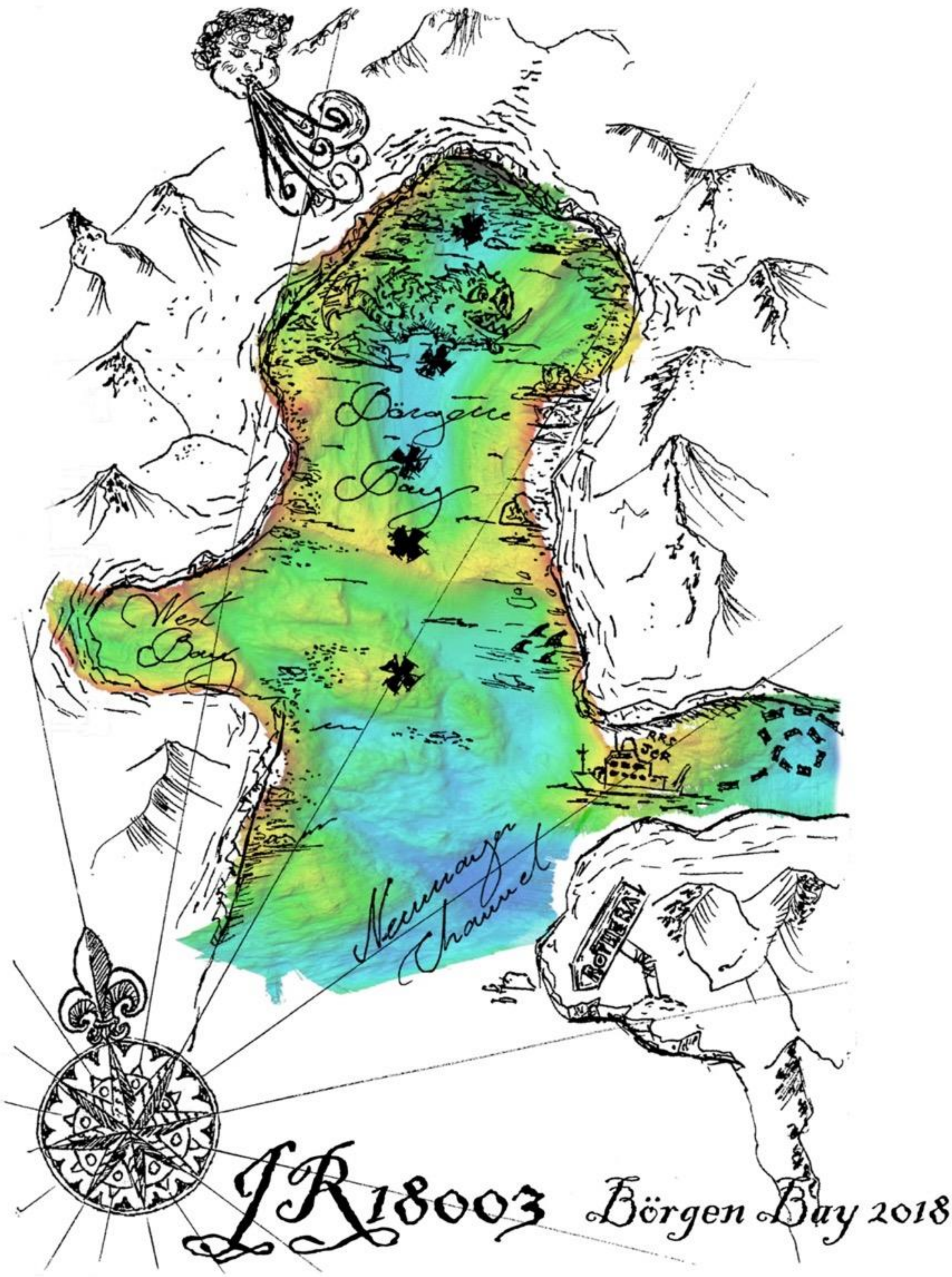
# JR18003 Cruise Report

ICEBERGS RACETRAX OCTONAUT MMA
PALEOMAP GLARE



Report Authors

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2nd – 31st December 2018 Stanley (FI) – West Antarctic Peninsula – Punta Arenas (Chile)

*Reconnaissance mission to Badgers Buttress, Adelaide Island, to assess ice conditions in Sheldon Cove*

Front cover artwork by Alejandro Roman-Gonzalez

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# 1. Objectives

JR18003 on the RRS James Clark Ross integrated science from three funded programs, three CASS programs and several bolt on collaboration projects. It included scientists from 14 institutes across the UK, US, Chile, Italy, Japan, Canada, Norway and Falkland Islands. The work on board started with a marine bathymetry survey and benthic sampling along the Burdwood Bank as part of a Darwin Plus funded project involving the South Atlantic Environment Research institute (SAERI) and British Antarctic Survey (BAS). The aim was to gather data to help inform management decisions regarding Falkland Island Government marine spatial planning. The two expert marine geophysical scientists on board as part of the ICEBERGS program were key in maximising the data quality collected over the limited time of the survey.

The main component of the expedition were the ICEBERGS and RACETRAX programs. ICEBERGS is a 3 year NERC-CONICYT funded grant to University of Concepción (Chile), University of Exeter, Bangor University and BAS. The project was to better understand through quantitative sampling the effects of glacial retreat on marine biological systems. The diverse team includes geologists, marine geochemists, biochemists, marine ecologists, oceanographers, evolutionary biologists, hydrographers and paelontologists. In the early stages of preparation the RACETRAX project, written to integrate into ICEBERGS, was awarded to Dr Amber Annett (University of Southampton), further diversifying the scope of ICEBERGS. The RACETRAX project aims to identify and characterise the nutrient mineral availability and origins in each of the fjord systems.

Three CASS funded projects added extra dimensions to the work at each of the fjords. The OCTONAUT project (Dr Katy Sheen) investigates the oceanographic processes contributing to melting icesheets and regulating discharge of melt water. The key piece of equipment contributed to the program was the VMP to assess turbulence mixing and was to be deployed between CTD casts. We were able to dedicate blocks of time to the VMP team in order to conduct transects across shallow sills increasing the spatial and temporal resolution of the study. The GLARE project (James Williams on board) closely integrated with RACETRAX and OCTONAUT as it aimed to measure concentrations of rare earth elements in the water column across meltwater gradients. Finally, PalaeoMAP (Dr Sev Kender) aimed to examine the retreat rate of glaciers by examining deep (3m) sediment cores taken from each fjord. Although a single core would have been useful from each location, 5 cores were taken from Marian Cove and Börgen Bay, and 7 from Sheldon Cove.

Several small self-funded projects completed the diverse science conducted on board. A continuation of the microplastics project (from filtered water and sediment cores) was undertaken by Dr Tina Whittaker on behalf of Dr Alexis Janosik. Dr Anna Pienkowski continued her micropalaeo work from last year. Dr Liqiang Zhao is investigating the origins of the carbon in the water to better understand the origins of carbon in bivalve shells. Microbial diversity at each station is to be investigated by Dr Carmen Falagan Rodriguez from samples taken on board by Dr Alejandro Roman Gonzalez.

In summary, the cruise achieved all the predetermined scientific objectives, and exceeded expectations for most collectors. This is largely down to the excellent cooperation between the ship's crew and the scientists on board.

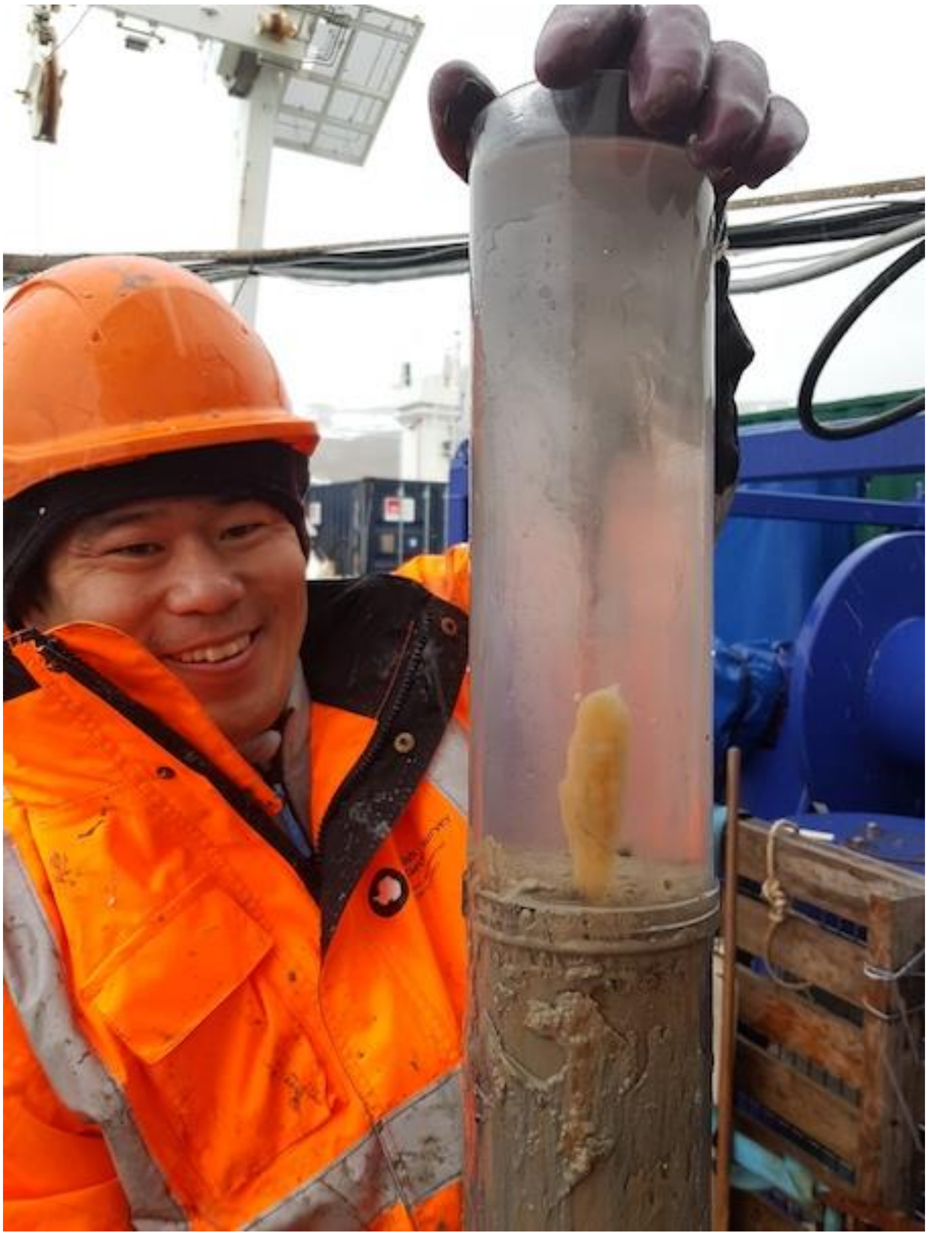
## 2. List of Personnel

| | | |
|---|---|---|
| Chester Sands | BAS | Principal Science Officer |
| James Scourse | U.Exeter | PI ICEBERGS |
| Amber Annett | U.Southampton | PI RACETRAX |
| Bjørg Apeland | BAS | Marine Engineer |
| David Barnes | BAS | Marine Biologist |
| Miguel Bascur | U.Concepción | Marine Biologist |
| Paulina Brunig | U.Laval | Marine Biologist |
| Marina Costa | SAERI | Cetacean Biologist |
| George Dadd | Kiote Ltd | Marine Engineer |
| Ander De Leccea | SAERI | Marine Biologist |
| Natalie Ensor | BAS | Laboratory Manager |
| Amy Featherstone | U.Aahaus | Sclerochronologist |
| Gareth Flint | BAS | Marine Engineer |
| David Goodger | BAS | Electrical Engineer |
| Alice Guzzi | U.Genoa | Marine Biologist |
| Floyd Howard | ONFA | Geospatial Specialist |
| David Hunter | BAS | IT |
| Stuart Jenkins | U.Bangor | Marine Ecologist |
| Sev Kender | U.Exeter | Palaeoceanographer |
| Ben Lincoln | U.Bangor | Physical Oceanographer |
| Carlos Munoz Ramirez | U.Concepción | Molecular Ecologist |
| Anna Pienkowski | UNIS | Micropalaeontologist |
| Kate Retallick | U.Bangor | Hydrographer |
| Alejandro Roman Gonzalez | U.Exeter | Sclerochronologist |
| Katy Sheen | U.Exeter | Physical Oceanographer |
| Tina Whittaker | U.W.F | Marine Biologist |
| James Williams | U. Cardiff | Palaeoclimatelogist |
| Liqiang Zhao | U. Tokyo | Marine Biochemist |
| Nadescha Zwerschke | BAS | Marine Biologist |

