD\DY158\Data' Metadata: '\Public\DY158\ Scientific work area \CTD\Microplastics' 'Public\DY158\Scientific work area\CTD\Eventlog\ 'Public\DY158\Scientific work area\CTD\POM Samples DY158\'
Physical samples	The primary repository for physical samples will be the BAS biological store. Biological samples were collected and stored as the following:

	4 °C fridge: Dissolved silicon isotopes, phytoplankton composition -20 °C freezer: Dissolved nutrients, Particulate biogenic silica, particular organic carbon and nitrogen Filter lab: Methane - Physical samples will be sent back to BAS and eventually transferred to the University of Liege. -80 °C freezer: POM Deck lab: In addition, O18 and salts were collected and stored in the following: O18 were stored in the deck lab, shipped back in +4 °C conditions - eventually will be transferred to BGS Keyworth Salts were kept in salinometry lab (Polar Oceans) and disposed of after analysis.
Long-term management	Raw and processed data will be stored at the BODC and CCHDO. Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre at BAS.
Users of the data	Povl Abrahamsen, Jon Rosser, Michael Meredith, Chris Auckland, Laura Taylor, Evelyn Workman, Phillipa Birchenall, Gabi Stowasser, Amanda Burson

Table 65. Description of CTD instrumentation on DY158.

Dataset/Activity	Mammoth
Instruments	Hydro-Bios Apparatebau GmbH – Multi Plankton Sampler MultiNet Type Mammoth
Description	Mammoth net collects data on temperature, depth and uses 300micron mesh nets to collect meso-zooplankton.
Digital data	Metadata as digital event log: '\DY158\Scientific work area\Mammoth\' Data: '\Public\DY158\Geraint\Mammoth\Deployment_data'
Long-term management	All samples preserved in 4% formaldehyde and stored in the Biological store at BAS. Metadata stored in the Marine Metadata Portal at the UK Polar Data Centre (PDC) at BAS.
Users of the data	Geraint Tarling, Clara Manno [SCOOBIES]

Table 66. Description of Mammoth net on DY158.

Dataset/Activity	EK80 Acoustic Transect ECB + WCB
Instruments	Kongsberg Maritime Simrad EK80 scientific echosounder
Description	The echosounder operated at 6 frequencies (18, 38, 70, 120, 200, 333 kHz) and generated crucial data for locating swarms of Antarctic krill. Acoustic data from both the WCB and ECB transects were recorded as part of the surveys. The ping rate was configured to be every 2 seconds. The EK80 was calibrated on 2023-01-04 in Rosita Bay, South Georgia. All frequencies were successfully calibrated except 333 kHz, Calibrations were applied to all frequencies immediately on

	completion, except 200 kHz, which was reprocessed later to reduce RMS error. 200 kHz calibration was applied on 2022-01-07.
Digital data	'\current_cruise\Ship_Systems\Data\Acoustics\EK-80'
Long-term management	Data will be stored on the SAN at BAS and will also be available from BODC. Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC).
Users of the data	Tracey Dornan, Sophie Fielding

Table 67. Description of echosounder on DY158.

Dataset/Activity	Air sampling
Instruments	KNF hand-held pump + tedlar air bag
Description	Samples were taken twice a day; once during daylight, once without daylight. This was carried out in order to measure Carbon-13 and deuterium throughout the entirety of the cruise
Metadata	'Public\DY158\Evelyn'
Physical samples	Samples will be stored at Royal Holloway University. Samples were stored in +4 °C refrigerated storage
Long-term management	Data will be stored on the SAN at BAS. Event metadata will be stored at the UK Polar Data Centre at BAS.
Users of the data	Evelyn Workman

Table 68. Description of air sampling equipment on DY158.

Dataset/Activity	Underway water sampling
Instruments	SLH80 Twin Screw Pump
Description	Samples were taken from the underway seawater stream for the following investigations: Salinity and O18 (Polar Oceans), Particulate Organic Matter (POM) for stable isotope analysis* (GS), dissolved nutrients (LT), dissolved silicon isotopes (DSi; LT), lugols* (LT), methane (EW), Phytoplankton composition (CM), Microplastics composition (PB), parasite spores (AC), other eDNA projects (AC) Samples were also targeted at various intervals for Iceberg 76A. *Only at Iceberg 76A
Metadata	Digital Event Logs and sampling metadata: '\Public\DY158\Scientific work area\O18 sampling' '\Public\DY158\Scientific work area\Underway iceberg A76' sampling '\Public\DY158\Laura' '\Public\DY158\Evelyn' '\Public\DY158\Alison'
Physical samples	All biological samples will be stored at the biological store upon return to BAS. During the cruise, they were stored as the following: Lugols in +4 °C fridge

	DSi in +4 °C fridge Dissolved nutrients in -20 °C freezer Phytoplankton in -20 °C freezer Microplastics in -20 °C freezer POM in -80 °C freezer eDNA in -80 °C freezer O18 in deck lab, transferred in +4 °C conditions, to be transferred to BGS Keyworth for analysis. Salts in salinometry lab (disposed of after analysis) Methane in the +4 °C refrigerator (EW), to be sent to Royal Holloway University.
Long-term management	Data will be stored on the SAN at BAS and will also be available from BODC. Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC).
Users of the data	Evelyn Workman, Jon Rosser, Chris Auckland, Michael Meredith, Povl Abrahamsen, Laura Taylor, Alison Cleary, Gabi Stowasser, Geraint Tarling, Pip Birchenall, Amanda Burson* *Only for Iceberg 76A

Table 69. Description of underway water sampling equipment on DY158.

Dataset/Activity	VMADCP
Instruments	Teledyne RDI Ocean Surveyor (75 kHz)
Description	Ran consistently on 75 kilohertz, narrow-band mode without bottom tracking or other frequencies. Measured current velocities, signal return and error in the velocity measured,
Metadata	Science logs – vmadcp
Digital data	'\current_cruise\Ship_systems\Data\Acoustics\ADCP\UHDAS\' Processed data stored in: '\Public\DY158\Scientific work area\VMADCP\'
Long-term management	Data will be stored on the SAN at BAS and will also be available from BODC. Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC).
Users of the data	BIOPOLE, other external collaborators on international projects

Table 70. Description of VMADCP on DY158.

Dataset/Activity	LADCP
Instruments	Teledyne RDI Workforce Sentinel 600 kHz (upward) Teledyne RDI Workforce Monitor 300 kHz (downward)
Description	Ran consistently on 600 kHz (upward) and 300 kHz (downward), free-pinging, no synchronisation between instruments. Set up in narrow-band mode. Measured current velocities, signal return and error in the velocity measured.
Digital data	Raw data: '\current_cruise\Sensors_and_Moorings\LADCP\DY158' Processed data: '\Public\DY158\Scientific work area\LADCP'

Long-term management	Data will be stored on the SAN at BAS and will also be available from BODC. Event metadata will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC).
Users of the data	BIOPOLE, other external collaborators on international projects

Table 71. Description of LMADCP equipment on DY158.

Dataset/Activity	Atmospheric GHG concentrations using mast-fitted instrumentation
Instruments	Tube inlet
Description	Continuous measurements of air
Digital data	Stored within instrumentation
Long-term management	Data will be stored on the SAN at BAS. Event metadata and data collected will be stored within the Marine Metadata Portal developed by the UK Polar Data Centre (PDC).
Users of the data	Evelyn Workman

Table 72. Description of mast-fitted instrumentation on DY158.

Dataset/Activity	P3 deep mooring
Instruments	SBE CTD. RDI ADCP. Seaguard current meters with 2 sensor. SAMI pH sensor. ProCEANUS PCO2 sensor. Aquamonitor. Sediment trap. PPS Phytoplankton collector.
Description	Recovery 2022-12-28. (Deployed by DY098). Redeployed 2022-12-29 Sediment bottles – collecting data on biogeochemical flux POM samples for stable isotope analysis
Digital data	'\DY158\Scientific working area\Moorings_Ecosystems\' '\Public\DY158\'
Long-term management	The primary repository for physical samples will the BAS biological store, where samples will be further examined, described, and analysed post-cruise. Samples from sediment bottles were stored in 4% formaldehyde within the +4 °C fridge. POM stored in -80 °C freezer
Users of the data	Gabi Stowasser, Clara Manno, Povl Abrahamson

Table 73. Description of VMADCP on DY158.