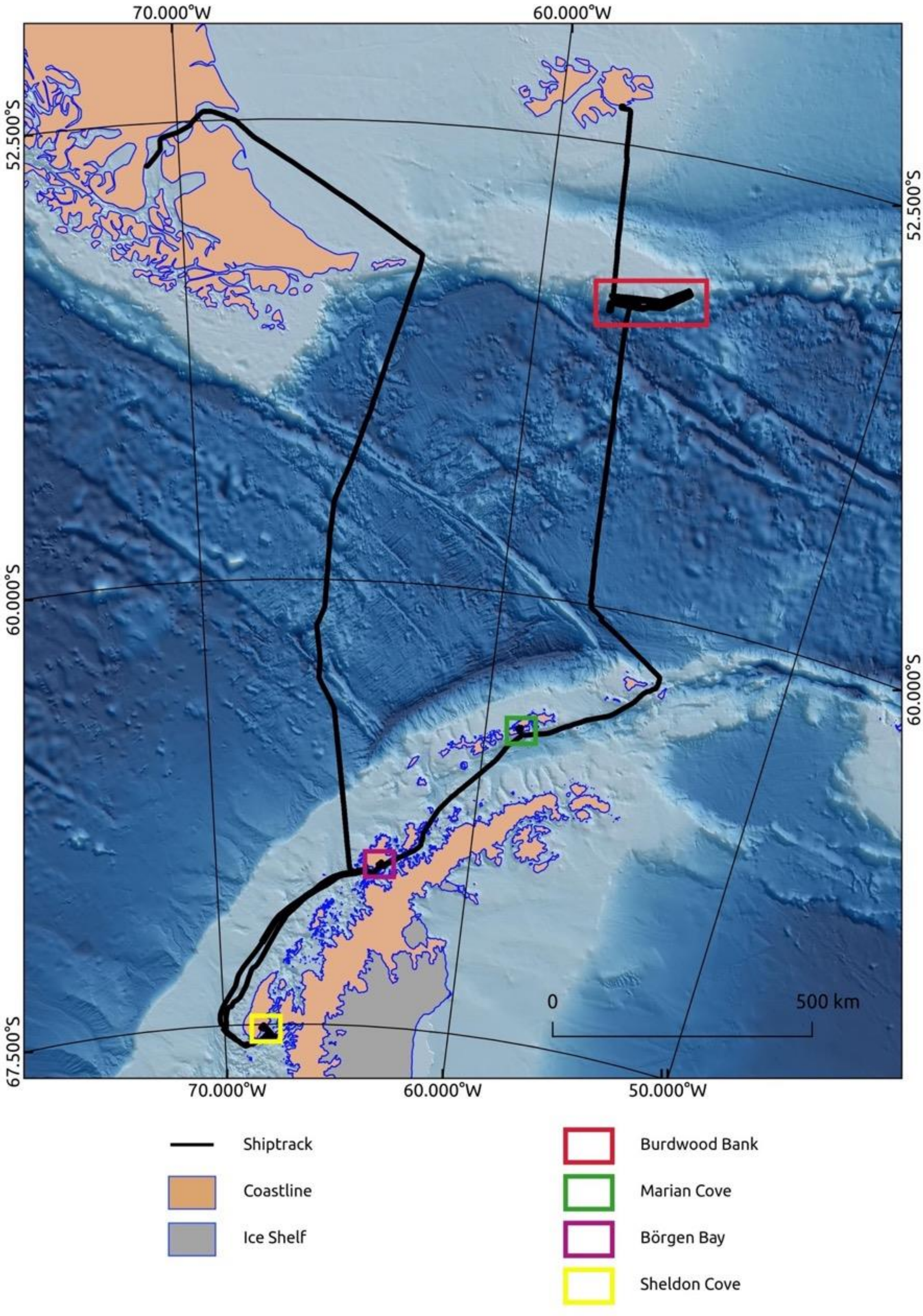
## 3. Timetable of events

| | |
|---|---|
| 30th November | Science party arrives and boards JCR |
| 1st December | Mobilisation of labs and deck equipment |
| 2nd December | Vessel departs 0800, Science meeting with Crew and PIs |
| 3rd December | Winch repairs, 0800 Arrive at Burdwood Bank, commence SWATH survey, CTD |
| 4th December | SWATH survey continues, AGT deployments |
| 5th December | SWATH survey continues, AGT deployments, work completed 1430, Continue to Marian Cove KGI |
| 6th December | Continue transit to Marian Cove KGI in heavy seas, course diverted due to decreasing weather conditions |
| 7th December | Continue transit to Marian Cove, arrive Maxwell Bay with Tow Fish 2130 |
| 8th December | CTD, VMP and N70 activities (Clean) at stations 1-5. 1300 – 1830 VMP transects across sill |
| 9th December | Clean activities end 0600, Muddy activities (Hamon Grab, Multicore, Gravity core) begin |
| 10th December | Muddy activities continue. SWATH survey 0820 – 1320. Muddy activities continue with Gravity Core focus 1700 - 2230 |
| 11th December | Muddy activities continue to 1730, Continue to Börgen Bay |
| 12th December | 1200 arrive Börgen Bay, SWATH survey until 1400, Clean activities commence. *Winch driver ill so winch free activities: SWATH survey 1720 – 2240, VMP sill transects from 2300 |
| 13th December | VMP transects to 0800, SWATH survey continues to 1050, Clean activities continue. TOPAZ survey commences 2200 |
| 14th December | TOPAZ to 0030. VMP transects to 0800. Muddy activities commence. |
| 15th December | Muddy activities continue. Gravity Core focus 0230 – 0900. Muddy activities continue |
| 16th December | Muddy activities continue to 0300, SWATH survey as vessel exits Börgen Bay, passage resumed 0500 to Rothera |
| 17th December | Vessel enters pack ice 0550. 0800 Biosecurity brief, Boating ops brief. Vessel clear of pack ice 1010. Enters Dagliesh Bay, Porquoi Pas, 1320. 1340 Small boat operations to maintain sea ice camera. 1500 proceed to Rothera Wharf. Cargo discharge. Winters Dinner |
| 18th December | Cargo operations alongside Rothera Wharf. |
| 19th December | Cargo operations alongside Rothera Wharf. |
| 20th December | 0830 depart Rothera Wharf. 0900 commence Sheldon Cove Clean activities. 2200 commence VMP transect. |
| 21st December | VMP transect continues to 0600. 0630 – 0900 TOPAZ survey. Clean activities continue. 1900 – 2130 SWATH survey. 2130 Muddy activities commence. |
| 22nd December | Muddy activities continue with focus on Gravity Core 1520 – 2200. |
| 23rd December | Muddy activities continue. SWATH survey 1300 – 2200. Muddy activities resume. |
| 24th December | Muddy activities continue including Agassiz Trawls from 0500. 1330 vessel departs Sheldon Cove for Rothera. 1440 cargo and pax unloaded. |

| | |
|---|---|
| | 1450 vessel departs wharf. Vessel in pack ice 1530 – 2200. Carols on Monkey Island 1930-2000. |
| 25th December | Ships crew and science party resting. Merry Christmas! |
| 26th December | 0800 vessel anchors off Palmer Station. 0915 Cargo tender begins shuttle of ships personnel for station visits, and station personnel for ship visits. Visit complete 1500. 1545 Vessel resumes passage. |
| 27th December | Transit to Punta Arenas and demob. |
| 28th December | Ship continues towards Punta Arenas. 1030 begin deep CTD cable test. 1800 Cable test ends, ship resumes passage. |
| 29th December | Transit to Punta Arenas and demob. |
| 30th December | Transit to Punta Arenas. Pilot meets ship in Straits of Magellan 2200 |
| 31st December | Ship anchors in Harbour 0800. 1400 Science party take shuttle to shore. Happy New Year |
| 01 January 2019 | 0800 Science party depart. |



## 3. Working area



# 4. Introduction

## 4.1 IMPACTS OF DEGLACIATION ON BENTHIC MARINE ECOSYSTEMS IN ANTARCTICA ("ICEBERGS")

Prof. James Scourse, PI, University of Exeter, Penryn, Cornwall UK

Surface waters around the West Antarctic Peninsula (WAP) are experiencing rapid warming (e.g. Meredith and King 2005, Vaughan et al. 2013) resulting in retreating glaciers, collapse of ice shelves and lengthening of the sea-ice melting season (e.g. Cook et al. 2005, Stammerjohn et al. 2012). Increased iceberg scouring (Barnes and Souster 2011) and sediment discharge (Sahade et al. 2015) are the dominant physical disturbances impacting the shallow benthos of West Antarctica. However, sea ice losses over West Antarctica's continental shelves have also lead to longer phytoplankton blooms, resulting growth increases by benthos and thus increased (blue) carbon capture and storage on the seabed – the largest negative feedback on climate change (Barnes et al 2016). Given the lack of scientific knowledge of the Antarctic coastal ecosystems it is difficult to predict present and future responses of these ecosystems to regional warming. There is an urgency to, first, evaluate the real changes in environmental variables due to this disturbance, and second, estimate the magnitude and direction of ecosystem responses at different biological levels and spatial scales to regional warming. In addition, it is important to develop new tools to detect disturbance. These new data will allow quantification of the impact of regional warming in Antarctica and inform conservation and management strategies. **In this context, ICEBERGS aims to investigate the impacts of physical disturbance arising from climate-warming induced deglaciation on benthic communities around the West Antarctic Peninsula. We adopt a multidisciplinary approach across nested scales from individual to ecosystem level, and from an ecological to evolutionary scale, evaluating genetic, physiological, population, community and ecosystem impacts of this deglacial perturbation. In addition, we use sclerochronology to develop biological proxies for reconstructing multidecadal environmental changes in Antarctica.**

The overall aim of the ICEBERGS project is guided by the **general hypothesis** that *ice loss and deglaciation in the Antarctic Peninsula due to regional warming will have significant impacts on glacier dynamics, local coastal oceanographic conditions and the benthic coastal marine biota. These effects are observed from the individual to ecosystem level.* At the **assemblage level** we test the hypothesis that *the combined disturbance effects of glacier retreat, loss of winter sea ice and disintegration of ice shelves generate assemblage-wide effects on the diversity and dominance patterns of benthic assemblages modulated by the differential resistance of species, leading to major shifts in community structure according to perturbation strength (magnitude of glacier retreat).* At the **individual level** we test the hypothesis that ***i**ce loss and deglaciation affect the coastal environmental conditions in terms of temperature, salinity, turbidity and primary productivity affecting individual performance and reproductive investment. These effects are recorded temporally in the shell increments of marine invertebrate species*. At the **evolutionary level** we test the hypothesis that *ice loss and deglaciation perturbations affect genetic diversity and population connectivity of marine benthic species, especially in species with low dispersal potential (brooding species).*

The **general objective** of ICEBERGS is *to assess the effects of ice loss and deglaciation on coastal marine habitats from the individual to the ecosystem level*. **Specific objectives are:**

1. Monitoring glacier retreat over time and scour intensity on the adjacent seabed.
2. Determine the benthic assemblage structure from localities with different perturbation levels.
3. Evaluate nutritional and reproductive conditions of adults.
4. Analyse growth rates from bivalve/ gastropod shells and bryozoan populations with different perturbation levels.
5. Develop reconstructions of physical disturbance due to iceberg discharge from growth patterns present in the carbonate structure of the shells of marine molluscs.
6. Estimate the effect of marine glacier discharge and iceberg scouring on the genetic diversity and connectivity of marine invertebrate populations and the role of dispersal potential.

In order to achieve these objectives ICEBERGS has, and will, deploy, from RRS *James Clark Ross,* physical oceanographic (CTD), marine geophysics (multi-beam swath bathymetry, TOPAS sub-bottom profiling) and habitat mapping (shallow underwater camera system) instrumentation, alongside water column (plankton net) and bottom sampling (Agassiz trawl, Hamon grab, multi-corer) gear for determining and sampling seabed sediments, community structure and benthic biodiversity at three actively deglaciating fjord sites along the west Antarctic Peninsula during three field seasons starting in 2017 (Figure 4.1). These sites, Marian Cove (Maxwell Bay, King George Island, South Shetland Islands), William Glacier (Börgen Bay, Anvers Island) and Sheldon Glacier (Sheldon Cove, Ryder Bay, Adelaide Island adjacent to the BAS base at Rothera) have been selected on the basis of the availability of pre-existing bathymetric (multibeam swath bathymetry) and glacier retreat data from satellite observations (e.g. Cook et al., 2016).

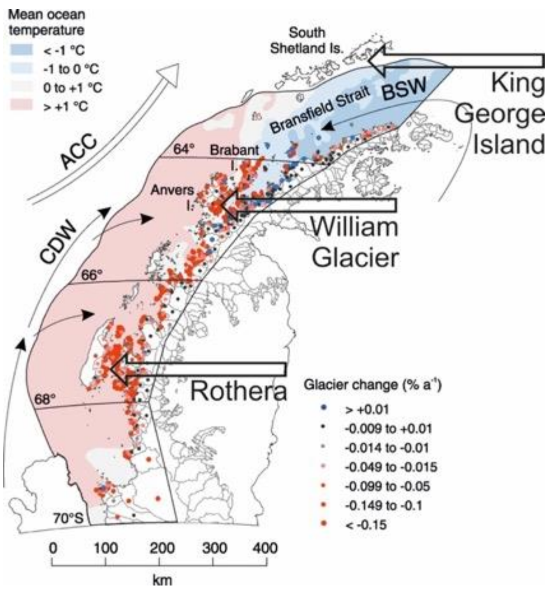



*Figure 4.1. Field sites for sample collection (base map from Cook et al., 2016)*

During the 2018 research cruise four satellite projects have taken advantage of the ICEBERGS opportunity and, independently funded, these have allowed additional specialist personnel (and additional equipment) to participate in the cruise in turn conferring significant additional capability and data for the core ICEBERGS project. These are 1**: Characterisation of the impacts of microplastic ingestion by Southern Ocean filter-feeders (Alexis Janosik, West Florida University, USA; represented on JR18003 by Tina Whitaker)**, 2: **Characterisation of modern foraminifera and ostracods of Ryder Bay, Marian Cove and Börgen Bay (Antarctic Peninsula), and reconstruction of palaeoclimatic changes over the past ~200 yrs (Sev Kender, University of Exeter, UK), 3: Ocean Turbulence effects on Antarctic Glacier Outflows (OCTONAUT) (Katy Sheen, University of Exeter, UK**), **and 4**: **Biological and biogeochemical proxy calibration of deglaciating environments in Antarctica (Anna Pieńkowski, University Studies on Svalbard [UNIS], Norway). Projects 1, 3 and 4 are continuations of satellite projects initiated alongside ICEBERGS in 2017. Project 3 involved the deployment of a VMP vertical turbulence profiler. Project 2 involved the deployment, for the first time in the context of ICEBERGS, a 3 m gravity corer loaned from the British Geological Survey.**

Barnes and Souster 2011 *Nature Climate Change* 1, 365-368
Barnes et al. 2016 Global Change Biology 22, 1110-1120
Cook et al. 2005 *Science* 22 541-544
Cook et al. 2016 Science *353* 283-286
Meredith and King 2005 *Geophysical Research Letters* 32 L19604
Sahade et al. 2015 Science Advances 1, doi: 10.1126/sciadv.1500050
Stammerjohn et al. 2012 *Geophysical Research Letters* 39 L06501

## 4.2 Radium in Changing Environments: Tracing Fluxes (RACETRAX – NERC Independent Research Fellowship)

Dr. Amber Annett, PI, University of Southampton, University Road, Southampton UK

In addition to providing food for the benthic organisms (by opening up new open water for primary production), glacial retreat can also provide macro- and micro-nutrients to coastal areas via melt water. These dissolved nutrients have the potential to be dispersed over long distances. The RaCE:TraX project (Radium in Changing Environments: Tracing Fluxes) complements the ICEBERGS project by characterizing the dissolved and particulate components of glacial melt water and the temporal/spatial scales over which these components are decoupled. The lateral distribution of glacial sediment, fine grained glacial flour and dissolved compounds is not known around the study sites.

Naturally occurring radioisotopes of radium (Ra) are especially useful tracers of coastal inputs, produced from particle reactive thorium (Th). Th decays, producing highly soluble Ra, thus distributions of Ra therefore show a strong source from glacial/subglacial melt water, due to elevated Th from entrained sediment. The so-called "Ra quartet" of four isotopes decay at different rates, and can be used to investigate a range of time scales from days/weeks (loss of particles from the water column) to months/years (advection and dispersal of glacially-derived nutrients). Pairs of Ra isotopes can be used to account for adsorption/desorption due to salinity changes, as well as to discriminate between different sediment sources (for example glacial versus marine sediment, both of which likely provide significant Ra flux in the coastal Antarctic). Large volume seawater samples for Ra are combined with oxygen isotopes and trace metal samples to quantify delivery of glacial sediment to the surrounding area and spatial and temporal scales of sediment loss from the water column to the seafloor.

A second component of this work investigates chemical distributions in pore waters from sediments at the three ICEBERG locations, to quantify and account for benthic fluxes in coastal budgets. Sediment cores from the multicorer were used to determine the feasibility of using a Ra/Th disequilibrium approach to quantify trace metal and nutrient fluxes in Antarctic sediments. This novel technique leverages the solubility of the daughter isotope Ra and the high particle affinity of Th, where the deficit of Ra in sediments relative to the expected activity determined from Th content reflects solute loss from diffusion, bioirrigation and porewater exchange over a time period of 1-2 weeks. Ratios of e.g. nutrients to Ra in porewaters can be used to determine nutrient flux from sediments from this method.

## 4.3 Darwin Plus Burdwood Bank marine spatial planning

Obligations of member states under the Convention of Biological Diversity include a better understanding and management of existing biodiversity. On behalf of the Falkland Islands Government, the South Atlantic Environment Research Institute (SAERI), together with British Antarctic Survey (BAS), successfully competed for Darwin Plus funding to begin investigations relating to marine resources, habitat structure and community composition, to better inform management decisions principally regarding marine spatial planning. Data collection for this project commenced with a 48 hr multibeam and TOPAS survey and Agassiz Trawl collections of macro and mega fauna from the southern shelf break of Burdwood Bank.

## 4.4 CASS participation

### 4.4.1 Ocean impacts of Cryospheric TransformatiON by Antarctic Underwater Turbulence (OCTONAUT)

The discharge to the ocean of glacial melt from Antarctica has strong implications for global sea level rise, ocean stratification and ventilation, sea ice production, and marine ecosystems and carbon cycling. Increasingly, it is seen that the enhanced supply of oceanic heat to the Antarctic cryosphere is responsible for the strong glacial retreat rates observed, especially in regions of West Antarctica. However, much uncertainty remains concerning the key processes by which ocean mixing can impact the characteristics (including heat content and nutrients) of the waters that impinge on Antarctica, and also the distribution and fate of the meltwater. Assessing the underlying physical processes responsible for melting Antarctic Ice Sheets, as well as monitoring the impact of Antarctic Ice sheet melt, is paramount for predicting the future trajectory of Antarctic coastal systems and wider scale environmental change in the coming century.

OCTONAUT key aims:

- To characterise the oceanic environment in actively de-glaciating margins along the West Antarctic Peninsula (ICEBERGS field sites) using CTD, (L)ADCP, EK80 and turbulence data
- To assess the underlying physical processes responsible for melting Antarctic Ice Sheets (turbulent mixing)
- To assess the processes regulating the discharge and fate of meltwater

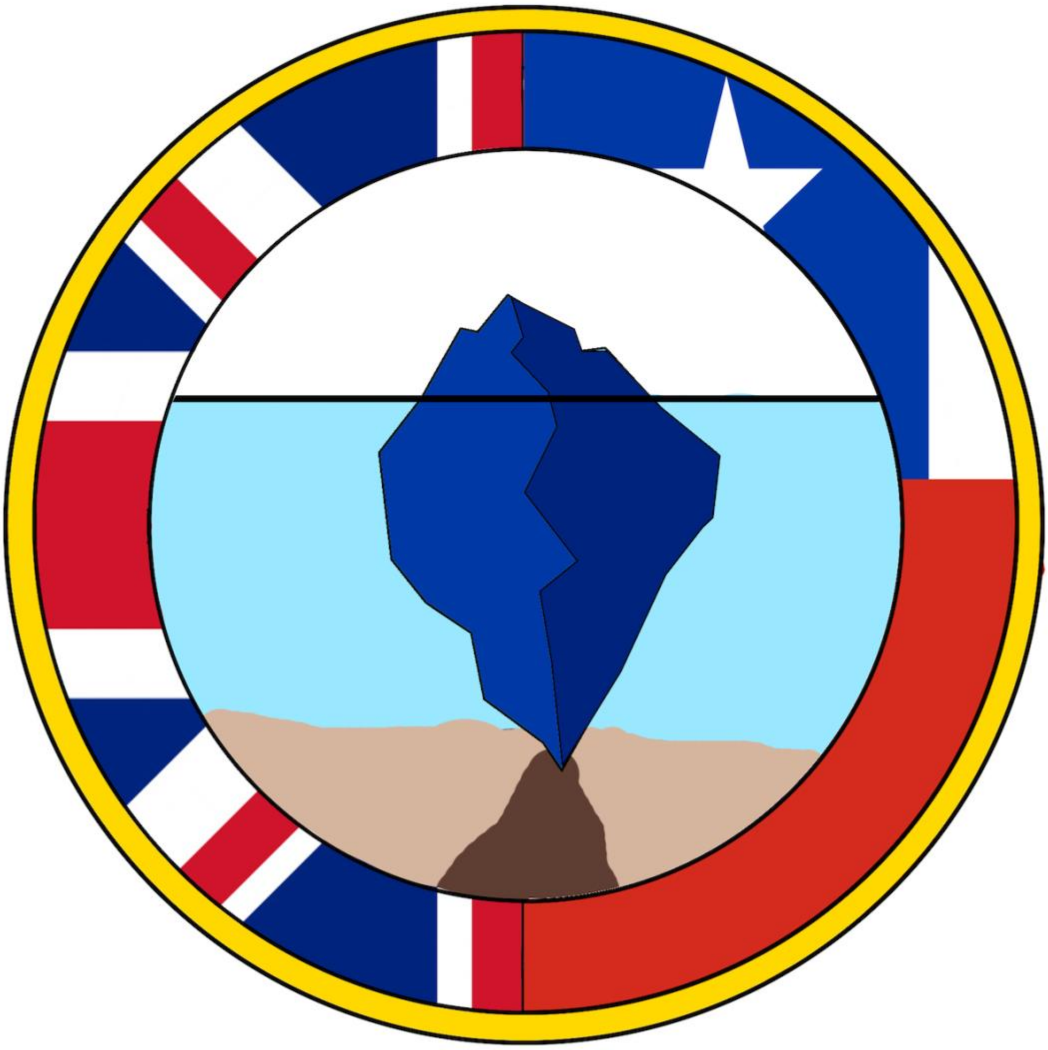
In addition to the above, quantifying the turbulent properties and water mass modifications in the field sites will significantly aid the understanding of the dynamics influencing benthic ecosystems in actively deglaciating margins including nutrient fluxes. It will also provide process understanding that, alongside measurements of seawater oxygen isotopes, will be used to inform calibration of oxygen isotopes from sclerochronological series to provide long records of density, temperature and/or salinity. Furthermore, we will seek to add a turbidity sensor to the VMP, providing data that will strongly complement particle size distribution estimates and help establish the benthic marine environment, key to ICEBERGS scientific goals. The work will also draw on (and contribute to) the current international research effort on the WAP shelf, complementing data from a number of historical and ongoing experiments (e.g ORCHESTRA, Southern Ocean GLOBEC and the US-led Palmer Long-Term Ecological Research Program (Pal-LTER)).

### 4.4.2 Palaeoclimate from Microbiota of the Antarctic Peninsula (PalaeoMAP, CASS 147)

The recent glacial retreat from marginal marine locations of Antarctica, including the Antarctic Peninsula, are considered to be unprecedented in the recent geological past, and possibly the result of anthropogenic climate change and increased incursions of warm Upper Circumpolar Deep Water onto Antarctic shelves. In addition, glacial retreat is thought to have had impacts on benthic organisms and fundamentally changed the phytoplankton communities in the region. These hypotheses will be tested by CASS-147 with palaeoclimatic reconstructions of sea ice, sea surface temperature and microbiota from sediment cores spanning the past several thousand years. This project initially proposed the deployment of box cores, but as these were not taken on expedition JR18003, Sev Kender sourced a gravity corer from the British Geological Survey (see Section 5.4.3) which has allowed the reconstruction of palaeoceanography further back in time. The project will address these research questions by studying sediment cores using established (micropalaeontology, geochemistry) and novel (ancient environmental DNA) techniques with collaborators. Post-expedition analytical work will include $^{14}$C and $^{210}$Pb dating, micropalaeontology (diatoms, foraminifera and dinoflagellate cysts), sediment and microfossil stable isotopes, foraminiferal Mg/Ca, sediment $TEX_{86}$ and eDNA.

### 4.4.3 Glacial meltwater signals from Rare Earth Elements (GLARE, CASS 150)

Glacial meltwater signals from Rare Earth Elements (GLARE) aims to measure water column concentrations of rare earth elements (REE) across meltwater gradients to assess the application of REEs in tracing meltwater input along the Antarctic Peninsula.



# 5. Equipment used and science areas

## 5.1 Geophysics

**Kate Retallick** Bangor University, UK ktr18cgp@bangor.ac.uk
**Floyd Howard** floyd.j.f.howard@gmail.com

### 5.1.1 Multibeam mapping

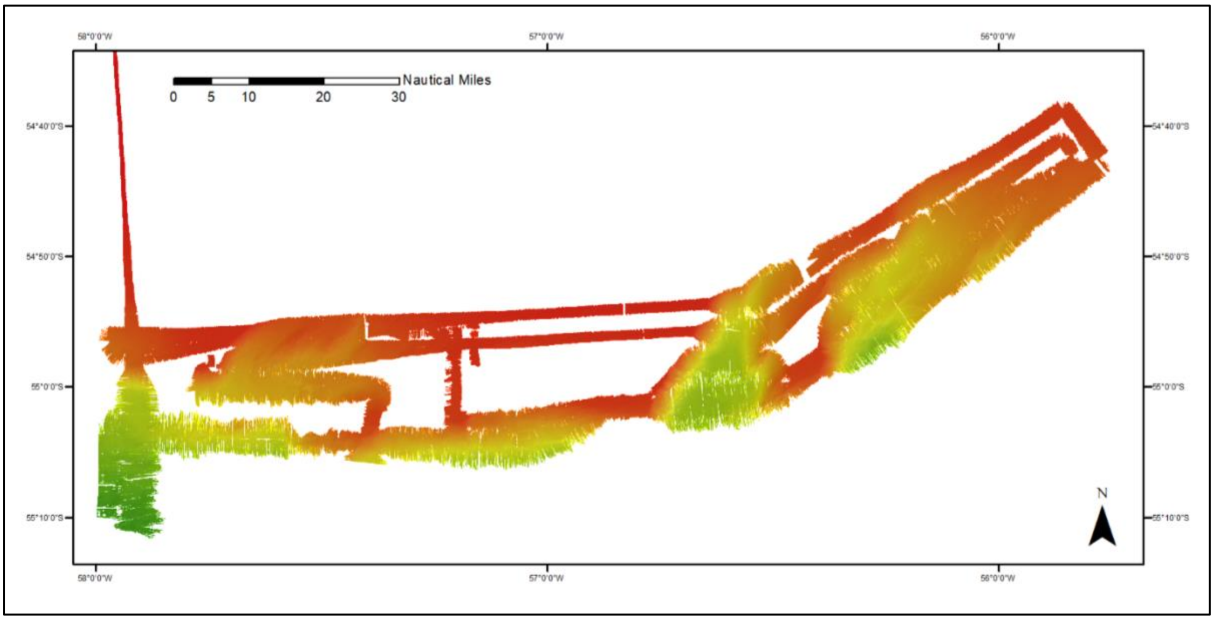



*Figure 5.1.1 Multibeam bathymetry collected at Burdwood Bank on JR18003.*

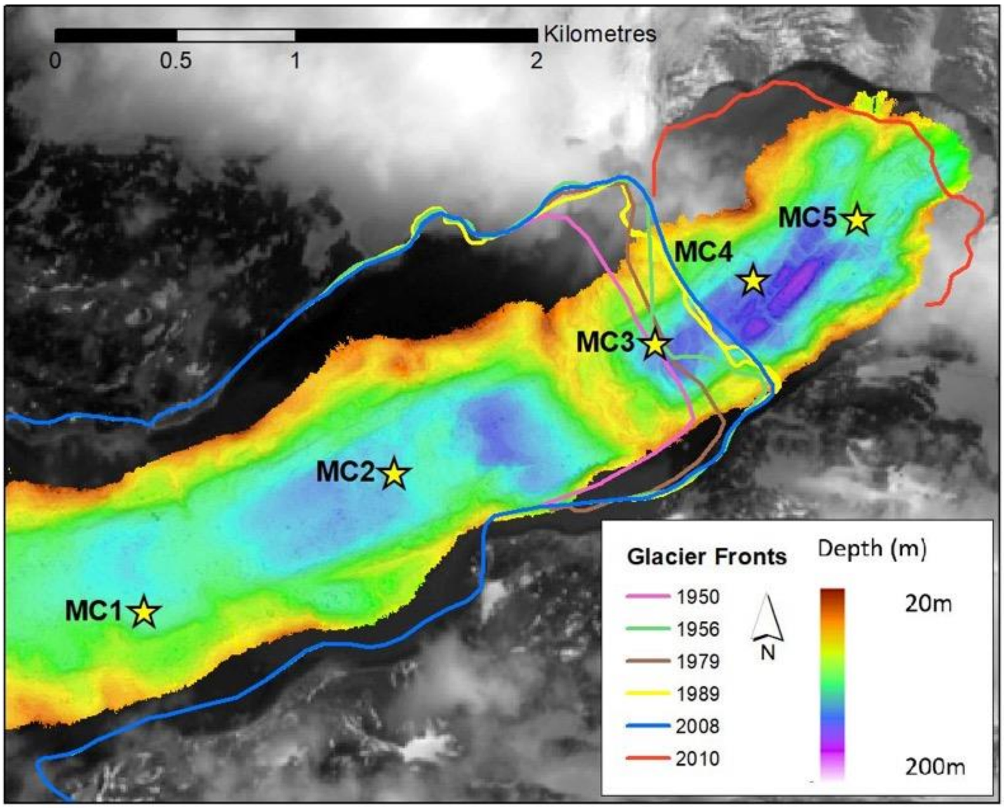


*Figure 5.1.2 Multibeam bathymetry collected within Marian Cove, King George Island on JR18003. Positions of past glacier fronts were provided by Dr Alison Cook (Cook et al., 2014). Stars indicate the location of sampling stations.*

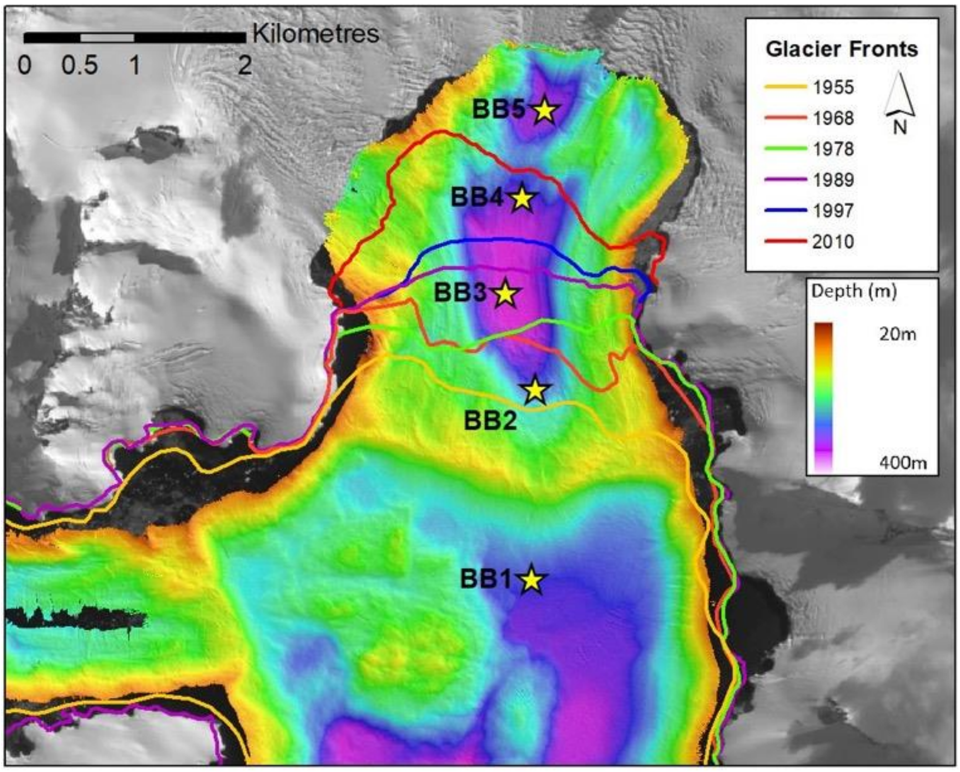


*Figure 5.1.3 Multibeam bathymetry collected within Börgen Bay, Anvers Island on JR18003. Positions of past glacier fronts were provided by Dr Alison Cook (Cook et al., 2014). Stars indicate the location of sampling stations.*

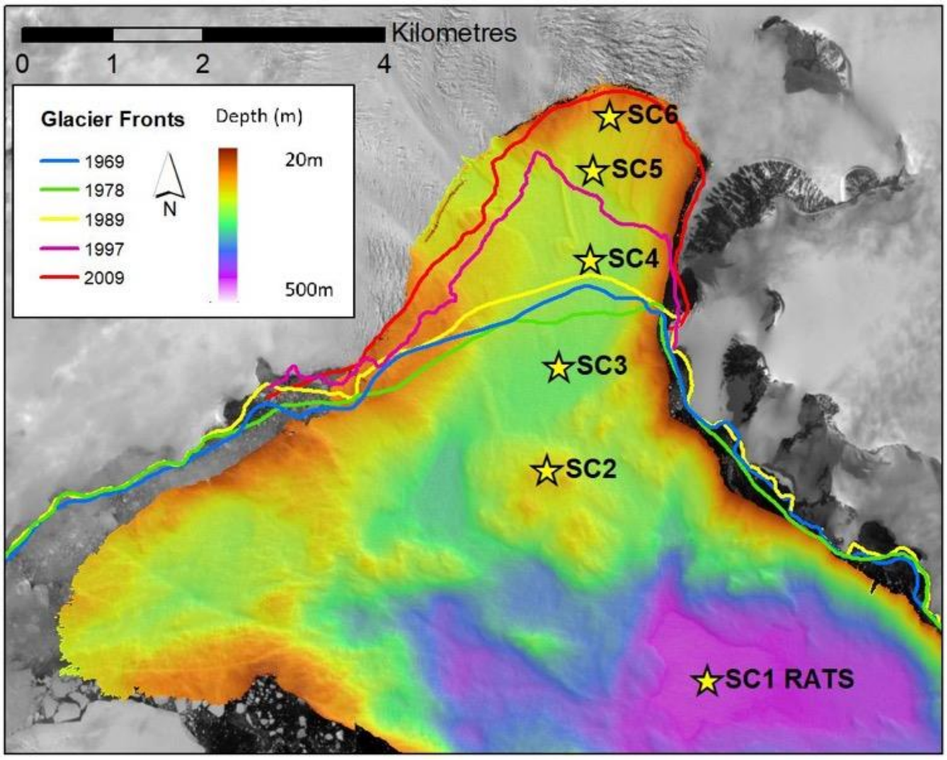



*Figure 5.1.4 Multibeam bathymetry collected at Sheldon Glacier on JR18003 Positions of past glacier fronts were provided by Dr Alison Cook (Cook et al., 2014). Stars indicate the location of sampling stations.*

### 5.1.2 Data Acquisition and Processing

Bathymetric data was collected using a hull-mounted 1° x 1° EM122 Multibeam Echo Sounder (MBES) (see appendix A1.1 for further details). The EM122 equipment was operated using Kongsberg Seafloor Information System (SIS) and Helmsman software. A detailed report on the collection and processing of the data with an evaluation of data quality and surveying methods is presented in Appendix A1.1. Data was organised into eight separate surveys, summarised in table 5.1.1. Changes to acquisition parameters are summarised in the EM122 event log[1], available on request from the UK Polar Data Centre (polardatacentre@bas.ac.uk).

Where possible, data were collected in a systematic manner with survey lines running parallel along depth contours to achieve consistent swath coverage and maximise insonification of slope areas. This facilitated high-quality backscatter data which suffer from significant noise during turns. High swell and sea states on Burdwood Bank affected the quality of the resulting data. The presence of ice, particularly in Börgen Bay and at Sheldon Cove, impacted our ability to conduct a systematic survey. In these instances, the ship was driven to best achieve coverage.