Dataset/Activity	WCB mooring
Instruments	SBE CTD. RADCP. SonoVault acoustic recorder. WBAT echosounder.
Description	Deployment 2023-01-05 (Deployed by DY098). Data from sediment trap was collected to analyse biogeochemical flux.
Digital data	\DY158\Scientific Work Area\Moorings_Ecosystems\

Long-term management	The primary repository for physical samples will the BAS biological store, where samples will be further examined, described, and analysed post-cruise. Samples from sediment bottles were stored in 4% formaldehyde within the +4°C fridge. POM stored in -80 °C freezer
Users of the data	Gabi Stowasser, Clara Manno, Emily Rowlands, Angelika Slomska, Povl Abrahamson, Michael Meredith

Table 74. Description of WCB mooring while on DY158.

Dataset/Activity	ECB mooring
Instruments	SBE CTD. RADCP. SonoVault acoustic recorder. WBAT echosounder.
Description	Deployment 2023-01-06. (Deployed by DY098). Data from sediment trap was collected to analyse biogeochemical flux.
Digital data	\DY158\Scientific Work Area\Moorings_Ecosystems\
Long-term management	The primary repository for physical samples will the BAS biological store, where samples will be further examined, described, and analysed post-cruise. Samples from sediment bottles were stored in 4% formaldehyde within the +4 °C fridge. POM stored in -80 °C freezer
Users of the data	Gabi Stowasser, Clara Manno, Emily Rowlands, Angelika Slomska, Povl Abrahamson, Michael Meredith

Table 75. Description of ECB mooring work while on DY158.

Dataset/Activity	Argo Floats
Instruments	Four Teledyne Webb Research Apex profiling float
Description	Deployed: Argo Float 9619: 2023-01-15 WMO ID = 190291 Argo Float 9618: 2023-01-13 WMO ID = 1902090 Argo Float 9617: 2023-01-11 WMO ID = 1902089
Digital data	No data onboard – data collected going into the Global Argo Array – can be located using WMO ID
Long-term management	Data produced by the Argo floats will be managed and stored at BODC and other Global Data Assembly Centres.
Users of the data	On behalf of the UK Met Office as part of the Global Argo Array for use by the global oceanographic community.

Table 76. Description of Argo float work while on DY158.

Dataset/Activity	M2 Mooring
Instruments	SBE-37, SBE-39, Aquadopp DW (6000 m),
Description	Recovery 2023-01-19. (Deployed by JR18004). Redeployed 2023-01-20
Digital data	For Polar Oceans: \Public\Scientific Work Area\Moorings_PO\ For Eventlog: \Public\Scientific Work Area\Moorings_Eventlog\

Long-term management	All data will be stored at the BODC, Lamont-Doherty Earth Observatory at Columbia University at OceanSITES. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Arnold Gordon, Bruce Huber, Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 77. Description of M2 mooring work while on DY158.

Dataset/Activity	OP1 Mooring
Instruments	Aquadopp DW (6000m), SBE-39, SBE-37SM
Description	Recovery 2023-01-21 (Deployed by JR18004). Redeployed 2023-01-23
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 78. Description of OP1 mooring work while on DY158.

Dataset/Activity	OP2 Mooring
Instruments	SBE-39, SBE-37, Aquadopp DW (6000 m)
Description	Recovery 2023-01-05. (Deployed by JR18004). Redeployed 2023-01-23
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl, Chris, Mike

Table 79. Description of OP2 mooring work while on DY158.

Dataset/Activity	OP3 Mooring
Instruments	SBE-37, SBE-39, Aquadopp DW
Description	Recovery 2023-01-22. (Deployed by JR18004). Redeployed 2023-01-22
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 80. Description of O3 mooring work while on DY158.

Dataset/Activity	OP4 Mooring
Instruments	SBE-37SM, SBE-39, Aquadopp DW (6000 m)
Description	Recovery 2023-01-21. (Deployed by JR18004).
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 81. Description of OP4 mooring work while on DY158.

Dataset/Activity	OP5 Mooring
Instruments	SBE-39, Aquadopp DW (6000 m)
Description	Recovery 2023-01-22. (Deployed by JR18004). Redeployed 2023-01-23
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 82. Description of OP5 mooring work while on DY158.

Dataset/Activity	OP6 Mooring
Instruments	SBE-37SM, Aquadopp DW (6000 m)
Description	Recovery 2023-01-21. (Deployed by JR18004).
Digital data	\Public\Scientific Work Area\Moorings_PO\
Long-term management	All data will be stored at the BODC. All metadata will be stored with the Polar Data Centre (PDC) at BAS.
Users of the data	Povl Abrahamsen, Michael Meredith, Chris Auckland

Table 83. Description of OP6 mooring work while on DY158.

Event log:

Time (GMT)	Event	Comment	Latitude	Longitude
24/12/2022 11:50	1	On station for test deployments	-40.6799	-50.6167
24/12/2022 12:08	1	CTD deployed	-40.6798	-50.617
24/12/2022 12:53	2	Bongo net deployed	-40.6944	-50.6366
24/12/2022 12:58	1	Max wire out 2000 m	-40.6959	-50.6385
24/12/2022 13:07	2	Max wire out 200 m	-40.6986	-50.6421
24/12/2022 13:24	2	Bongo net recovered	-40.7033	-50.6483
24/12/2022 15:08	1	CTD recovered	-40.7395	-50.6965
24/12/2022 16:50	3	RMT8 commence deployment	-40.7380	-50.6946
24/12/2022 16:55	3	Cod Ends deployed	-40.7375	-50.6939
24/12/2022 17:05	3	RMT8 deployed	-40.7338	-50.6891
24/12/2022 17:19	3	All nets fired	-40.7289	-50.6825
24/12/2022 17:36	3	RMT8 recovered	-40.7241	-50.6761
24/12/2022 18:34	4	Sediment trap deployed	-40.7227	-50.6742
24/12/2022 18:53	4	Sediment trap recovered	-40.7227	-50.6742
24/12/2022 19:04		Off station	-40.7227	-50.6742
26/12/2022 13:36	5	On DP for RMT8 deployment	-46.4854	-45.8765
26/12/2022 13:49	5	RMT8 commence deployment	-46.4916	-45.8757
26/12/2022 13:58	5	RMT8 at 240 m wire out	-46.4966	-45.8759
26/12/2022 14:39	5	RMT8 recovered to deck	-46.5202	-45.8745
26/12/2022 14:52		Off station resume passage	-46.5231	-45.8746
28/12/2022 12:28		On DP for talking to mooring	-52.7985	-40.0812
28/12/2022 12:50		Repositioning to new position given for P3	-52.8006	-40.0523
28/12/2022 13:41		In position 500 m east of P3 to talk to mooring	-52.8069	-40.1073
28/12/2022 16:27	6	Release code sent	-52.8069	-40.1074
28/12/2022 16:36	6	Top float on surface	-52.8069	-40.1074
28/12/2022 16:55	6	Commence approach	-52.8069	-40.1075
28/12/2022 17:07	6	Grapnelled	-52.8066	-40.1139
28/12/2022 17:08	6	Recovery wire on	-52.8065	-40.1138
28/12/2022 17:12	6	Mooring astern	-52.8064	-40.1150
28/12/2022 17:16	6	Top float recovered	-52.8065	-40.1158
28/12/2022 17:58	6	Sediment trap recovered	-52.8067	-40.1299
28/12/2022 18:28	6	2nd sediment trap recovered	-52.8074	-40.1366
28/12/2022 19:05	6	Mooring recovery complete	-52.8083	-40.1417
28/12/2022 19:28		In DP at P3 position	-52.8075	-40.1140
28/12/2022 20:26	7	Commenced sediment trap deployment	-52.8074	-40.1141
28/12/2022 21:16	7	Sediment trap deployment complete	-52.8077	-40.1189
28/12/2022 23:04	8	CTD deployed	-52.8079	-40.1139
29/12/2022 00:09	9	Bongo nets deployed	-52.8079	-40.1138
29/12/2022 00:29	8	Max wire out 3715 m	-52.8078	-40.1138
29/12/2022 00:34	9	Bongo nets recovered	-52.8079	-40.1139