*Table 5.1.1: Summary of EM122 data collected on JR18003.*

| Survey Name | Start (UTC) | End (UTC) | Description | Number of RAW files (.all) | Processed (Qimera / Fledermaus) | Comment |
|---|---|---|---|---|---|---|
| **jr18003_a** | 2/12/18 1621 | 5/12/18 1846 | Burdwood Bank | 77 | 77 | SAERI Burdwood Bank |
| **jr18003_b** | 5/12/18 1846 | 10/12/18 1123 | Transit from Burdwood Bank to Marian Cove | 55 | 0 | Opportunistic passage sounding |
| **jr18003_c** | 10/12/18 1123 | 10/12/18 1655 | Marian Cove | 18 | 18 | ICEBERGS |

[1] \\scientific_work_areas\EM122\EM122 Event Log.csv

| | | | | | | |
|---|---|---|---|---|---|---|
| **jr18003_d** | 11/12/18 2047 | 12/12/18 1508 | Transit from Marian Cove to Börgen Bay | 21 | 0 | Opportunistic passage sounding |
| **jr18003_e** | 12/12/18 1522 | 16/12/18 0719 | Börgen Bay | 79 | 79 | ICEBERGS<br>Include lines 0018 and 0019 from JR18003_d |
| **jr18003_f** | 16/12/18 0722 | 17/12/18 1903 | Transit from Börgen Bay to Rothera | 34 | 0 | Opportunistic passage sounding |
| **jr18003_g** | 17/12/18 1804 | 24/12/18 0202 | Sheldon Glacier | 69 | 69 | ICEBERGS / Deep Impact<br>New draught entered prior to departure following cargo operations.<br>Include line 0031 from JR18003_f |
| **jr18003_h** | 24/12/18 1851 | 28/12/18 0139 | Transit from Rothera to Interim Seamount | 36 | 0 | Opportunistic passage sounding including Interim Seamount (lines 0033-0035) |

In the four primary survey areas, in excess of 130 million depth soundings were obtained over ~7170 km$^2$ (an area 1/3 the size of Wales).

Figures 5.1.1, 5.1.2, 5.1.3 and 5.1.4 illustrate the final bathymetry grids at each location. Initial processing of MBES bathymetry data enabled assessment of the seabed to support cruise scientific activity. Slope and hillshade products along with TOPAS data (see section 2) were used to assist selection of additional sampling stations during science operations at Marian Cove, Börgen Bay and Sheldon Glacier.

Sound velocity profiles (SVPs) were generated from CTD casts and applied during data acquisition. XBTs were not used to reduce cost and reduce environmental impact. Although it is intended to use GPS tide to resolve errors arising from changes in the height of tide, observations from Prat, Vernadsky and Rothera stations were downloaded from the IOC website[2] as backup. For opportunistic sounding collected during passage synthetic SVPs were applied due to time and budget constraints. These SVPs were generated using Sound Speed Manager software using the WOA09 model and following the procedure outlined in JR17004's cruise report. Seabed texture information was generated through MBES backscatter processing and Angular Range Analysis (ARA) using the Geocoder Tool[3] (Fonseca and Calder, 2005) in QPS FM Geocoder Toolbox (FMGT) software. Selected ship's tracks were processed in each area to reduce errors associated with turning. ARA returns a phi value for sediment characterisation and requires ground truthing using sediment samples to generate a vessel beam pattern correction model. This process was achieved at Burdwood Bank through analysis of the sediments acquired by AGT trawls but particle size analysis of sediment samples acquired by multicore for the ICEBERGS sites is required before similarly calibrated products can be generated for these areas. Initial processed uncalibrated ARA and backscatter mosaic images are shown in figure 5.1.5.

Despite initial evidence of some change to small scale features from ICEBERGS 2017 MBES data, the lack of corrections for horizontal position or tide prevent a full assessment at this time. Post processed RTK observations will be applied to enable accuracy of soundings to be refined to ensure small scale features can be directly compared between successive years. Figures 5.1.6 to 5.1.12 illustrate preliminary interesting seabed features observed in the multibeam data.

MBES data at Sheldon Glacier will be of particular interest to the United Kingdom Hydrographic Office to improve navigational safety for operations in vicinity of Rothera. Data from the 100-300m contour in this area will

[2] http://www.ioc-sealevelmonitoring.org

[3] Fonseca, L. and Calder, B. (2005) 'Geocoder: An Efficient Backscatter Map Constructor', *U.S. Hydro 2005 Conference*, p. 9.

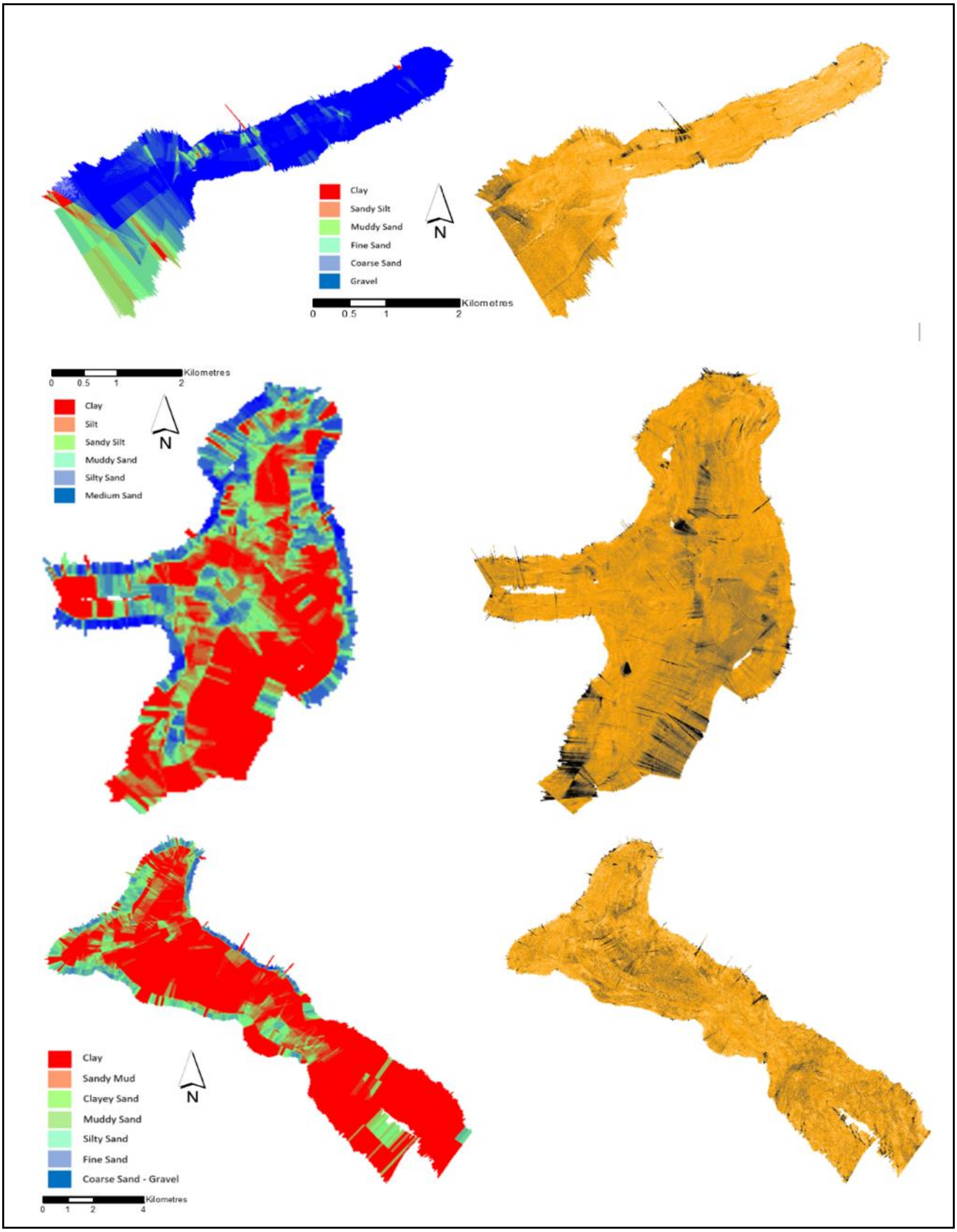



*Figure 5.1.5 Preliminary Angular Range Analysis (ARA) and backscatter mosaics for Marian Cove (top), Börgen Bay and Sheldon Glacier (bottom). ARA values have not been corrected for the vessel's beam pattern and require sediment particle-size analysis to calibrate results.*

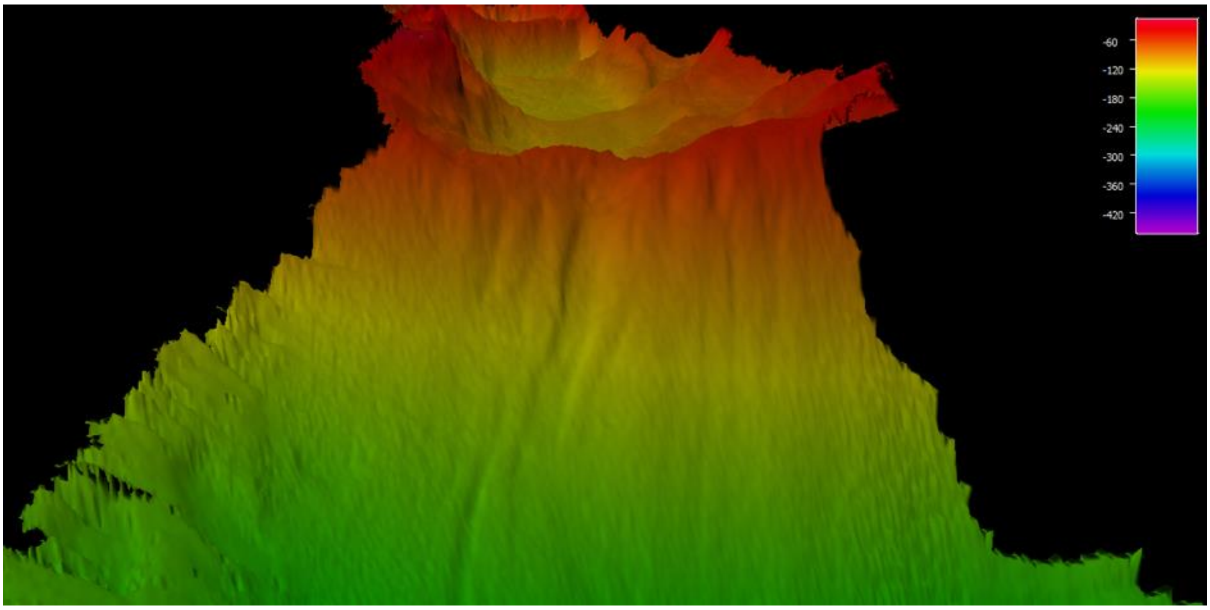


*Figure 5.1.6 Distal sill feature at Marian Cove. 3D view looking North East. Scour or channel feature is evident and similar to that observed in Börgen Bay.*

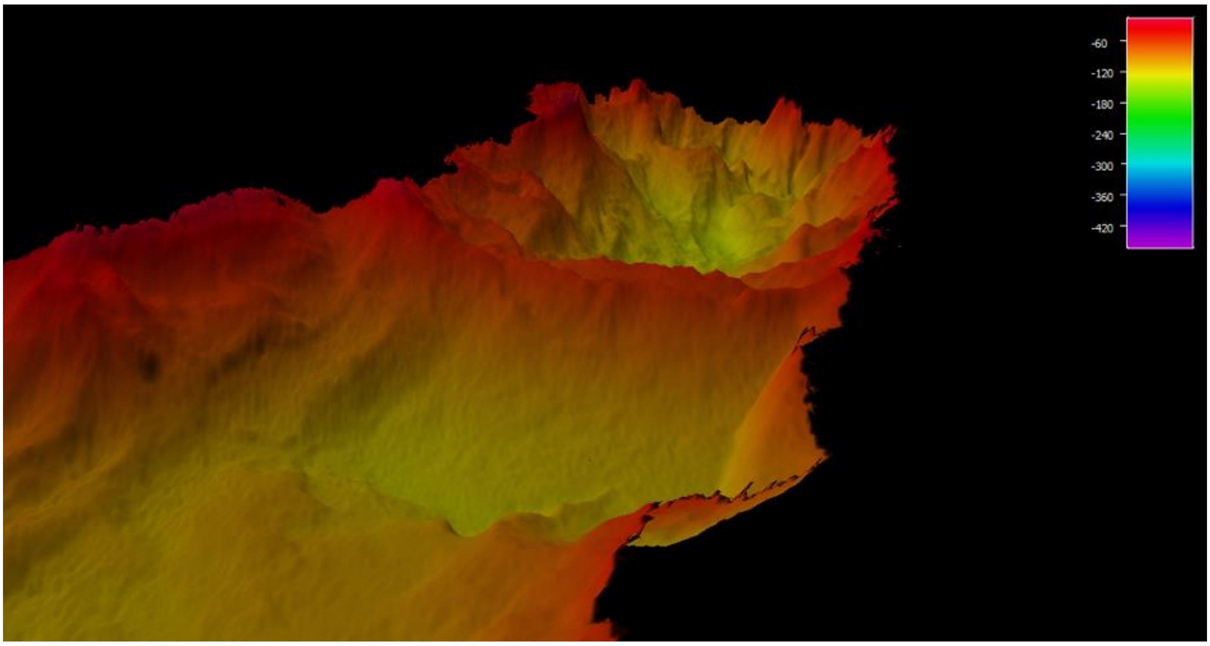


*Figure 5.1.7 Marian Cove inner sill. 3D view looking North East.*

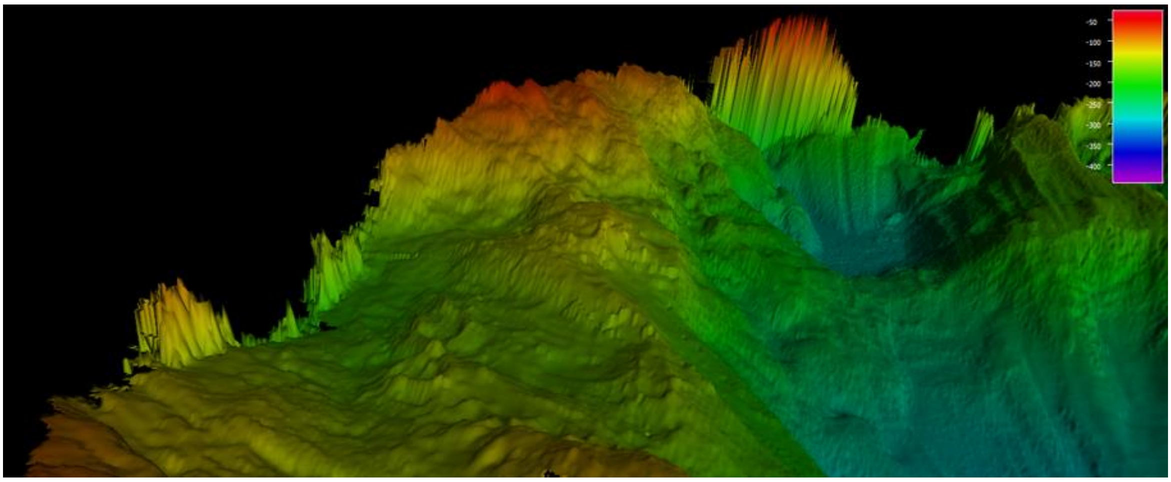



*Figure 5.1.8 Grounded ice appears as sharp vertical lines in Börgen Bay data. 3D view looking North.*

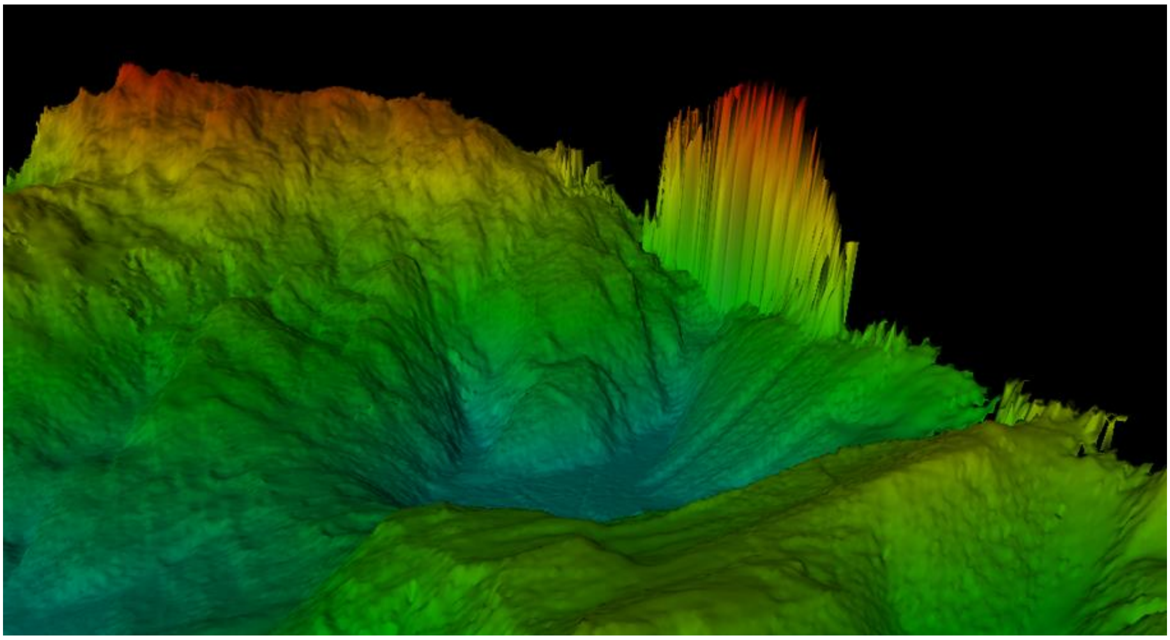


*Figure 5.1.9 Grounded Ice at the Northern limit of Börgen Bay.*

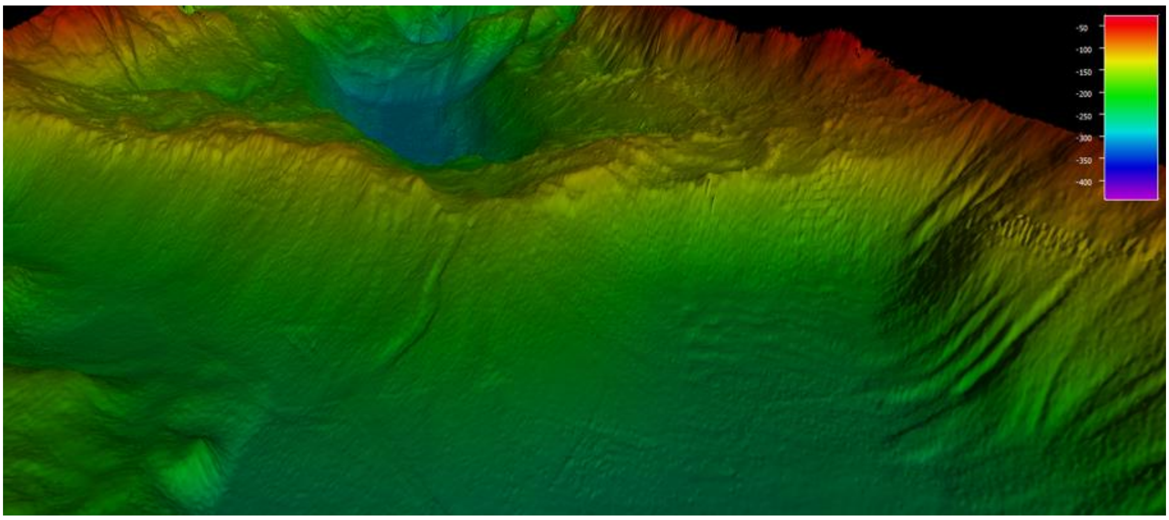



*Figure 5.1.10 Börgen Bay 'Sill' feature showing scour or channel similar in nature to Marian Cove. 3D view looking North.*

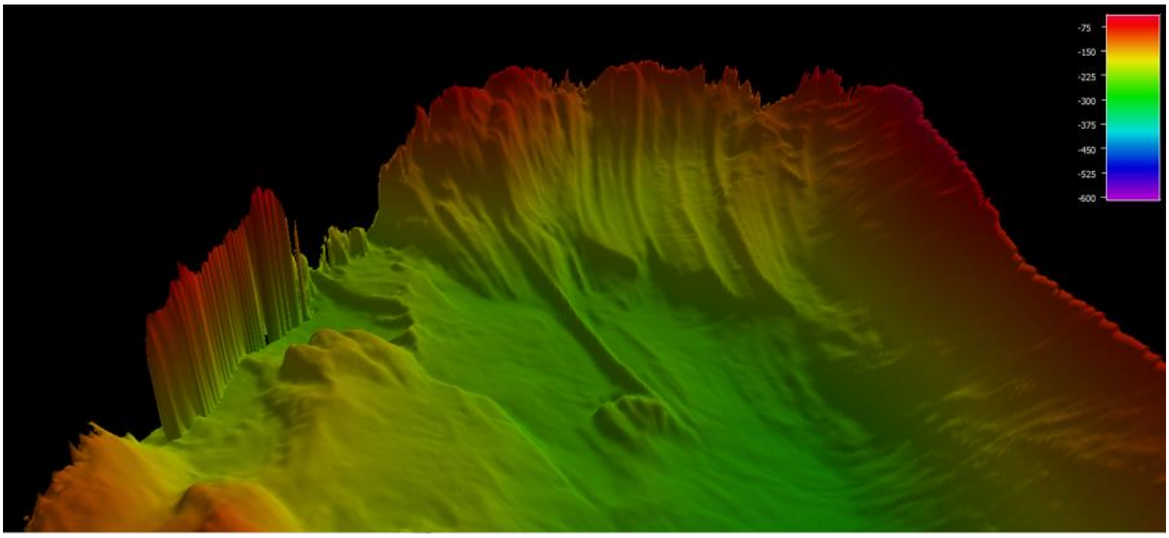



*Figure 5.1.11 Grounded ice and features at Sheldon Glacier. 3D view looking North.*

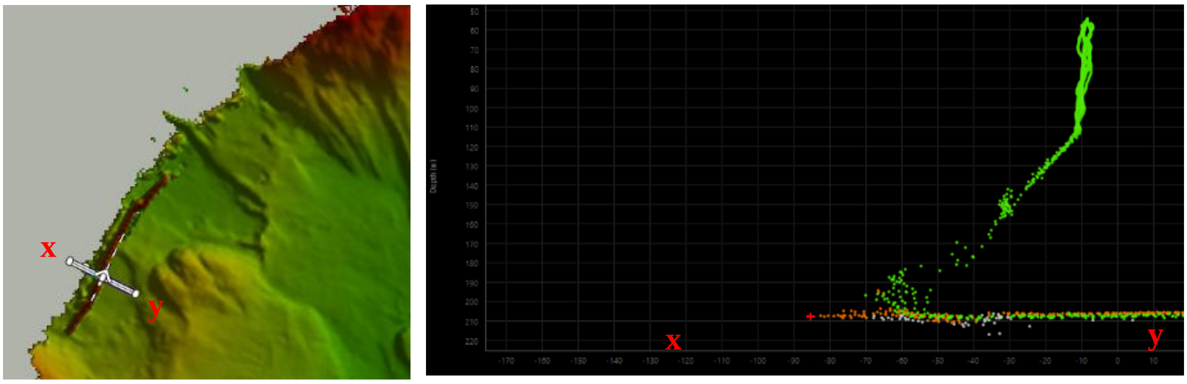



*Figure 5.1.12 Grounded ice at Sheldon Glacier. Transect across ice front showing ice is undercut by around 30m at the base.*

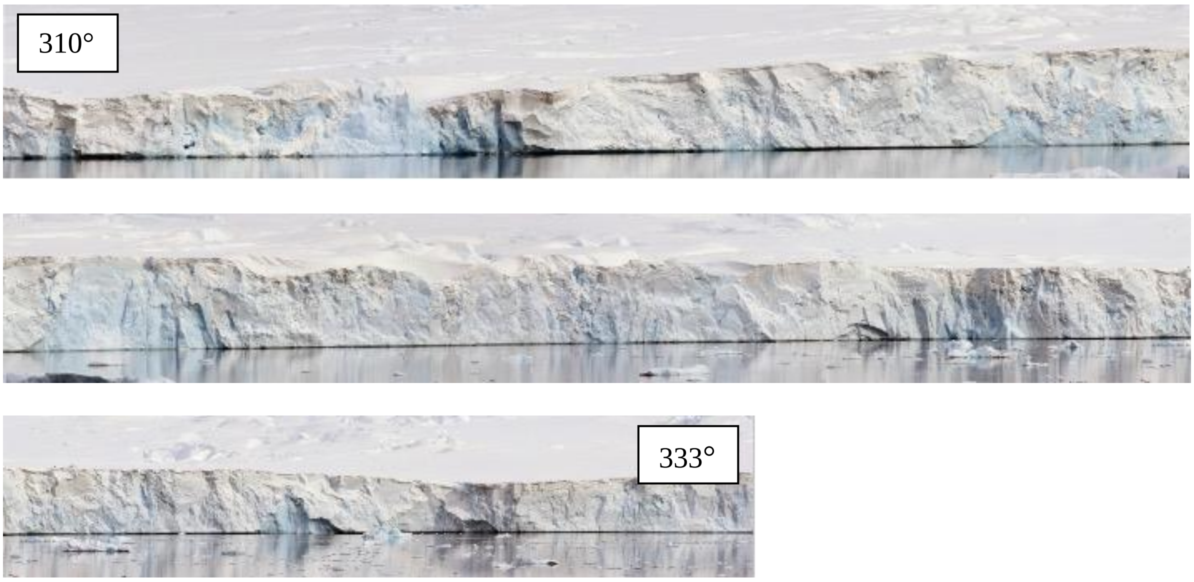



*Figure 5.1.13 Panorama showing grounded ice at the feature in figure 5.1.12 Ship's position: 67°32'.34S, 068° 15'.83W, 24/12/18 1125 UTC (0825 Local)*

### 5.1.3 Additional Multibeam sounding

#### Deep Impact

100-300m depth contours from Rothera to Sheldon Glacier were insonified where possible and are included in the project JR18003_g. Shoaler depths were not possible owing to navigational and echo sounder constraints. An area to the South East of Rothera was established in depths 200-400m to provide a region of deeper water for repeat survey opportunity. It is intended this be re-surveyed during ICEBERGS 2019 and subsequent cruises to assess the short term impact of iceberg scour.

#### Interim Seamount

A single line of sounding was conducted over Interim Seamount (60° 35'.07S, 065° 57'.0W) to support future science activity. The raw data is saved as lines 0033-0035 in project 'jcr_18003_h'.

### 5.1.4 TOPAS (PS018) Sub-bottom Profiler

The hull-mounted Kongsberg Marine TOPAS (PS018) sub-bottom profiler was used intermittently in support of the ICEBERGS and Burdwood Bank components of JR18003. Generally, TOPAS was run for a single line through each station within each fjord to investigate the shallow seabed subsurface to ensure that there was sufficient sediment and identify targets prior to deploying the gravity corer (see 5.4.3 section for further details). Additional lines were run on an opportunistic basis over deeper basins within or near each fjord to locate extra sites for gravity coring. At Burdwood Bank TOPAS was run concurrently with the EM122 to help confirm a site's suitability for miniAGT deployment and identify suitable targets for future gravity coring.

### 5.1.5 Data Acquisition

All lines were run in water less than 700 m. Typical parameter settings on the control work station are summarised in Table 5.1.2. Data was acquired using Kongsberg Marine TOPAS acquisition software version 1.7.0. The TOPAS was operated in a synchronised mode with other echo sounders through an external trigger issued from the KSYNC unit (see EM122 section for further details). A time variable gain (TVG) and small adjustments to Pulse Form, Power, Gain and Beam Control were used to improve imaging of the seafloor on the screen display. Lines were run with a ship speed <6 kn within the fjords and <8 kn at Burdwood Bank. During acquisition both raw and segy formats were recorded. Acquisition parameters were changed from time to time with parameter changes summarised in JR18003's TOPAS event log. A copy of this log is available on request from the UK Polar Data Centre (polardatacentre@bas.ac.uk).

*Table 5.1.2: Summary of typical TOPAS acquisition parameters generally used on JR18003. Please contact the UK Polar Data Centre (polardatacentre@bas.ac.uk) for a copy of the TOPAS event log.*

| Acquisition Parameters | | |
|---|---|---|
| Transmitter | Mode | Normal |
| | Trigger | External |
| | Pulse Form | Chirp (LFM) |
| | Start Frequency | 1 kHz |
| | Stop Frequency | 5 kHz |
| | Chirp Length | 10-20 ms |
| | Power Level | 0 to -3 dB |
| | HRP | Enabled |
| | Beam Forming | Auto |
| Receiver | Delay Control | Manual |
| | Master Trigger Delay | Depth dependant |

| | | |
|---|---|---|
| | Delay offset | 0 ms |
| | Sample Rate | 30 kHz |
| | Trace Length | Generally 200ms but did increase occasionally when bottom lost or passing over rapidly changing depths. |
| | Gain | 10 dB |
| | HP-filter | 1kHz |
| Depth Selector | Enabled | Generally used Bottom Tracker 1 over EM122 since the EM122 was operating at the shallow end of its range. |
| Average Sound Speed Selector | Enabled | 1500 m/s |
| Processing Chain | | |
| Filters | Filter Type | Matched |
| | Corner Frequencies | Auto |
| Bottom Tracker | Enabled | Used this feature when bottom detection was lost/lagging. |
| | Show Master Depth | Enabled |
| | Window Start | Depth dependant |
| | Window Length | 8 ms |
| | Threshold | 30% |
| | Auto Search | Disabled |
| Time Variable Gain (TVG) | Enabled | TVG values were set by clicking and dragging the squares in the Single Trace Area. See JR18003 TOPAS event log for values used. |
| | TVG control | Tracking |
| | Offset | -5 ms |
| Attribute Processing | Enabled | Instant Amplitude. |

### 5.1.6 Problems Encountered

The intention was for the TOPAS output files (both. raw and segy) to be labelled with meaningful names using the acquisition software. Instead, files received names using a time stamp from when recording started (YYYYMMDDHHMMSS.raw), writing to new files when the maximum file size was reached or when SEGY files were split (as this option was enabled). It is recommended for future acquisition that the *Split RAW files like SEG Y files* option is not selected to avoid splitting lines into numerous segments. Table 5.1.3 provides a summary of logged raw file names and the corresponding line numbers as they were referred to in the TOPAS event log.
At times clear interference was observed with the TOPAS and the centre beams EM122. This resulted in false bottom detection both just above and below the actual seabed. It was determined that these artefacts could be processed out of the final bathymetry product.

*Table 5.1.3: Overview of the raw files logged and the name that they are referred to in the TOPAS event log, Burd = Burdwood Bank, MC = Marian Cove, BB = Börgen Bay, SC = Sheldon Cove. Please note that there was no TOPAS raw file that corresponded to Line Number 005 in the event log – it appears that this file did not log correctly, likely due to operator error.*

| Raw Filename | Size (Mb) | Start Time (UTC) | End Time (UTC) | Location | Line Number (TOPAS Log) |
|---|---|---|---|---|---|
| **20181204042209.raw** | 30.91 | 04/12/18 04:22 | 04/12/18 05:25 | Burd | 001 |

| Raw Filename | Size (Mb) | Start Time (UTC) | End Time (UTC) | Location | Line Number (TOPAS Log) |
|---|---|---|---|---|---|
| **20181204052201.raw** | 22.11 | 04/12/18 05:22 | 04/12/18 06:25 | Burd | 001 |
| **20181204062200.raw** | 21.85 | 04/12/18 06:22 | 04/12/18 07:25 | Burd | 001 |
| **20181204072203.raw** | 29.22 | 04/12/18 07:22 | 04/12/18 08:25 | Burd | 001 |
| **20181204082201.raw** | 22.94 | 04/12/18 08:22 | 04/12/18 09:25 | Burd | 001 |
| **20181204092200.raw** | 0.46 | 04/12/18 09:22 | 04/12/18 09:26 | Burd | 001 |
| **20181204092745.raw** | 29.62 | 04/12/18 09:27 | 04/12/18 10:30 | Burd | 002 |
| **20181204102702.raw** | 36.18 | 04/12/18 10:27 | 04/12/18 11:30 | Burd | 002 |
| **20181204112701.raw** | 38.7 | 04/12/18 11:27 | 04/12/18 12:30 | Burd | 002 |
| **20181204122700.raw** | 42.48 | 04/12/18 12:27 | 04/12/18 13:30 | Burd | 002 |
| **20181204132700.raw** | 5 | 04/12/18 13:27 | 04/12/18 13:37 | Burd | 002 |
| **20181204213227.raw** | 24.04 | 04/12/18 21:32 | 04/12/18 22:35 | Burd | 003 |
| **20181204223201.raw** | 25.35 | 04/12/18 22:32 | 04/12/18 23:35 | Burd | 003 |
| **20181204233207.raw** | 43.59 | 04/12/18 23:32 | 05/12/18 00:35 | Burd | 003 |
| **20181205003202.raw** | 30.34 | 05/12/18 00:32 | 05/12/18 01:35 | Burd | 003 |
| **20181205013204.raw** | 4.21 | 05/12/18 01:32 | 05/12/18 01:44 | Burd | 003 |
| **20181205021725.raw** | 49.01 | 05/12/18 02:17 | 05/12/18 03:20 | Burd | 004 |
| **20181205031700.raw** | 35.09 | 05/12/18 03:17 | 05/12/18 04:20 | Burd | 004 |
| **20181205041703.raw** | 33.82 | 05/12/18 04:17 | 05/12/18 05:20 | Burd | 004 |
| **20181205051702.raw** | 36.73 | 05/12/18 05:17 | 05/12/18 06:20 | Burd | 004 |
| **20181205061703.raw** | 40.13 | 05/12/18 06:17 | 05/12/18 07:20 | Burd | 004 |
| **20181205071701.raw** | 34.4 | 05/12/18 07:17 | 05/12/18 08:20 | Burd | 004 |