Time (GMT)	Event	Comment	Latitude	Longitude
29/12/2022 00:34	10	Bongo nets deployed	-52.8079	-40.1139
29/12/2022 00:46	10	Bongo nets at 200 m start recovery	-52.8079	-40.1139
29/12/2022 00:59	10	Bongo net recovered	-52.8079	-40.1139
29/12/2022 02:23	8	CTD recovered	-52.8079	-40.1139
29/12/2022 04:11	11	CTD deployed	-52.8079	-40.1139
29/12/2022 04:45	11	Max wire out 1000 m	-52.8079	-40.1138
29/12/2022 05:56	11	CTD recovered	-52.8080	-40.1139
29/12/2022 13:53	12	Mammoth net deployed	-52.8074	-40.1141
29/12/2022 14:29	12	Mammoth net max wire out 250 m	-52.8074	-40.1141
29/12/2022 15:01	12	Mammoth net recovered to deck	-52.8074	-40.1142
29/12/2022 15:30		Off station	-52.8074	-40.1141
29/12/2022 16:35		In position for deployment of P3	-52.8538	-40.0764
29/12/2022 17:27	13	Commence P3 deployment	-52.8560	-40.0854
29/12/2022 17:30	13	Top float deployed	-52.8550	-40.0851
29/12/2022 18:47	13	Sediment trap deployed	-52.8228	-40.1047
29/12/2022 20:02	13	Mooring released	-52.8059	-40.1154
29/12/2022 21:30	7	Sediment trap recovery line grappled	-52.8900	-40.0320
29/12/2022 21:49	7	Recovered - wire parted and some parts missing	-52.8859	-40.0340
29/12/2022 22:27		In DP 2nm off P3	-52.8353	-40.0838
29/12/2022 23:18	14	Mammoth net deployed	-52.8353	-40.0839
30/12/2022 00:13	14	Mammoth net at 1080 m commence recovery	-52.8353	-40.0839
30/12/2022 01:49	14	Mammoth net recovered to deck	-52.8352	-40.0836
30/12/2022 02:23	13	In position for 1st trilateration	-52.8289	-40.0932
30/12/2022 03:45	13	2nd tri spot	-52.7847	-40.0930
30/12/2022 03:52	13	3rd tri spot	-52.7868	-40.0909
30/12/2022 03:52		Off station	-52.7869	-40.0910
30/12/2022 08:02	15	Commenced EK80 transect W1.1	-53.3451	-39.6036
30/12/2022 12:47	15	Finish EK80 transect W1.1	-54.0600	-39.3900
30/12/2022 14:07	16	Commenced EK80 transect W1.2	-54.0251	-39.0888
30/12/2022 19:57	16	Finish EK 80 transect W1.2	-53.3158	-39.303
30/12/2022 21:49		In DP on station W1.2CTDN	-53.4919	-39.2508
30/12/2022 22:30	17	CTD deployed	-53.4919	-39.2507
30/12/2022 23:22	17	CTD max wire out 1000 m	-53.4919	-39.2508
31/12/2022 00:11	17	CTD recovered to deck	-53.4919	-39.2508
31/12/2022 00:26		Off station	-53.4919	-39.2508
31/12/2022 04:00		On station W1.2CTDS	-53.8468	-39.143
31/12/2022 04:44	18	CTD Deployed	-53.8467	-39.143
31/12/2022 05:04	18	Max wire out 270 m	-53.8468	-39.143
31/12/2022 05:29	18	CTD recovered	-53.8468	-39.143
31/12/2022 05:46		Off station	-53.8437	-39.1449
31/12/2022 08:04	19	Commenced EK80 transect W2.1	-53.9942	-38.8185
31/12/2022 13:06	19	Finish EK80 transect W2.1	-53.2724	-39.0421
31/12/2022 14:37	20	Start survey transect W2.2	-53.2563	-38.7512

Time (GMT)	Event	Comment	Latitude	Longitude
31/12/2022 19:26	20	Finish EK80 transect W2.2	-53.9626	-38.5267
31/12/2022 19:56		In DP 2nm downwind of krill target	-53.9310	-38.4919
31/12/2022 20:02	21	Approaching krill target at 2 knots	-53.9322	-38.4935
31/12/2022 20:08	21	RMT8 deployed	-53.9348	-38.4970
31/12/2022 21:31	21	RMT8 recovered	-53.9739	-38.5497
31/12/2022 23:06	22	On DP for W2.2CTDS RMT deployment	-53.7772	-38.5546
31/12/2022 23:12	22	Heading for W2.2 position at 2.5 knots	-53.7778	-38.5570
31/12/2022 23:26	22	Deploy RMT8	-53.7821	-38.5726
01/01/2023 00:06	22	RMT8 at depth 215 m	-53.7917	-38.6015
01/01/2023 00:46	22	RMT8 recovered	-53.8001	-38.632
01/01/2023 00:56		Off station	-53.8004	-38.6383
01/01/2023 01:35		On DP W2.2CTDS	-53.7833	-38.5833
01/01/2023 01:40	23	CTD deployed	-53.7833	-38.5834
01/01/2023 01:57	23	Max wire out 195 m	-53.7833	-38.5833
01/01/2023 02:38	23	CTD recovered	-53.7833	-38.5833
01/01/2023 02:59		Off DP for W2.2CTDN	-53.7833	-38.5834
01/01/2023 05:33		W2.2 CTD N ready for RMT8 deployment	-53.4241	-38.6479
01/01/2023 05:40	24	RMT8 deployed	-53.4252	-38.6545
01/01/2023 07:10	24	RMT8 recovered	-53.4465	-38.7341
01/01/2023 07:16		On passage to transect W3.1	-53.4455	-38.7349
01/01/2023 09:11	25	Commence EK80 transect W3.1	-53.2211	-38.4506
01/01/2023 13:52	25	Finish EK80 transect W3.1	-53.9275	-38.2195
01/01/2023 15:09	26	Commence EK80 transect W3.2	-53.8913	-37.9072
01/01/2023 19:42	26	Transect EK80 transect W3.2	-53.1852	-38.1404
01/01/2023 21:00		In DP at W3.2 CTD N	-53.3614	-38.0819
01/01/2023 21:11	27	CTD deployed	-53.3616	-38.0822
01/01/2023 21:25	28	Bongo nets deployed	-53.3616	-38.0822
01/01/2023 21:37	27	Max wire out 1000 m	-53.3615	-38.0822
01/01/2023 21:49	28	Bongo nets recovered	-53.3615	-38.0822
01/01/2023 21:50	29	Bongo nets deployed	-53.3615	-38.0822
01/01/2023 22:02	29	Bongo nets recovered	-53.3615	-38.0823
01/01/2023 22:41	27	CTD recovered	-53.3616	-38.0823
01/01/2023 22:45		Off station	-53.3617	-38.0825
02/01/2023 00:52		On DP for RMT8 deployment	-53.6727	-37.9759
02/01/2023 01:06		Heading to target @2.5kts	-53.6696	-37.9774
02/01/2023 01:23	30	RMT8 deployed	-53.6605	-37.9819
02/01/2023 01:36	30	Max wire out 65 m start haul	-53.6519	-37.9857
02/01/2023 01:57	30	RMT8 recovered to deck, vessel stopped to regear for 2nd deployment	-53.6451	-37.9885
02/01/2023 02:22	31	RMT8 deployed	-53.6419	-37.9895
02/01/2023 02:30	31	Max wire out 65m start haul	-53.6384	-37.9912
02/01/2023 02:53	31	RMT8 recovered	-53.6290	-37.9937