| Raw Filename | Size (Mb) | Start Time (UTC) | End Time (UTC) | Location | Line Number (TOPAS Log) |
|---|---|---|---|---|---|
| **20181205081701.raw** | 37.69 | 05/12/18 08:17 | 05/12/18 09:20 | Burd | 004 |
| **20181205091700.raw** | 32.9 | 05/12/18 09:17 | 05/12/18 10:20 | Burd | 004 |
| **20181205101704.raw** | 30.38 | 05/12/18 10:17 | 05/12/18 11:13 | Burd | 004 |
| **20181210153209.raw** | 3.97 | 10/12/18 15:32 | 10/12/18 15:40 | MC | 006 |
| **20181210154030.raw** | 5.56 | 10/12/18 15:40 | 10/12/18 15:45 | MC | 006 |
| **20181210154600.raw** | 1.31 | 10/12/18 15:46 | 10/12/18 15:48 | MC | 006 |
| **20181210154804.raw** | 20.5 | 10/12/18 15:48 | 10/12/18 16:11 | MC | 006 |
| **20181210205147.raw** | 12.67 | 10/12/18 20:51 | 10/12/18 21:05 | MC | 007 |
| **20181210210544.raw** | 15.19 | 10/12/18 21:05 | 10/12/18 21:17 | MC | 007 |
| **20181214013002.raw** | 3.19 | 14/12/18 01:30 | 14/12/18 01:34 | BB | 008 |
| **20181214013430.raw** | 9 | 14/12/18 01:34 | 14/12/18 01:46 | BB | 008 |
| **20181214014604.raw** | 6.14 | 14/12/18 01:46 | 14/12/18 01:54 | BB | 008 |
| **20181214022122.raw** | 20.99 | 14/12/18 02:21 | 14/12/18 02:56 | BB | 009 |
| **20181214025604.raw** | 14.19 | 14/12/18 02:56 | 14/12/18 03:20 | BB | 009 |
| **20181214145009.raw** | 8.75 | 14/12/18 14:50 | 14/12/18 15:01 | BB | 010 |
| **20181214150607.raw** | 20.99 | 14/12/18 15:06 | 14/12/18 15:33 | BB | 011 |
| **20181214153331.raw** | 6.22 | 14/12/18 15:33 | 14/12/18 15:41 | BB | 011 |
| **20181214154129.raw** | 6.67 | 14/12/18 15:41 | 14/12/18 15:53 | BB | 011 |
| **20181214155602.raw** | 0.94 | 14/12/18 15:56 | 14/12/18 15:57 | BB | 012 |
| **20181214155743.raw** | 16.51 | 14/12/18 15:57 | 14/12/18 16:18 | BB | 012 |
| **20181215081949.raw** | 11.86 | 15/12/18 08:19 | 15/12/18 08:40 | BB | 013 |

| Raw Filename | Size (Mb) | Start Time (UTC) | End Time (UTC) | Location | Line Number (TOPAS Log) |
|---|---|---|---|---|---|
| **20181215084038.raw** | 0.22 | 15/12/18 08:40 | 15/12/18 08:41 | BB | 013 |
| **20181215084103.raw** | 0.13 | 15/12/18 08:41 | 15/12/18 08:41 | BB | 013 |
| **20181215084119.raw** | 0.18 | 15/12/18 08:41 | 15/12/18 08:41 | BB | 013 |
| **20181221093549.raw** | 20.99 | 21/12/18 09:35 | 21/12/18 10:01 | SC | 014 |
| **20181221100120.raw** | 16.29 | 21/12/18 10:01 | 21/12/18 10:24 | SC | 014 |
| **20181221102429.raw** | 0.11 | 21/12/18 10:24 | 21/12/18 10:24 | SC | 014 |
| **20181221102436.raw** | 2.34 | 21/12/18 10:24 | 21/12/18 10:28 | SC | 014 |
| **20181221102855.raw** | 0.44 | 21/12/18 10:28 | 21/12/18 10:30 | SC | 014 |
| **20181221103011.raw** | 8.42 | 21/12/18 10:30 | 21/12/18 10:50 | SC | 014 |
| **20181221105044.raw** | 1.16 | 21/12/18 10:50 | 21/12/18 10:51 | SC | 014 |
| **20181221105152.raw** | 1.88 | 21/12/18 10:51 | 21/12/18 10:55 | SC | 014 |
| **20181221105527.raw** | 20.99 | 21/12/18 10:55 | 21/12/18 11:34 | SC | 015 |
| **20181221113413.raw** | 12.87 | 21/12/18 11:34 | 21/12/18 11:51 | SC | 015 |
| **20181221115132.raw** | 4.45 | 21/12/18 11:51 | 21/12/18 11:59 | SC | 015 |
| **20181221140424.raw** | 14.78 | 21/12/18 14:04 | 21/12/18 14:21 | SC | 016 |
| **20181221142153.raw** | 2.28 | 21/12/18 14:21 | 21/12/18 14:26 | SC | 016 |

### 5.1.7 TOPAS Targets

The following section summarises TOPAS data recorded at each gravity coring location during JR18003 and identifies potential future coring targets found on Burdwood Bank.

#### Burdwood Bank

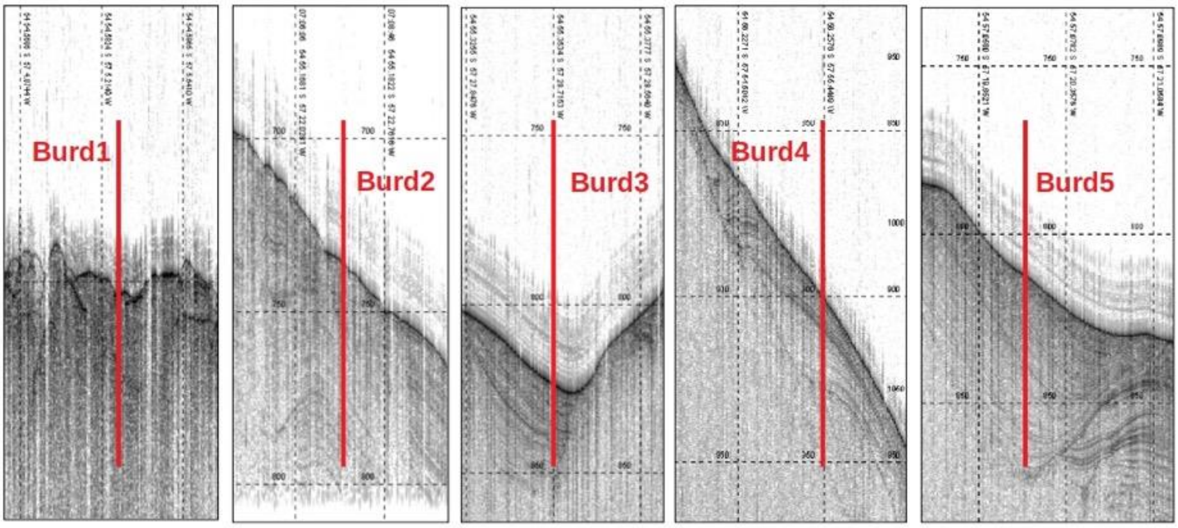



*Figure 5.1.14: TOPAS profiles identifying potential targets for gravity coring at Burdwood Bank. These sites are summarised further in Table 4.*

*Table 5.1.4: Summary of location and depths for gravity core targets identified from TOPAS data at Burdwood Bank. No coring was undertaken at these sites on JR18003.*

| Site Name | Latitude (DM) | Longitude (DM) | WaterDepth (m) | Raw file |
|---|---|---|---|---|
| **Burd1** | -54° 54'.5850 | -57° 7'.1929 | 300 | 20181204052201.raw |
| **Burd2** | -54° 55'.1765 | -57° 22'.4728 | 550 | 20181204062200.raw |
| **Burd3** | -54° 55'.3534 | -57° 28'.7153 | 620 | 20181204072203.raw |
| **Burd4** | -54° 56'.2676 | -57 ° 55'.4409 | 675 | 20181204082201.raw |
| **Burd5** | -54° 57'.1428 | -57° 22'.5095 | 615 | 20181205091700.raw |

## Marian Cove

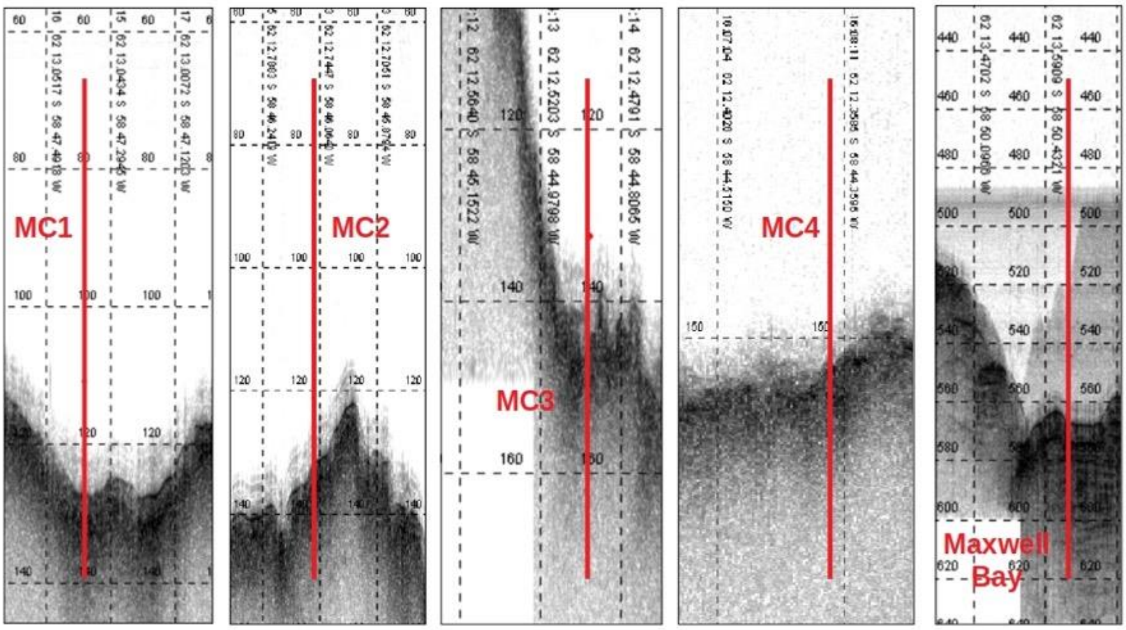



*Figure 5.1.15: TOPAS profiles at stations MC1, MC2, MC3, MC4 and Maxwell Bay from Marian Cove, King George Island. Red lines indicate the location on the profile that was targeted by gravity coring and are summarised further in Table .*

*Table 5.1.5: Summary of location and depths for gravity core targets identified from TOPAS data at Marian Cove. Please refer to section 5.4.3 for further details and description of the cores retrieved from each site.*

| Site Name | Latitude (DM) | Longitude (DM) | Water Depth (m) | Raw file | Success |
|---|---|---|---|---|---|
| **MC1** | -62° 13'.0484 | -58° 47'.3562 | 109 | 20181210154804.raw | Y |
| **MC2** | -62° 12'.7475 | -58° 46'.0762 | 103 | 20181210154804.raw | Y |
| **MC3** | -62° 12'.4930 | -58° 44'.8641 | 125 | 20181210154804.raw | Y |
| **MC4** | -62° 12'.3652 | -58° 44'.3815 | 130 | 20181210154804.raw | N |
| **Maxwell Bay** | -62° 13'.6347 | -58° 50'.5674 | 430 | 20181210210544.raw | Y |

## Börgen Bay

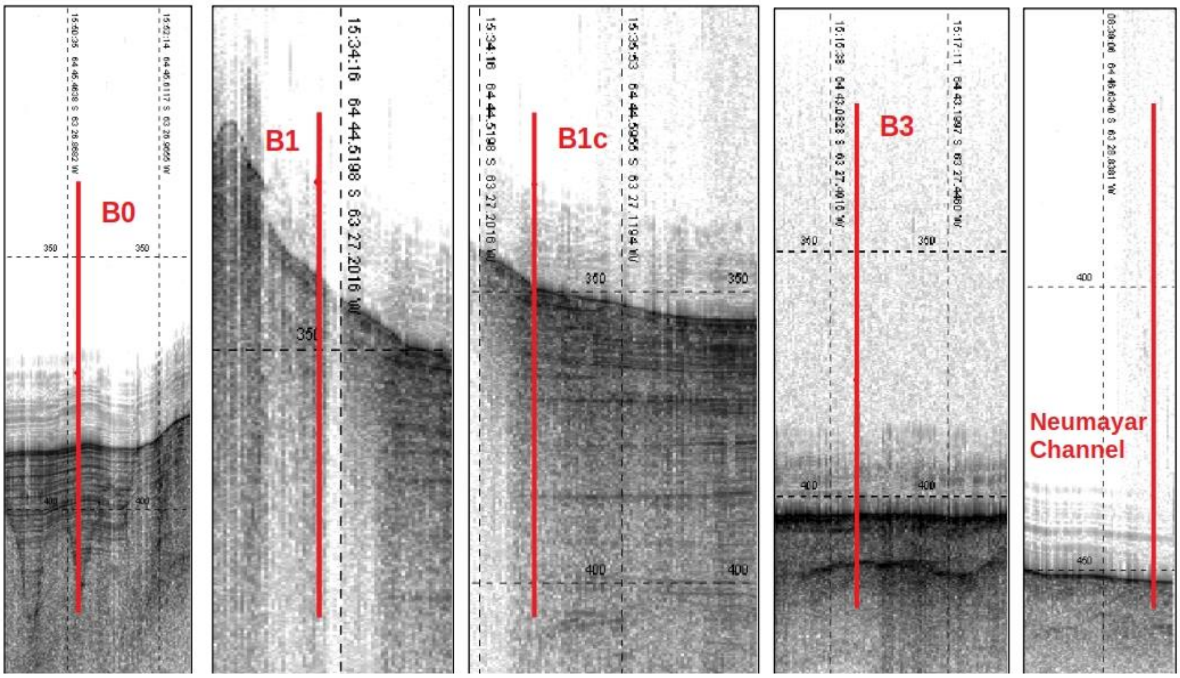



*Figure 5.1.16: TOPAS profiles at stations BB0, BB1, BB1c, B3 and Neumayer Channel from Börgen Bay, Anvers Island. Red lines indicate the location on the profile that was targeted by gravity coring, and are summarised further in Table .*

*Table 5.1.6: Summary of location and depths for gravity core targets identified from TOPAS data at Börgen Bay. Please refer to section 5.4.3 for further details and description of the cores retrieved from each site.*

| Site Name | Latitude (DM) | Longitude (DM) | Depth (m) | Raw file | Success |
|---|---|---|---|---|---|
| **BB0** | -64° 45’.4713 | -63° 26’.8728 | 299 | 20181214154129.raw | Y |
| **BB1** | -64° 44’.5026 | -63° 27’.2047 | 265 | 20181214153331.raw | N |
| **BB1c** | -64° 44’.5503 | -63° 27’.1715 | 269 | 20181214153331.raw | N |
| **BB3** | -64° 43’.1069 | -63° 27’.4937 | 311 | 20181214150607.raw | Y |
| **Neumayer Channel** | -64° 46’.6671 | -63° 28’.8280 | 345 | 20181215081949.raw | N |

## Sheldon Cove

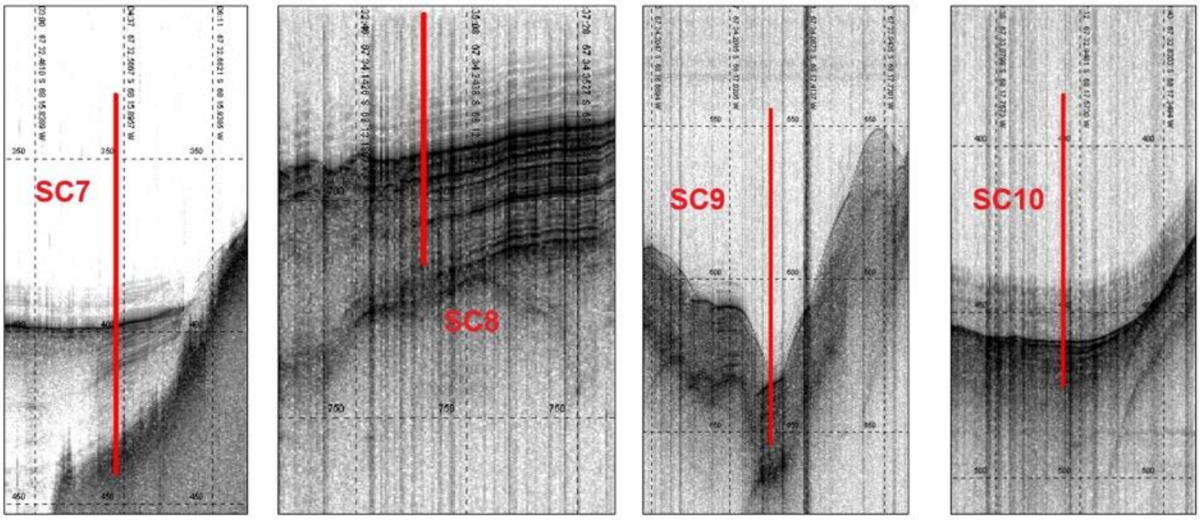



*Figure 5.1.17: TOPAS profiles at stations SC7, SC8, SC9 and SC10 from Sheldon Cove, Adelaide Island. Red lines indicate the location on the profile that was targeted by gravity coring, and are summarised further in Table 5.1.7.*