Time (GMT)	Event	Comment	Latitude	Longitude
02/01/2023 03:07		Off station	-53.6249	-37.9951
02/01/2023 05:02		On station W4.2S	-53.6773	-37.6570
02/01/2023 05:08	32	CTD deployed	-53.6772	-37.6551
02/01/2023 05:18	32	CTD max wire 115	-53.6772	-37.6551
02/01/2023 05:55	32	CTD recovered	-53.6773	-37.6550
02/01/2023 06:17		Off station	-53.6778	-37.6563
02/01/2023 08:05	33	Commenced EK80 transect W4.1	-53.8689	-37.7287
02/01/2023 14:07	33	Finish EK80 transect W4.1	-53.1657	-37.9647
02/01/2023 14:50	34	Commenced EK80 transect W4.2	-53.1533	-37.8314
02/01/2023 19:18	34	Finish EK80 transect W4.2	-53.8536	-37.5942
02/01/2023 23:35		On DP at Station WC84.2CTDN	-53.3245	-37.7723
02/01/2023 23:45	35	CTD deployed	-53.3245	-37.7725
03/01/2023 00:15	35	Max wire out 1000 m	-53.3246	-37.7725
03/01/2023 00:59	35	CTD recovered	-53.3245	-37.7725
03/01/2023 01:06		Off DP for RMT8 setup	-53.3245	-37.7725
03/01/2023 01:31		Vessel on DP for RMT8 deployment	-53.3391	-37.7527
03/01/2023 01:38	36	RMT8 deployed	-53.3366	-37.7558
03/01/2023 02:15	36	Max wire out 350 m start haul	-53.3188	-37.7820
03/01/2023 02:54	36	RMT8 recovered	-53.3034	-37.8077
03/01/2023 03:00		Off DP for W3.2CTDS	-53.3021	-37.8095
03/01/2023 05:55		On station W3.2 CTD	-53.7141	-37.9647
03/01/2023 06:02	37	CTD deployed	-53.7147	-37.9658
03/01/2023 06:17	37	Max wire 120 m	-53.7147	-37.9658
03/01/2023 06:47	37	CTD recovered	-53.7147	-37.9658
03/01/2023 11:39	38	Off DP start running ADCP line	-53.7175	-37.9603
03/01/2023 13:00	38	Run reciprocal ADCP line	-53.6591	-38.0826
03/01/2023 14:04	38	Finish ADCP line, repos on DP	-53.7164	-37.9605
03/01/2023 15:20	39	Ready for net deployment @ WPT3.2s	-53.7155	-37.9388
03/01/2023 15:39	39	RMT8 deployed	-53.7155	-37.9391
03/01/2023 16:51	39	RMT8 recovered	-53.7137	-37.9959
03/01/2023 17:10		Off station	-53.7136	-37.997
03/01/2023 18:59	40	In DP for target fishing	-53.6817	-37.6527
03/01/2023 19:01	40	RMT deployed	-53.6810	-37.6534
03/01/2023 19:31	40	RMT recovered	-53.6644	-37.6744
03/01/2023 19:47		Commence EK80 target search	-53.6636	-37.6724
03/01/2023 20:41		In DP for RMT deployment	-53.6620	-37.6911
03/01/2023 21:01	41	RMT deployed	-53.6615	-37.6947
03/01/2023 21:28	41	RMT recovered	-53.6598	-37.7218
03/01/2023 22:24	42	RMT deployed	-53.6694	-37.7741
03/01/2023 22:51	42	RMT recovered	-53.6581	-37.7972
03/01/2023 23:50	43	On DP for bongo deployment (WC84.2CTDS)	-53.6785	-37.6524
03/01/2023 23:55	43	Bongo nets deployed	-53.6782	-37.6527
03/01/2023 23:58	43	Bongo nets stoppered off, respooling	-53.6781	-37.6527

Time (GMT)	Event	Comment	Latitude	Longitude
04/01/2023 01:36	44	Bongo nets redeployed	-53.6780	-37.6527
04/01/2023 01:48	44	Bongo nets max wire out 200 m, start recovery	-53.6780	-37.6527
04/01/2023 02:01	44	Bongo nets recovered	-53.6780	-37.6527
04/01/2023 02:03	45	Bongo nets deployed	-53.6780	-37.6527
04/01/2023 02:08	45	Bongo max wire out 100 m, start recovery	-53.6780	-37.6527
04/01/2023 02:15	45	Bongo nets recovered	-53.6780	-37.6527
04/01/2023 02:25		Off DP en route to Rosita Harbour for trials	-53.6781	-37.6527
04/01/2023 09:38		In DP at Rosita Harbour	-54.0162	-37.4279
04/01/2023 09:55	46	CTD deployed	-54.0166	-37.4292
04/01/2023 10:05	46	Max wire out 45 m	-54.0166	-37.4292
04/01/2023 10:36	46	CTD recovered	-54.0167	-37.4292
04/01/2023 11:22	47	Start of Rosita Bay calibration	-54.0167	-37.4292
04/01/2023 20:27	47	EK80 calibration complete	-54.017	-37.4268
04/01/2023 21:36	48	WBAT 1 deployed	-54.0173	-37.4269
05/01/2023 00:16	48	WBAT recovered	-54.0169	-37.4265
05/01/2023 01:39	49	WBAT deployed	-54.0171	-37.4273
05/01/2023 02:41	49	WBAT recovered	-54.0168	-37.4272
05/01/2023 12:17		On DP for WCB mooring - 500 upwind	-53.7968	-37.9265
05/01/2023 12:35	50	Start mooring deployment, pellet buoy deployed	-53.7967	-37.9261
05/01/2023 13:02	50	Mooring deployed, anchor released	-53.7982	-37.9348
05/01/2023 13:19		On DP for CTD deployment at WCB Mooring (300 m W)	-53.7990	-37.9390
05/01/2023 13:47	51	CTD deployed	-53.7990	-37.9390
05/01/2023 14:03	51	Max wire out 287 m	-53.7990	-37.9390
05/01/2023 14:54	51	CTD recovered	-53.7990	-37.9390
05/01/2023 15:14	52	Bongo nets deployed	-53.7990	-37.9390
05/01/2023 15:31	52	Bongo nets recovered	-53.7990	-37.9390
05/01/2023 15:32	53	Bongo nets redeployed	-53.7990	-37.9390
05/01/2023 15:45	53	Bongo nets recovered	-53.7990	-37.9390
05/01/2023 16:12		Off station	-53.8096	-37.8885
05/01/2023 16:46	54	Begin methane seep survey of Stromness Bay	-53.8432	-37.7483
05/01/2023 23:25	54	Vessel on DP M1 Stromness Bay - End of Survey	-54.1534	-36.6333
05/01/2023 23:33	55	CTD deployed	-54.1535	-36.6334
05/01/2023 23:50	55	Max wire out 108 m	-54.1535	-36.6334
06/01/2023 00:38	55	CTD recovered to deck	-54.1535	-36.6334
06/01/2023 00:48		Vessel off DP enroute to ECB survey	-54.1535	-36.6341
06/01/2023 02:43	56	Start swath survey of ECB mooring site	-54.1340	-36.2948
06/01/2023 07:45	56	Swath survey complete	-54.1182	-36.1407

Time (GMT)	Event	Comment	Latitude	Longitude
06/01/2023 08:22		In DP 650 m downwind of mooring position	-54.1031	-36.2370
06/01/2023 09:04	57	Commenced ECB mooring deployment	-54.1033	-36.2364
06/01/2023 09:27	57	Mooring deployed	-54.1034	-36.2468
06/01/2023 09:48	58	Commenced EK80 transect E1.1	-54.0968	-36.2618
06/01/2023 14:14	58	Finish EK80 transect E1.1	-53.6925	-35.2559
06/01/2023 14:33		On DP ECB1.1N	-53.6899	-35.251
06/01/2023 14:43	59	CTD deployed	-53.6901	-35.2516
06/01/2023 15:13	59	Max wire 1000 m	-53.6901	-35.2516
06/01/2023 15:52	59	CTD recovered	-53.6901	-35.2516
06/01/2023 15:59		Off station	-53.6900	-35.2516
06/01/2023 16:58	60	Start EK80 transect E1.2	-53.7697	-35.1626
06/01/2023 22:19	60	Finish EK80 transect E1.2	-54.1733	-36.1744
06/01/2023 22:57		In DP 200m off ECB mooring	-54.1046	-36.2426
06/01/2023 23:11	61	CTD deployed	-54.1042	-36.2425
06/01/2023 23:34	61	Max wire out 257 m	-54.1042	-36.2425
07/01/2023 00:17	61	CTD recovered to deck	-54.1042	-36.2426
07/01/2023 00:25		Vessel off DP	-54.1043	-36.2426
07/01/2023 09:42		In DP at A23-52	-55.2154	-34.5082
07/01/2023 09:51	62	CTD deployed	-55.2154	-34.5082
07/01/2023 10:17	62	Max wire out 541 m	-55.2154	-34.5081
07/01/2023 11:08	62	CTD recovered	-55.2154	-34.5081
07/01/2023 11:11		Off station heading for A23-15A	-55.2154	-34.5081
07/01/2023 11:35		In DP at A23-51A	-55.2300	-34.4904
07/01/2023 11:44	63	CTD deployed	-55.2302	-34.4899
07/01/2023 11:53	64	Bongo nets deployed	-55.2302	-34.4900
07/01/2023 12:05	64	Bongo nets max wire out 200 m	-55.2302	-34.4900
07/01/2023 12:15	63	Max wire out 1015 m	-55.2302	-34.4900
07/01/2023 12:18	64	Bongo nets recovered	-55.2302	-34.4900
07/01/2023 12:20	65	Bongo nets deployed	-55.2302	-34.4900
07/01/2023 12:24	65	Max wire on Bongo net 100 m	-55.2302	-34.4900
07/01/2023 12:31	65	Bongo nets recovered	-55.2302	-34.4900
07/01/2023 13:12	63	CTD recovered	-55.2302	-34.4900
07/01/2023 13:13		Off DP	-55.2302	-34.4900
07/01/2023 14:09		On DP A23-52	-55.2592	-34.4436
07/01/2023 14:11	66	CTD deployed	-55.2593	-34.4436
07/01/2023 14:49	66	Max wire out 1491 m	-55.2597	-34.4435
07/01/2023 15:37	66	CTD recovered	-55.2597	-34.4435
07/01/2023 15:41		Off station	-55.2596	-34.4435
07/01/2023 16:19		On station A23-50A	-55.2894	-34.3997
07/01/2023 16:26	67	CTD deployed	-55.2899	-34.3995
07/01/2023 17:15	67	Max wire out 2058 m	-55.2898	-34.3995
07/01/2023 18:29	67	CTD recovered	-55.2896	-34.3995
07/01/2023 18:37		Off station	-55.2899	-34.3991

Time (GMT)	Event	Comment	Latitude	Longitude
07/01/2023 20:25		In DP at A23-50	-55.4840	-34.1332
07/01/2023 20:30	68	CTD deployed	-55.4845	-34.1331
07/01/2023 21:27	68	Max wire out 2442 m	-55.4845	-34.1331
07/01/2023 21:58	69	Bongo nets deployed	-55.4846	-34.1330
07/01/2023 22:08	69	Bongo nets recovered	-55.4845	-34.1330
07/01/2023 22:48	68	CTD recovered	-55.4845	-34.1330
07/01/2023 22:57		Off station	-55.4857	-34.1315
08/01/2023 01:13		Vessel on DP A23-49	-55.7247	-33.7846
08/01/2023 01:14	70	CTD deployed	-55.7248	-33.7846
08/01/2023 02:29	70	Max wire out 3509 m	-55.7251	-33.7848
08/01/2023 04:43	70	CTD recovered	-55.7251	-33.7849
08/01/2023 04:55		Off station	-55.7251	-33.7849
08/01/2023 07:20		In DP on station A23-48	-55.9898	-33.4189
08/01/2023 07:26	71	CTD deployed	-55.9901	-33.4191
08/01/2023 08:30	71	Max wire out 3020 m	-55.9902	-33.4192
08/01/2023 09:19	72	Bongo nets deployed	-55.9902	-33.4192
08/01/2023 09:31	72	Max wire out 200 m	-55.9902	-33.4192
08/01/2023 09:43	72	Bongo nets recovered	-55.9902	-33.4192
08/01/2023 09:46	73	Bongo nets deployed	-55.9902	-33.4192
08/01/2023 09:52	73	Max wire out 100 m	-55.9902	-33.4192
08/01/2023 09:57	71	CTD recovered	-55.9902	-33.4192
08/01/2023 09:59	73	Bongo nets recovered	-55.9902	-33.4192
08/01/2023 10:10		Off station	-55.9905	-33.4189
08/01/2023 13:28		Vessel on DP A23-47	-56.3813	-32.8725
08/01/2023 13:36	74	CTD deployed	-56.3811	-32.8724
08/01/2023 14:45	74	Max wire out 3112 m	-56.3811	-32.8725
08/01/2023 16:27	74	CTD recovered	-56.3811	-32.8725
08/01/2023 16:38		Off station	-56.3810	-32.8725
08/01/2023 19:56		In DP on station A23-46	-56.7749	-32.3043
08/01/2023 20:08	75	CTD deployed	-56.7755	-32.3037
08/01/2023 21:15	75	Max wire out 3205 m	-56.7755	-32.3037
08/01/2023 22:05	76	Bongo nets deployed	-56.7755	-32.3037
08/01/2023 22:11	76	Max wire out 100 m	-56.7755	-32.3038
08/01/2023 22:19	76	Bongo nets recovered	-56.7755	-32.3038
08/01/2023 22:51	75	CTD recovered	-56.7755	-32.3037
08/01/2023 22:59		Off station	-56.7762	-32.3037
09/01/2023 01:46		Vessel on DP A23-45	-57.1179	-31.8142
09/01/2023 01:52	77	CTD deployed	-57.1181	-31.8143
09/01/2023 03:01	77	Max wire out 3395 m	-57.1184	-31.8143
09/01/2023 05:03	77	CTD recovered	-57.1184	-31.8143
09/01/2023 05:13		Off station	-57.1194	-31.8134
09/01/2023 07:55		In DP on station A23-44	-57.4583	-31.3272
09/01/2023 08:02	78	CTD deployed	-57.4583	-31.3272
09/01/2023 09:05	79	Bongo nets deployed	-57.4583	-31.3272
09/01/2023 09:15	79	Max wire out 200 m	-57.4583	-31.3272