*Table 5.1.7: Summary of location and depths for gravity core targets identified from TOPAS data at Sheldon Cove. Please refer to section 5.4.3for further details and description of the cores retrieved from each site.*

| Site Name | Latitude (DM) | Longitude (DM) | Water Depth (m) | Raw file | Success |
|---|---|---|---|---|---|
| **SC7** | -67° 32’.5595 | -68° 15’.8919 | 293 | 20811221100120.raw | Y |
| **SC8** | -67° 34’.2416 | -68° 12’.7196 | 508 | 20181221103011.raw | Y |
| **SC9** | -67° 34’.1499 | -68° 17’.2184 | 468 | 20181221105527.raw | Y |
| **SC10** | -67° 32’.9562 | -68° 17’.5865 | 336 | 20181221113413.raw | Y |

## 5.2 Oceanography

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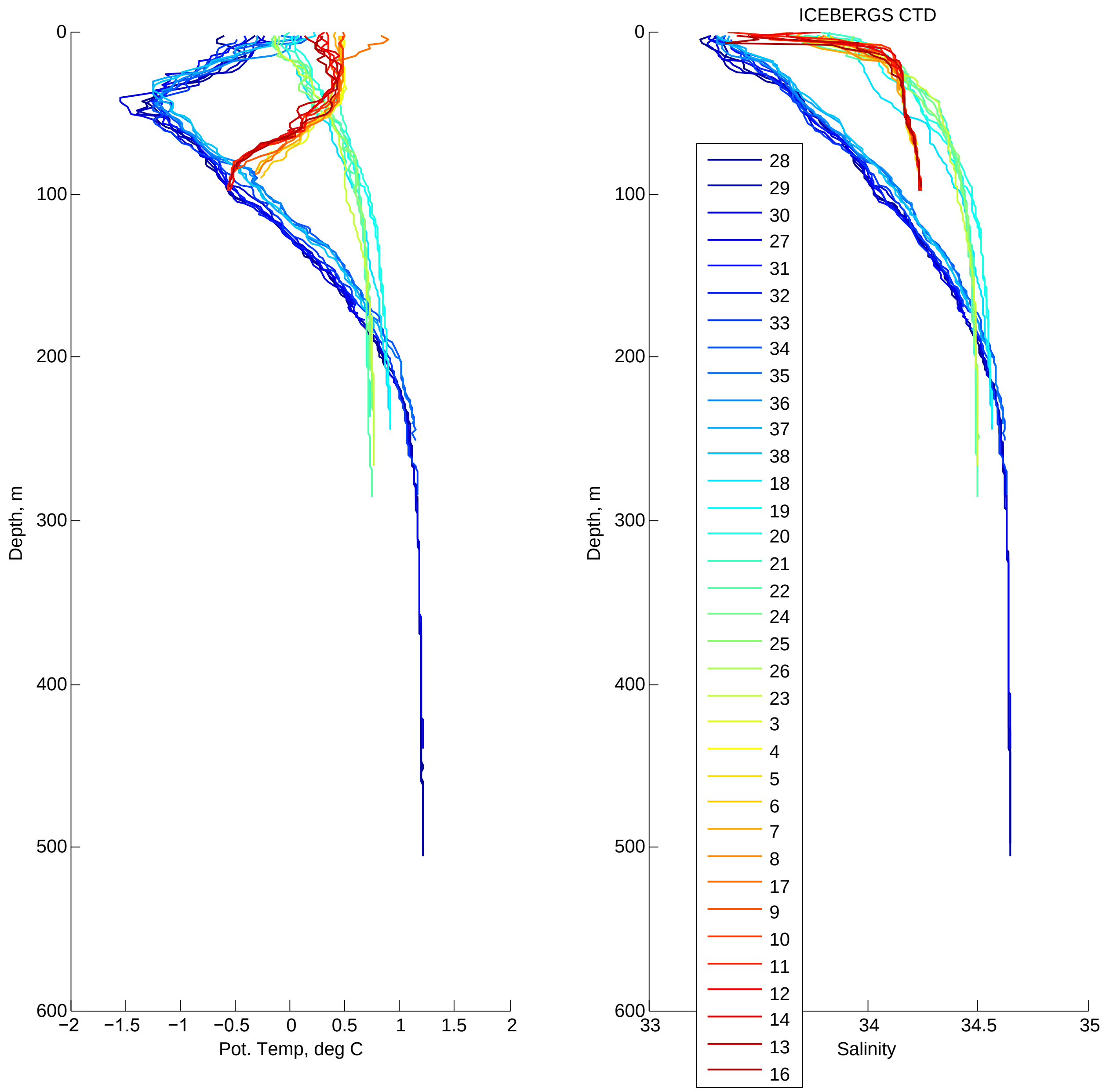
**Marina Costa**, CTD & LADCP set-up (SAERI, Falkland Islands)
**James Williams,** running salinometer samples (Cardiff U.)
**Alice Guzzi,** running salinometer samples (MNA U. Genoa)
**George Dadd**, EK80 data (Kiote Ltd)
**Floyd Howard**, VMADCP data

### 5.2.1 CTD

CTD/LADCP deployments, with water sampling for salinity, nutrients, oxygen isotopes ($dO^{18}$), microplastics, Radium samples for RACETRAX and rare earth elements (REE) for GLARE (James W.) and diatom samples (James W) were performed at the fifteen ICEBERGS sites. Typically, at each of the ICEBERGS sites, one CTD was collected for 'ICEBERGS' during which nutrients, salts, $dO^{18}$, REE, diatoms, microplastics and radium were sampled. The 'ICEBERGS' CTD was followed by one to two 'RACETRAX' CTDs in which only Radium samples were collected. In addition to the above, one successful CTD was deployed (CTD 1) in Burdwood Bank for the Marine Management Area of the Falkland Islands project (A. M. de Lecea). The ICEBERGS sites are represented by CTD casts 3-17 (Marian Cove), 18-26 (Börgen Bay) and 27-38 (Sheldon Glacier) and summarised in Table 5.2.1. All original CTDLADCP/Bottlesample logsheets, can be found in: scientific_work_areas/CTD_LADCP/CTD_logsheets.

Salinity samples from the entire cruise were used to calibrate the CTD conductivity sensors. Seawater samples for oxygen isotope ratio analysis were taken in glass bottles from both the CTD Niskins (see Table 5.2.2) and the underway pumped seawater supply (40 samples), to investigate the variability in freshwater sources with distance from the glacial sites and/or from the sea ice edge (see Table 5.2.3). The samples will be analysed ashore by Mike Meredith. In addition diatom samples were collected from the underway data (Table 5.2.3).

Interestingly, it is noted that temperatures in Marian Cove and Börgen Bay appear to be much warmer than during JR17001, even at 250 m (Nov-Dec 2017). To confirm this raw CTD data files were double checked.




*5.2.1 Potential temperature and salinity depth profiles at the ICEBERGS sites (legend shows CTD numbers). Note warmer circumpolar deep water influence in Börgen Bay and Sheldon compared with Marian Cove.*

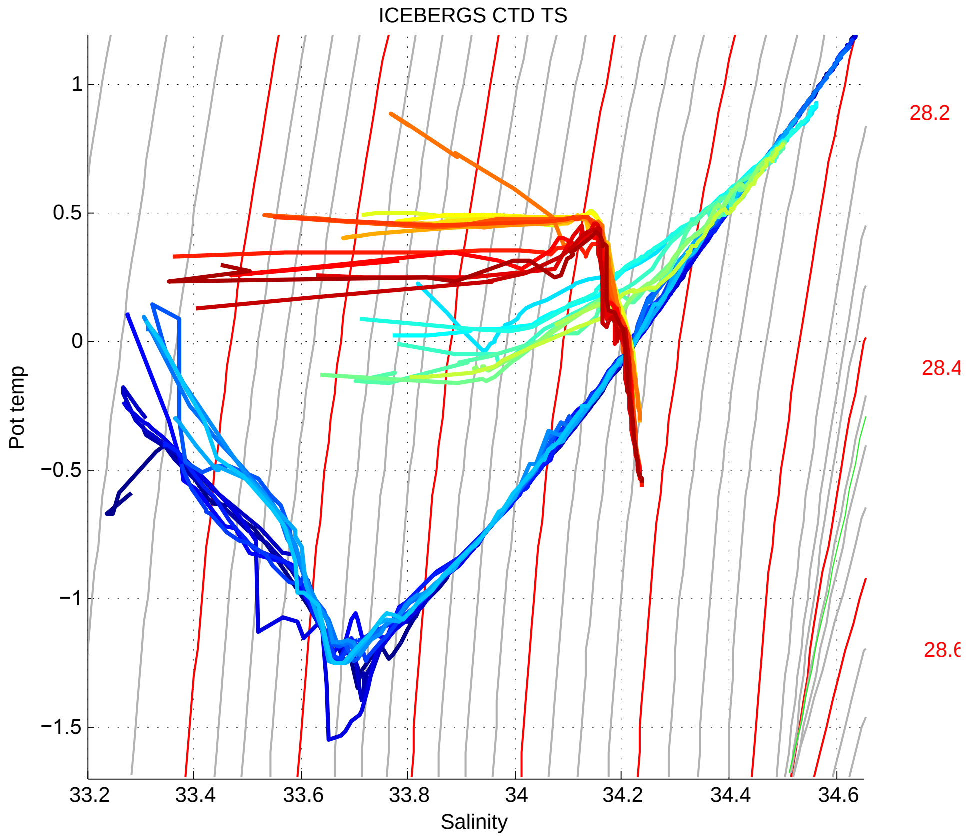



*Figure 5.2.2 T-S relationship at the ICEBERGS sites. See Figure 5.2.1 for legend.*

## CTD operations and initial data processing

The CTD instrumentation and setup are described in the AME cruise report. CTD data were acquired with SeaSave V 7.22.3. Subsequently, three steps were run in SBE Data Processing: Data Conversion, to export the data as a text (.cnv) file; Align CTD, to apply a time alignment offset to the oxygen data (note that the hysteresis correction is applied subsequently); and Cell Thermal Mass, to correct the conductivity readings. The settings for these steps are provided by the manufacturer.

## Water sampling and analysis

As descried above water samples were taken for several different analyses and projects. In this section we largely cover salinity samples taken to calibrate the CTD conductivity. It is desirable to take salinity samples in locations of relatively stable water properties, covering a range of conductivity and oxygen values, as well as temperature and pressure. For oxygen 18 samples it is desirable to take samples over a range of depths and water masses, including in or at the edge of pycnoclines. However, in practice to save water for Radium, commonly, nutrients, $dO^{18}$, REE and salinity were taken from the same bottles (see Table 5.2.2). Opportunistic microplastics sampling was also performed on free Niskin bottles and diatom samples were taken from the shallowest bottle depth.

### Salinity

Salinity samples were taken in 200 mL glass sample bottles, rinsed three times before filling and sealed with clean dry stoppers. Crates of samples were stored in the Bio Lab for a minimum of 12 hours before analysis to allow equilibration to laboratory temperature (approximately 22 deg C).

The samples were analysed for conductivity using a BAS-supply Guildline 8400B Salinometer, with a cell temperature of 24 C, following standard procedures as described in the GO-SHIP manual and cruise reports for JR306, JR15003, and JR16002. Bottle conductivity ratio readings were logged both by hand and using the OSIL Salinometer Data Logger software. IAPSO standard seawater bottles (batch P162) run before and after each crate of samples were used to compute a linearly drifting offset by reference to the nominal conductivity ratio of the standard. The auto-salinometer instrument proved to be rather flaky, with the pump or flush constantly breaking, and several bubbles – this was the case particularly at the start of the cruise (see AME report). As such in some cases multiple readings had to be taken for each salinity sample and the variability is quite high from some crates. Obvious outliers were removed during processing (msal_standardise_avg).

### Oxygen Isotopes (d$^{18}$O)

Samples were collected in glass bottles from the CTD Niskins, following REE sample collection and before collection of salinity and other samples (see Table 5.2.2). In addition oxygen isotope samples were collected roughly four times a day from the underway tap whilst in the ICEBERGS study sites (see Table 5.2.3).

### CTD data processing and calibration

Data were processed (KLS) using Mexec 3.1, a suite of MATLAB programs developed by the Ocean Circulation and Processes group at the NOC as kindly left set-up by Yvonne Firing from the previous cruise (JR18002). Processing log files can be found in scientific_work_areas/CTD_LADCP/CTD_processing_logs. NB. There was a problem processing CTD 15 (which was a sound velocity profile for multibeam work).

The CTD temperature sensor was calibrated by comparison with SBE35 values obtained at bottle firing times. The conductivity (salinity) were calibrated by comparison between laboratory analysed values from Niskin water samples, and CTD values at bottle firing times as noted below.

| | |
|---|---|
| temp1 | 0 |
| temp2 | -0.0025 |
| cond1 | 0 |
| cond2 | +0.0025/35+1 |

*CTD calibrations applied to each of the temperature and conductivity sensors. Due to generally shallow CTD casts, and the highly variable temperature and salinities found in the fjords, along with several auto-sal samples being unusable, it was decided to only apply constant offsets to data (rather than as a function of station number or pressure).*

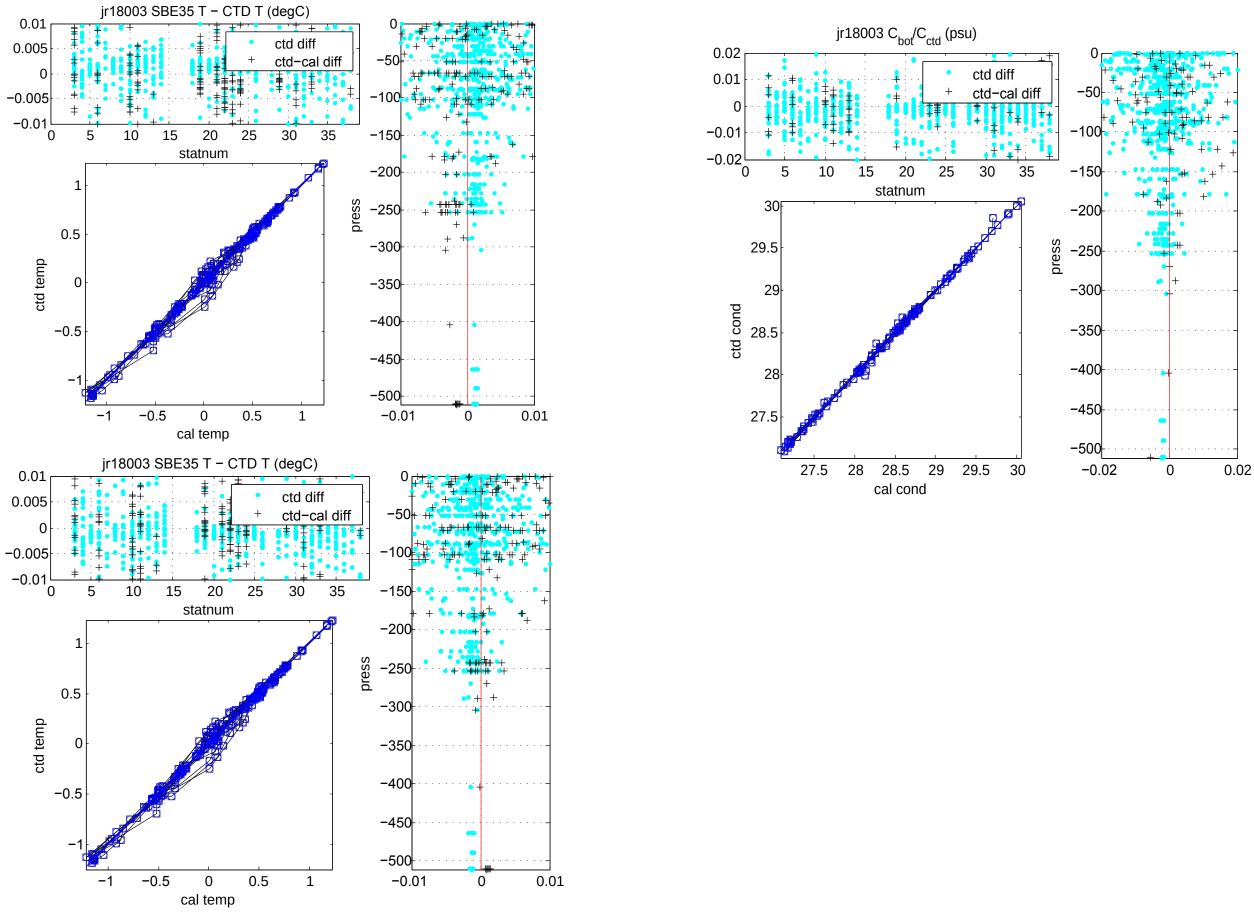



*Figure 5.2.3 Comparison of SBE35 and CTD temperature sensor 2 (in salinity equivalent units) before (left) and after (right) calibration. The top left panels show residuals as a function of time. Cyan dots are the differences between the two CTD sensors.*