Time (GMT)	Event	Comment	Latitude	Longitude
09/01/2023 09:23	78	Max wire out 3735 m	-57.4583	-31.3272
09/01/2023 09:28	79	Bongo nets recovered	-57.4582	-31.3272
09/01/2023 11:08	78	CTD recovered	-57.4582	-31.3272
09/01/2023 11:21		Vessel off DP heading south towards A23-24	-57.4612	-31.3291
11/01/2023 06:00		On station A23-24	-63.9645	-28.8740
11/01/2023 06:06	80	CTD deployed	-63.9646	-28.8740
11/01/2023 07:48	80	Max wire out 4755 m	-63.9646	-28.8741
11/01/2023 09:06	81	Bongo nets deployed	-63.9646	-28.8740
11/01/2023 09:17	81	Max wire out 200 m	-63.9645	-28.8740
11/01/2023 09:28	81	Bongo nets recovered	-63.9645	-28.8740
11/01/2023 10:25	80	CTD recovered	-63.9645	-28.8740
11/01/2023 10:39	82	Argo float deployed	-63.9642	-28.8761
11/01/2023 10:40		Off station	-63.9637	-28.8775
11/01/2023 15:16		On station A23-25	-63.3467	-29.5688
11/01/2023 15:19	83	CTD deployed	-63.3467	-29.5688
11/01/2023 16:48	83	Max wire 4694 m	-63.3467	-29.5689
11/01/2023 19:11	83	CTD recovered	-63.3467	-29.5688
11/01/2023 19:19		Off station	-63.3461	-29.5676
11/01/2023 21:51		In DP on station A23-26	-63.0723	-30.1157
11/01/2023 21:54	84	CTD deployed	-63.0723	-30.1156
11/01/2023 22:45	85	Bongo nets deployed	-63.0726	-30.1153
11/01/2023 22:51	85	Max wire out 100 m	-63.0726	-30.1153
11/01/2023 22:57	85	Bongo nets recovered	-63.0726	-30.1153
11/01/2023 23:27	84	CTD max wire out 4840 m	-63.0726	-30.1153
12/01/2023 01:19	84	CTD recovered to deck	-63.0726	-30.1152
12/01/2023 01:29		Vessel off station for A23-27	-63.0726	-30.1152
12/01/2023 04:06	86	On station A23-27	-62.7822	-30.6938
12/01/2023 04:11	86	CTD deployed	-62.7825	-30.6944
12/01/2023 05:46	86	Max wire 4791 m	-62.7826	-30.6942
12/01/2023 08:20	86	CTD recovered	-62.7826	-30.6943
12/01/2023 08:29		Off station	-62.7824	-30.6945
12/01/2023 11:04		Vessel on DP at A23-28	-62.4912	-31.2605
12/01/2023 11:10	87	CTD deployed	-62.4910	-31.2605
12/01/2023 11:30	88	Bongo nets deployed	-62.4910	-31.2605
12/01/2023 11:48	88	Max wire out 200 m	-62.4910	-31.2605
12/01/2023 11:59	88	Bongo nets recovered	-62.4910	-31.2605
12/01/2023 12:01	89	Bongo nets deployed	-62.4910	-31.2605
12/01/2023 12:07	89	Max wire 100 m	-62.4910	-31.2605
12/01/2023 12:14	89	Bongo nets recovered	-62.4910	-31.2605
12/01/2023 12:44	87	Max wire out 4723 m	-62.4910	-31.2605
12/01/2023 14:57	87	CTD recovered	-62.4912	-31.2606
12/01/2023 15:03		Off station	-62.4912	-31.2606
12/01/2023 17:50		On station A23-29	-62.0758	-31.1828
12/01/2023 17:53	90	CTD Deployed	-62.0758	-31.1829

Time (GMT)	Event	Comment	Latitude	Longitude
12/01/2023 19:24	90	Max wire out 4812 m	-62.0758	-31.1829
12/01/2023 21:50	90	CTD recovered	-62.0758	-31.1829
12/01/2023 21:52		Off station	-62.0757	-31.1827
13/01/2023 00:44		Vessel on DP A23-30	-61.6600	-31.1088
13/01/2023 00:50	91	CTD deployed	-61.6602	-31.109
13/01/2023 01:09	92	Bongo nets deployed	-61.6603	-31.1092
13/01/2023 01:13	92	Max wire 100 m	-61.6603	-31.1092
13/01/2023 01:20	92	Bongo nets recovered	-61.6603	-31.1092
13/01/2023 02:00	91	Max wire out 3357 m	-61.6604	-31.1092
13/01/2023 03:25	91	CTD recovered	-61.6603	-31.1092
13/01/2023 03:33	93	Argo float deployed	-61.6603	-31.1092
13/01/2023 03:34		Off station	-61.6602	-31.1092
13/01/2023 04:42		On station A23-31	-61.5507	-31.1043
13/01/2023 04:48	94	CTD deployed	-61.5508	-31.1043
13/01/2023 06:08	94	Max wire out 4028 m	-61.5505	-31.1043
13/01/2023 07:46	94	CTD recovered	-61.5505	-31.1043
13/01/2023 07:56		Off station	-61.5513	-31.1037
13/01/2023 10:31		In DP on station A23-32	-61.1706	-31.0460
13/01/2023 10:34	95	CTD deployed	-61.1707	-31.0460
13/01/2023 11:05	96	Bongo nets deployed	-61.1707	-31.0460
13/01/2023 11:14	96	Max wire out 200 m	-61.1707	-31.0460
13/01/2023 11:26	96	Bongo nets recovered	-61.1707	-31.0460
13/01/2023 11:27	97	Bongo nets deployed	-61.1707	-31.0460
13/01/2023 11:32	97	Max wire out 100 m	-61.1707	-31.0460
13/01/2023 11:37	97	Bongo net recovered to deck	-61.1707	-31.0460
13/01/2023 11:48	95	Max wire out 3447 m	-61.1707	-31.0460
13/01/2023 13:50	95	CTD recovered	-61.1707	-31.0460
13/01/2023 13:55		Vessel off DP for A23-33	-61.1707	-31.0460
13/01/2023 14:32		Vessel on DP A23-33	-61.1096	-31.0405
13/01/2023 14:48	98	CTD deployed	-61.1096	-31.0405
13/01/2023 15:46	98	Max wire out 2566 m	-61.1096	-31.0405
13/01/2023 17:08	98	CTD recovered	-61.1097	-31.0405
13/01/2023 17:16		Off station	-61.1096	-31.0402
13/01/2023 20:21		In DP on station A23-34	-60.6997	-31.0095
13/01/2023 20:26	99	CTD deployed	-60.6997	-31.0095
13/01/2023 20:35		USBL deployed	-60.6997	-31.0095
13/01/2023 21:09	100	Bongo nets deployed	-60.6997	-31.0096
13/01/2023 21:10	99	Max wire out 1609 m	-60.6997	-31.0096
13/01/2023 21:13	100	Max wire out 100 m	-60.6997	-31.0095
13/01/2023 21:20	100	Bongo nets recovered	-60.6997	-31.0096
13/01/2023 22:06		USBL recovered	-60.6997	-31.0095
13/01/2023 22:23	99	CTD recovered	-60.6997	-31.0095
13/01/2023 22:31		Off station	-60.6977	-31.0057
14/01/2023 01:15		Vessel on DP A23-35	-60.3150	-30.9570
14/01/2023 01:21	101	CTD deployed	-60.3150	-30.9570

Time (GMT)	Event	Comment	Latitude	Longitude
14/01/2023 02:20	101	Max wire out 2668 m	-60.3150	-30.9569
14/01/2023 03:58	101	CTD recovered	-60.3150	-30.9569
14/01/2023 04:05		Off station	-60.3152	-30.9573
14/01/2023 06:24		On station A2-36	-59.9955	-30.9295
14/01/2023 06:32	102	CTD Deployed	-59.9952	-30.9292
14/01/2023 07:39	102	Max wire out 2967 m	-59.9952	-30.9292
14/01/2023 09:31	102	CTD recovered	-59.9952	-30.9289
14/01/2023 09:41		Off station	-59.9954	-30.9250
14/01/2023 11:30		On DP A23-37	-59.7658	-30.9049
14/01/2023 11:42	103	CTD deployed	-59.7658	-30.9051
14/01/2023 13:03	103	Max wire 3762 m	-59.7659	-30.9048
14/01/2023 16:21	103	CTD recovered	-59.7666	-30.9049
14/01/2023 17:17		CTD deployed	-59.7666	-30.9072
14/01/2023 17:26	104	Bongo nets deployed	-59.7666	-30.9071
14/01/2023 17:32	104	Max wire out 200 m	-59.7666	-30.9071
14/01/2023 17:48	104	Bongo nets recovered	-59.7666	-30.9071
14/01/2023 17:50	105	Bongo nets deployed	-59.7666	-30.9071
14/01/2023 17:55	105	Max wire out 100 m	-59.7666	-30.9072
14/01/2023 18:02	105	Bongo recovered	-59.7666	-30.9072
14/01/2023 20:24		CTD recovered	-59.7667	-30.9071
14/01/2023 20:29		Off station	-59.7670	-30.9073
14/01/2023 23:10		Vessel on DP A23-39	-59.4364	-30.8597
14/01/2023 23:15	106	CTD deployed	-59.4364	-30.8597
15/01/2023 00:04	107	Bongo nets deployed	-59.4364	-30.8597
15/01/2023 00:10	107	Max wire out 100 m	-59.4364	-30.8598
15/01/2023 00:16	107	Bongo nets recovered	-59.4364	-30.8597
15/01/2023 00:27	106	Max wire 3420 m	-59.4364	-30.8597
15/01/2023 02:24	106	CTD recovered	-59.4364	-30.8597
15/01/2023 02:30		Off DP enroute for A23-40	-59.4364	-30.8597
15/01/2023 05:25		On station A23-40	-59.0505	-30.8290
15/01/2023 05:34	108	CTD Deployed	-59.0502	-30.8290
15/01/2023 06:45	108	Max wire 3093 m	-59.0502	-30.8290
15/01/2023 08:37	108	CTD recovered	-59.0502	-30.8290
15/01/2023 08:46		Off station	-59.0497	-30.8288
15/01/2023 11:35		On DP A23-41	-58.6342	-30.8241
15/01/2023 11:44	109	CTD deployed	-58.6346	-30.8241
15/01/2023 11:59	110	Bongo nets deployed	-58.6346	-30.8241
15/01/2023 12:12	110	Max wire out 200 m	-58.6346	-30.8241
15/01/2023 12:23	110	Bongo nets recovered	-58.6346	-30.8240
15/01/2023 12:25	111	Bongo nets deployed	-58.6346	-30.8241
15/01/2023 12:31	111	Max wire out 100 m	-58.6345	-30.8241
15/01/2023 12:39	111	Bongo nets recovered	-58.6345	-30.8241
15/01/2023 13:00	109	Max wire out 3503 m	-58.6345	-30.8240
15/01/2023 15:01	109	CTD recovered	-58.6345	-30.8241
15/01/2023 15:10	112	Argo float deployed	-58.6344	-30.8240

Time (GMT)	Event	Comment	Latitude	Longitude
15/01/2023 15:11		Off station	-58.6344	-30.8240
15/01/2023 17:58		On station A23-42	-58.2123	-30.8212
15/01/2023 18:02	113	CTD Deployed	-58.2128	-30.8210
15/01/2023 19:19	113	Max wire out 3967 m	-58.2128	-30.8211
15/01/2023 20:35	114	Bongo nets deployed	-58.2128	-30.8210
15/01/2023 20:41	114	Max wire out 100 m	-58.2128	-30.8210
15/01/2023 20:48	114	Bongo nets recovered	-58.2128	-30.8210
15/01/2023 21:12	113	CTD recovered	-58.2128	-30.8210
15/01/2023 21:19		Off station	-58.2129	-30.8210
16/01/2023 00:05		Vessel on DP A23-43	-57.8015	-30.8316
16/01/2023 00:09	115	CTD deployed	-57.8015	-30.8316
16/01/2023 01:22	115	Max wire out 3550 m	-57.8015	-30.8316
16/01/2023 03:22	115	CTD recovered	-57.8015	-30.8316
16/01/2023 03:34		Off station	-57.8017	-30.8316
18/01/2023 21:09		In DP 500 m downwind M2	-62.6138	-43.2286
18/01/2023 21:15		Releasers fired - no decrease in range	-62.6137	-43.2287
18/01/2023 22:05		Off station	-62.6136	-43.2288
19/01/2023 08:48		In DP 500 m off M2	-62.6155	-43.2294
19/01/2023 09:45		Preparing dragging gear	-62.6150	-43.2322
19/01/2023 14:04	116	Weight deployed for M2 mooring drag	-62.6158	-43.2347
19/01/2023 16:29	116	Commence shift	-62.6158	-43.2348
19/01/2023 17:30	116	Move complete	-62.6121	-43.2341
19/01/2023 18:09	116	Mooring rising	-62.6121	-43.2339
19/01/2023 20:48	116	First dragging anchor recovered	-62.6032	-43.2447
19/01/2023 22:20	116	Dragging gear recovery complete	-62.5995	-43.2638
19/01/2023 23:26	116	Mooring fully recovered to deck	-62.6006	-43.2812
20/01/2023 01:23	117	CTD deployed	-62.6150	-43.2438
20/01/2023 01:38	118	Bongo nets deployed	-62.6150	-43.2439
20/01/2023 01:50	118	Max wire out 200 m	-62.6151	-43.2439
20/01/2023 02:00	118	Bongo nets recovered	-62.6151	-43.2439
20/01/2023 02:02	119	Bongo nets deployed	-62.6151	-43.2439
20/01/2023 02:11	119	Max wire 100 m	-62.6151	-43.2439
20/01/2023 02:25	119	Bongo nets recovered	-62.6151	-43.2439
20/01/2023 02:25	117	Max wire out 3018 m	-62.6151	-43.2439
20/01/2023 04:16	117	CTD recovered	-62.6151	-43.2439
20/01/2023 04:33		Off station to reposition for mooring deployment	-62.6152	-43.2414
20/01/2023 07:00		In DP 3000m downwind of M2 drop position	-62.6176	-43.1829
20/01/2023 09:24	120	Commenced M2 deployment	-62.6175	-43.1832
20/01/2023 10:47	120	Anchor released - monitoring descent	-62.6154	-43.2454
20/01/2023 11:29	120	Trilaterate position 1. 274Tx1000 m from drop pos	-62.6148	-43.2623

Time (GMT)	Event	Comment	Latitude	Longitude
20/01/2023 11:55	120	Trilaterate postion 2 153T x 1000 m	-62.6234	-43.2345
20/01/2023 12:15	120	Trilaterate position. 034T x 1000 m from drop pos	-62.6081	-43.2318
20/01/2023 12:20		Off DP enroute to OP1 CTD	-62.6077	-43.2324
21/01/2023 01:23		Vessel on DP 500 m South East of OP1 mooring	-60.6308	-42.0867
21/01/2023 01:24	121	CTD deployed	-60.6308	-42.0868
21/01/2023 01:39	122	Bongo nets deployed	-60.6311	-42.0874
21/01/2023 01:50	122	Max wire out 200 m	-60.6312	-42.0875
21/01/2023 02:02	122	Bongo nets recovered	-60.6312	-42.0875
21/01/2023 02:04	123	Bongo nets deployed	-60.6312	-42.0875
21/01/2023 02:15	123	Max wire out 200 m	-60.6312	-42.0875
21/01/2023 02:26	123	Bongo nets recovered	-60.6312	-42.0875
21/01/2023 02:40	121	Max wire out 3632 m	-60.6312	-42.0874
21/01/2023 04:12	121	CTD recovered	-60.6310	-42.0877
21/01/2023 04:18		Off station	-60.6309	-42.0883
21/01/2023 05:00		On station OP3	-60.6534	-42.2205
21/01/2023 05:28	124	CTD deployed	-60.6534	-42.2205
21/01/2023 06:13	124	Max wire 1826 m	-60.6534	-42.2205
21/01/2023 07:23	124	CTD recovered	-60.6534	-42.2205
21/01/2023 07:29		Off station	-60.6536	-42.2204
21/01/2023 08:07		In DP 500 m downwind OP1	-60.6277	-42.0782
21/01/2023 08:18	125	OP1 released & ascending	-60.6279	-42.0792
21/01/2023 09:12	125	Recovery line hooked on	-60.6245	-42.0892
21/01/2023 10:52	125	Recovery complete	-60.6332	-42.1308
21/01/2023 11:00		Relocate to OP2 mooring recovery position	-60.6335	-42.1329
21/01/2023 11:27		In position 500 m off OP2 Mooring	-60.6403	-42.1614
21/01/2023 11:42	126	Mooring released	-60.6403	-42.1614
21/01/2023 11:58	126	Mooring sighted	-60.6403	-42.1614
21/01/2023 12:29	126	Recovery line hooked on	-60.6363	-42.1718
21/01/2023 13:52	126	Mooring recovered to deck	-60.6494	-42.2043
21/01/2023 13:55		Off DP enroute to OP4	-60.6504	-42.2067
21/01/2023 15:26	127	On station OP4	-60.5861	-41.8204
21/01/2023 16:17	127	On surface	-60.5890	-41.8197
21/01/2023 16:57	127	First package recovered	-60.5929	-41.8174
21/01/2023 17:41	127	Recovery complete	-60.5967	-41.8421
21/01/2023 18:54	128	On station OP6	-60.5653	-41.6238
21/01/2023 19:03	128	Mooring released & ascending	-60.5651	-41.6254
21/01/2023 19:40	128	Hooked on	-60.5671	-41.6285
21/01/2023 20:10	128	Mooring recovered	-60.5669	-41.6456
21/01/2023 20:56	129	In DP at OP6	-60.5643	-41.6329
21/01/2023 21:16		CTD inoperative	-60.5626	-41.6325
21/01/2023 21:49	129	CTD deployed	-60.5626	-41.6325
21/01/2023 22:10	130	Bongo nets deployed	-60.5626	-41.6326
21/01/2023 22:20	130	Max wire 200 m	-60.5626	-41.6326

Time (GMT)	Event	Comment	Latitude	Longitude
21/01/2023 22:29	130	Bongo nets recovered	-60.5626	-41.6325
21/01/2023 22:31	131	Bongo nets deployed	-60.5626	-41.6325
21/01/2023 22:38	129	Max wire out 2285 m	-60.5626	-41.6326
21/01/2023 22:40	131	Max wire out 200 m	-60.5626	-41.6326
21/01/2023 22:50	131	Bongo net recovered	-60.5626	-41.6326
21/01/2023 23:52	129	CTD recovered to deck	-60.5626	-41.6325
22/01/2023 00:00		Off DP for OP4 CTD	-60.5626	-41.6325
22/01/2023 00:56		On DP at OP4	-60.5900	-41.8287
22/01/2023 01:06	132	CTD deployed	-60.5900	-41.8287
22/01/2023 02:06	132	CTD max wire out 2919 m	-60.5900	-41.8287
22/01/2023 03:41	132	CTD recovered	-60.5900	-41.8287
22/01/2023 03:49		Off station	-60.5905	-41.8292
22/01/2023 04:50		On station OP5	-60.6074	-41.9665
22/01/2023 04:59	133	CTD deployed	-60.6073	-41.9669
22/01/2023 06:11	133	Max wire 3357 m	-60.6073	-41.9669
22/01/2023 07:38	133	CTD recovered	-60.6073	-41.9669
22/01/2023 11:04	134	OP5 released & ascending	-60.6094	-41.9685
22/01/2023 11:39	134	Mooring sighted	-60.609	-41.9698
22/01/2023 12:01	134	Mooring grappled	-60.6065	-41.9749
22/01/2023 12:29	134	Mooring recovered	-60.6048	-41.9861
22/01/2023 12:31		Heading to OP3	-60.6047	-41.9868
22/01/2023 13:37		On DP 500 m downwind of OP3 Mooring	-60.6585	-42.2202
22/01/2023 13:44	135	Mooring released	-60.6591	-42.2213
22/01/2023 13:55	135	Mooring sighted	-60.6590	-42.2242
22/01/2023 14:20	135	Mooring grappled	-60.6557	-42.2259
22/01/2023 15:00	135	Mooring recovered to deck	-60.6513	-42.2400
22/01/2023 16:34	136	Commence OP3 deployment	-60.6700	-42.2030
22/01/2023 17:38	136	Deployment complete	-60.6558	-42.2288
22/01/2023 18:21		Off station	-60.6549	-42.2292
22/01/2023 18:52	137	Commence Sediment trap deployment	-60.6424	-42.1633
22/01/2023 19:04	137	Sediment trap deployed	-60.6417	-42.1659
22/01/2023 19:08		On station OP2	-60.6411	-42.1689
22/01/2023 19:27	138	CTD deployed	-60.6413	-42.1692
22/01/2023 19:38	139	Bongo nets deployed	-60.6413	-42.1692
22/01/2023 19:47	139	Max wire out 200 m	-60.6413	-42.1692
22/01/2023 19:57	139	Recovered	-60.6413	-42.1692
22/01/2023 19:58	140	Bongo nets deployed	-60.6413	-42.1692
22/01/2023 20:07	140	Max wire out 200 m	-60.6413	-42.1692
22/01/2023 20:17	140	Recovered	-60.6413	-42.1692
22/01/2023 20:36	138	Max wire out 3122 m	-60.6413	-42.1691
22/01/2023 22:11	138	CTD recovered	-60.6413	-42.1692
22/01/2023 22:14		Off station	-60.6410	-42.1680
22/01/2023 22:43		On station between OPCTD8 & 9	-60.6343	-42.1292

Time (GMT)	Event	Comment	Latitude	Longitude
22/01/2023 23:03	141	CTD deployed	-60.6341	-42.1290
23/01/2023 00:15	141	3528 m max wire out	-60.6340	-42.1296
23/01/2023 01:31	141	CTD recovered	-60.6341	-42.1290
23/01/2023 01:36		Off DP for between OP11 & OP12	-60.6341	-42.1289
23/01/2023 02:14		On DP between OP11 & OP12	-60.6212	-42.0272
23/01/2023 02:28	142	CTD deployed	-60.6207	-42.0287
23/01/2023 03:38	142	Max wire out 3473 m	-60.6207	-42.0287
23/01/2023 05:01	142	CTD recovered	-60.6207	-42.0287
23/01/2023 05:15	142	Off station	-60.6202	-42.0276
23/01/2023 06:42		In DP 6000 m downwind OP1	-60.6264	-41.9687
23/01/2023 09:24	143	Commenced OP1 deployment	-60.6231	-41.9740
23/01/2023 11:31	143	OP1 Mooring deployed	-60.6311	-42.0938
23/01/2023 11:45		In position 4200m downwind of OP2 mooring deployent position	-60.6314	-42.1016
23/01/2023 13:07	144	Commence mooring deployment (OP2)	-60.6300	-42.1023
23/01/2023 14:27	144	OP2 Mooring deployed	-60.6444	-42.1726
23/01/2023 14:36		Off DP for OP5 deployment	-60.6449	-42.1760
23/01/2023 15:42	145	On station OP5 mooring deployment	-60.6082	-41.9538
23/01/2023 16:28	145	Commence deployment	-60.6087	-41.9543
23/01/2023 17:06	145	Deployed	-60.6134	-41.9732
23/01/2023 17:10	145	Off station	-60.6145	-41.9788
23/01/2023 17:44	137	Sediment trap hooked	-60.6058	-41.9971
23/01/2023 17:50	137	Float onboard	-60.6062	-41.9972
23/01/2023 18:03	137	Recovered	-60.6077	-42.0010
23/01/2023 18:07		Off station	-60.6078	-42.0012
23/01/2023 18:25		Commence trilateration	-60.5915	-41.9633
23/01/2023 22:03		On station OPCTD4	-60.6653	-42.2559
23/01/2023 22:04		Trilateration complete	-60.6653	-42.2559
23/01/2023 22:28	147	CTD deployed	-60.6653	-42.2560
23/01/2023 22:47	148	Bongo net deployed	-60.6653	-42.2560
23/01/2023 22:55	148	Max wire 200 m	-60.6653	-42.2560
23/01/2023 23:04	147	Max wire out 1510 m	-60.6653	-42.2559
23/01/2023 23:04	148	Bongo nets recovered	-60.6653	-42.2560
23/01/2023 23:07	149	Bongo nets deployed	-60.6653	-42.2560
23/01/2023 23:16	149	Max wire out 200m	-60.6653	-42.2560
23/01/2023 23:25	149	Bongo nets recovered	-60.6653	-42.2560
24/01/2023 00:15	147	CTD recovered to deck	-60.6653	-42.2560
24/01/2023 00:25		Off DP	-60.6648	-42.2568
24/01/2023 11:10		On DP for fishing deployment	-60.4095	-45.1908
24/01/2023 11:25		Off DP resume passage due to fishing vessel proximity and fog	-60.4097	-45.1939
24/01/2023 16:19	150	Target fishing South Orkneys in position	-60.4401	-46.5662
24/01/2023 16:26	150	RMT8 deployed	-60.4400	-46.5649
24/01/2023 17:18	150	RMT8 recovered	-60.4371	-46.5067

Time (GMT)	Event	Comment	Latitude	Longitude
24/01/2023 17:31		Resume passage	-60.4360	-46.5002
25/01/2023 04:30	151	Commenced A76 underway sampling profile	-59.3041	-48.4622
26/01/2023 02:15	151	A76 underway profile complete	-59.3185	-48.4574

Table 84. Bridge log for DY158.