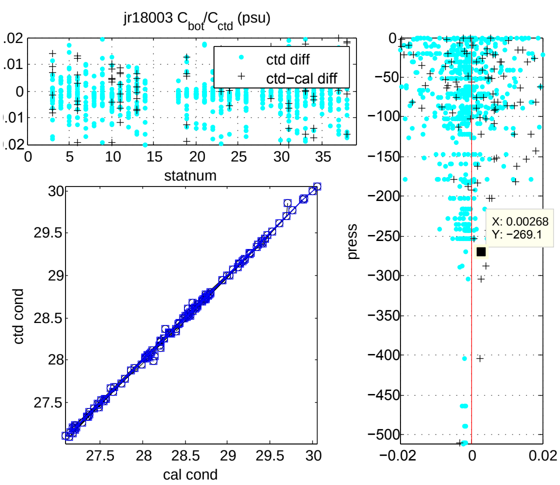



*Figure 5.2.4 Comparison of bottle and CTD conductivity sensor 2 (in salinity equivalent units) before (left) and after (right) calibration. The top left panels show residuals as a function of time. Cyan dots are the differences between the two CTD sensors.*

Key output files include:
ctd_jr18003_*nnn*_csv_list_2dbar_down.csv (*nnn* is station number: in data/collected_files or scientific_work_area/ctd_calibrated_ctdfiles)
sam_jr18003_csv_list_nisk_surf_to_deep.csv
station_summary_jr18003_all.nc
opt_jr18003.m (has bottle flags, calibration settings etc)

Finalised files were also output into CCHDO exchange file formats as icebergs_74JC20181201*.csv (in collected_files or scientific_work_area/ctd_calibrated_ctdfiles/cchdo_files).

### 5.2.2 LADCP

The 300-kHz Workhorse lowered acoustic Doppler current profiler (LADCP) was installed in a downward-looking configuration on the CTD rosette. The instrument was configured to sample 25 x 8- m bins, with data collected in beam coordinates and rotated to earth coordinates during processing. The LADCP was connected to a charger and by a serial cable to the CTD computer in the UIC for programming prior to each station and data download after each station using BBTalk. Data downloaded after each station were copied to the network data drive. No LADCP data was recorded on a few stations (2, 25, 26 and 35) do to set up errors. CTD 5 was also not deep enough to produce useful data. Overall, however, the LADCP does appear to have produced reasonable measurements. Log files are incorporated into CTD logs (see: scientific_work_areas/CTD_LADCP/CTD_logsheets). LADCP data were processed with the LDEO IX software, incorporating ship navigation and CTD pressure streams to constrain the solution for earth-relative velocity from the measured instrument-relative velocity.

### 5.2.3 VMADCP

VMADCP data collected in RDI's VMDAS software were also collected. The VMADCP was set up through VMDAS and configured with 8-m bins for most of the cruise (mostly shallow waters). Bottom tracking was switched on to begin with when in shallow water, before being changed to water tracking. Changes in VMADCP set-up (i.e. file numbers, bottom or water track etc were recorded digitally in the VMADCP event log and on a paper copy (scanned and placed in legwork in: scientific_work_areas/CTD_LADCP/CTD_logsheets). Further processing was not achieved due to difficulties with python codes and CODAS set-up. Post-processing ashore will need to be performed in due course.

### 5.2.4 EK80

The EK80 supersedes the EK60 Eco sounder which was previously used to identify Krill. The upgraded system is potentially more powerful and has enabled provision of a graphical display of density structures in the water column. In real time, this system highlighted regions where enhanced mixing was present and helped us to inform sampling strategy for the Vertical Mixing Profiler. We recorded data at the three sampling sites typically when passing over a sill, or whilst conducting CTD or VMP sampling. Continuous data recording was not possible due to storage and network capacity.

The data will provide an additional data set to support the findings of the VMP and CTD. The figure shows density changes in the water column detected by the EK80. The soundings are produced by transponders ES38 ES70 and ES120 which capture features of interest using low to high frequencies respectively. A hand written log was created which has been placed in 'Scientific_workarea/ek60_ek80' along with a selection of screen shots (e.g. Figure 5.2.5).

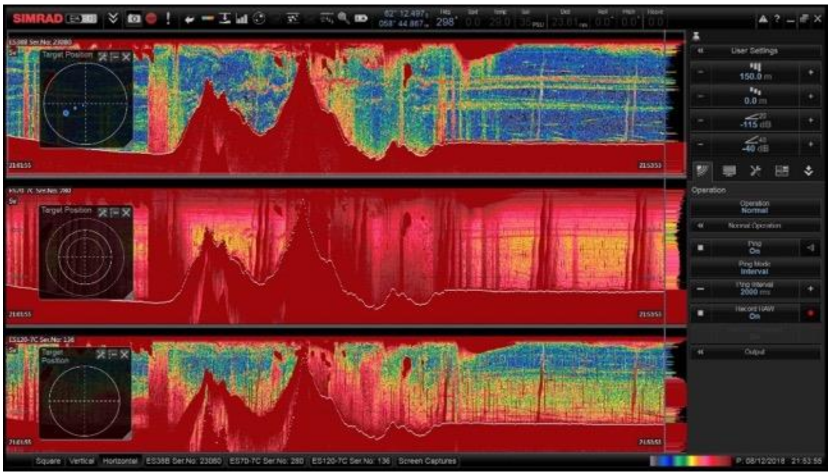


*Figure 5.2.5: Screen shot from EK80 over the sill at Marian Cove.*

**Issues to correct:**

1. Systematic vertical lines are seen, particularly in the ES70 and ES120 images. These are potentially from unwanted noise sources and other transponders. It is recommended that BAS configure the EK80's transponders to trigger sequentially with the other transponders on the ship by configuring the synchronisation mode.

2. The computer system stores sequential data at the rate of 102MB per minute. The disk size on the networked data storage space was not sufficient for round the clock data recording. We used a separate portable hard drive and reduced sampling to short durations to overcome this problem. It is recommended that BAS allocate more network space to allow round the clock sampling. Scientists using this equipment are advised to discuss data capacity in advance of the next cruise and bring own hard drives to take the data away further processing.

**Settings:**

Settings are potentially crucial for obtaining mix layer data. (see Acoustic mapping of mixed layer depth, Christian Stranne et al 2018, Ocean Sci.)

***User Settings:*** Most recent settings file is 'JCR18003C' which is stored on computer named 'PU1' for the EK80 system. The file can be selected from EK80 software under 'user settings'.

*Further info available at www.simrad.com/ek80*

### 5.2.5 Other Underway Data

The hydrographic measurements are complemented by ocean current and underway surface ocean and meteorological observations. The SCS underway data streams for navigation, meteorological parameters, and thermosalinograph (TSG) were read in and processed on a daily basis using Mexec v3.1. Processing included the removal of out-of-range values (or values when the seawater pumps were off, in the case of the TSG), some automatic despiking, and averaging (vector averaging in the case of the wind data). The TSG salinity was calibrated, following the same procedure described in 12.2.4, using samples taken from the underway pumped seawater supply throughout the cruise, at 6-hourly intervals during the active segments and opportunistically at other (i.e. steaming segments). Data was highly variable in the fjords (likely due cold freshwater influx) but confidence is gained as it stabilised during steaming periods (See Figure 5.2.6). It was decided to apply a constant offset calibration of +0.0159 to salinity values based on the mean of the smoothed difference between the bottle salinity and TSG values (see black line in Figure 5.2.6). This is corrected in mday_01_clean_ave.m.

Useful output files from Underway processing:

- sam_jr18003_all.nc
- **_jr18003_01.nc where ** is: ea600; em122; anemometer; furuno_gga; gyro_s_; seatex_hdt; bst; tsshrp; dopplerlog; oceanlogger;
- data/ocl/tsg/oceanlogger_jr18003_01_medav_clean.nc
- data/ocl/tsg/oceanlogger_jr18003_01_medav_clean_cal.nc
- Note scs_mat files are unprocessed.
- Other met files: met_jr18003_true.nc; met_jr18003_treuav.nc;
  met files: The latter file is reduced to 1-minute averages, with correct vector averaging when required. In order to avoid ambiguity, variable units are explicit in whether wind directions are 'towards' or 'from' the direction in question. The result is a bit cumbersome, but should be unambiguous if the units are read carefully. Note: TECHSAS stores wind speed in m/s, but says the variable unit is knots.

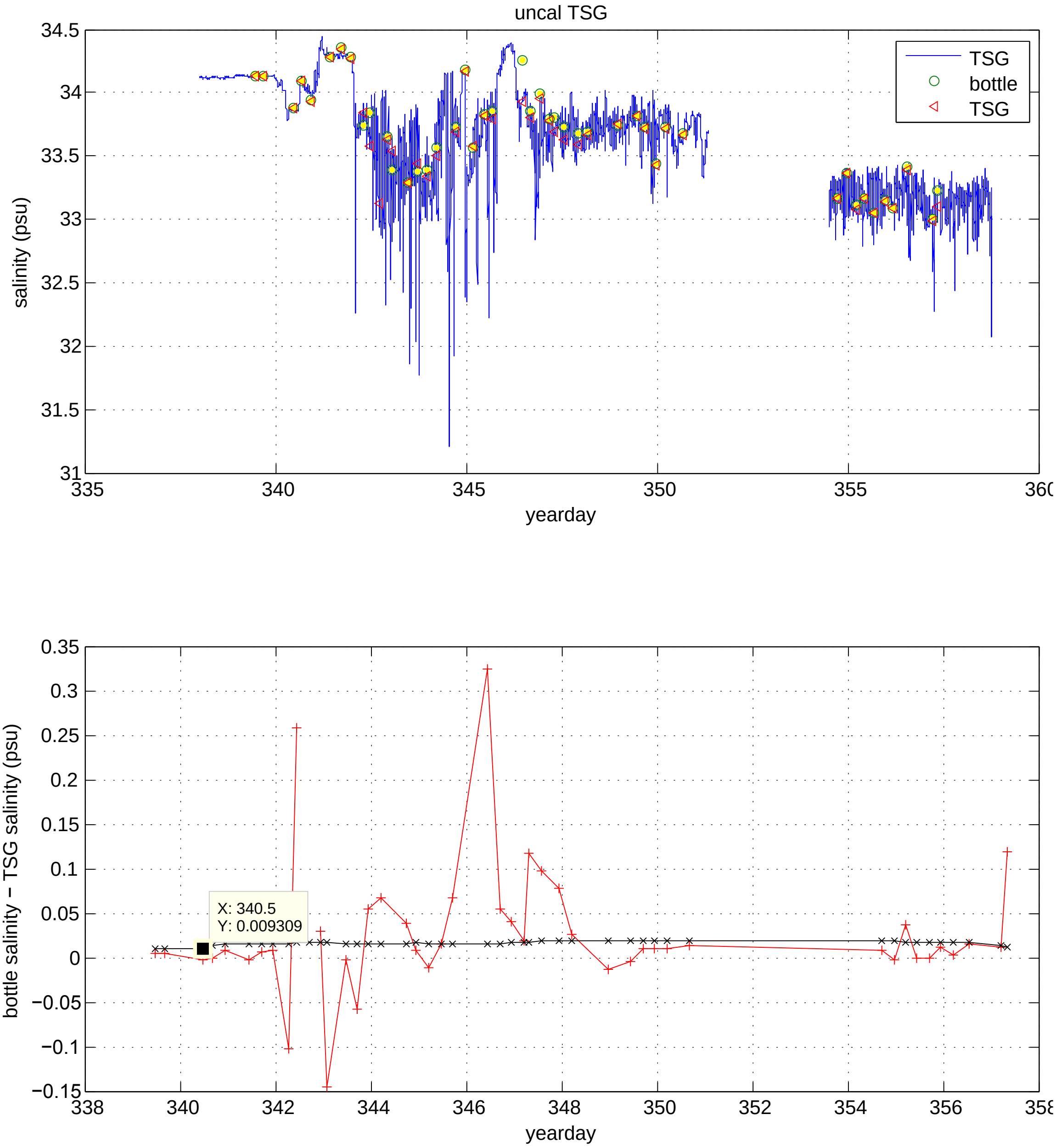



*Figure 5.2.6: TSG and bottle salinities before calibration (top), with differences (bottom); the smoothed black function was used to calibrate the TSG record.*

*Table 5.2.1 Summary of CTD stations at Burdwood Bank (grey), Marian Cove (blue), Börgen Bay (red) and Sheldon Glacier (yellow).*

| stn | yy/mo/dd | hhmm (at bottom) | dg | min | lat | dg | min | lon |
|---|---|---|---|---|---|---|---|---|
| 1 | 18/12/03 | 809 | 55 | 11.21 | S | 57 | 55.46 | W |
| 3 | 18/12/08 | 327 | 62 | 13.06 | S | 58 | 47.35 | W |
| 4 | 18/12/08 | 600 | 62 | 13.06 | S | 58 | 47.35 | W |
| 5 | 18/12/08 | 740 | 62 | 13.06 | S | 58 | 47.34 | W |
| 6 | 18/12/08 | 934 | 62 | 12.77 | S | 58 | 46.12 | W |
| 7 | 18/12/08 | 1116 | 62 | 12.77 | S | 58 | 46.11 | W |
| 8 | 18/12/08 | 1230 | 62 | 12.78 | S | 58 | 46.13 | W |
| 9 | 18/12/08 | 2214 | 62 | 12.5 | S | 58 | 44.87 | W |
| 10 | 18/12/08 | 2323 | 62 | 12.49 | S | 58 | 44.89 | W |
| 11 | 18/12/09 | 145 | 62 | 12.36 | S | 58 | 44.39 | W |
| 12 | 18/12/09 | 316 | 62 | 12.35 | S | 58 | 44.39 | W |
| 13 | 18/12/09 | 639 | 62 | 12.2 | S | 58 | 44.12 | W |
| 14 | 18/12/09 | 813 | 62 | 12.27 | S | 58 | 44.15 | W |
| 16 | 18/12/10 | 1630 | 62 | 12.2 | S | 58 | 44.08 | W |
| 17 | 18/12/10 | 1706 | 62 | 12.76 | S | 58 | 46.07 | W |
| 18 | 18/12/12 | 1758 | 64 | 44.5 | S | 63 | 27.21 | W |
| 19 | 18/12/13 | 1546 | 64 | 44.49 | S | 63 | 27.23 | W |
| 20 | 18/12/13 | 1745 | 64 | 44.51 | S | 63 | 27.23 | W |
| 21 | 18/12/13 | 1856 | 64 | 43.56 | S | 63 | 27.14 | W |
| 22 | 18/12/13 | 2032 | 64 | 43.06 | S | 63 | 27.53 | W |
| 23 | 18/12/13 | 2212 | 64 | 42.19 | S | 63 | 27.02 | W |
| 24 | 18/12/13 | 2317 | 64 | 42.65 | S | 63 | 27.27 | W |
| 25 | 18/12/14 | 19 | 64 | 42.65 | S | 63 | 27.27 | W |
| 26 | 18/12/14 | 100 | 64 | 42.64 | S | 63 | 27.26 | W |
| 27 | 18/12/20 | 1312 | 67 | 34.16 | S | 68 | 14.43 | W |
| 28 | 18/12/20 | 1729 | 67 | 34.2 | S | 68 | 13.45 | W |
| 29 | 18/12/20 | 1857 | 67 | 34.2 | S | 68 | 13.51 | W |
| 30 | 18/12/20 | 2029 | 67 | 34.2 | S | 68 | 13.51 | W |
| 31 | 18/12/20 | 2144 | 67 | 32.99 | S | 68 | 16.04 | W |
| 32 | 18/12/20 | 2248 | 67 | 32.98 | S | 68 | 16.06 | W |
| 33 | 18/12/21 | 0 | 67 | 32.35 | S | 68 | 15.82 | W |
| 34 | 18/12/21 | 1217 | 67 | 31.71 | S | 68 | 15.34 | W |
| 35 | 18/12/21 | 1334 | 67 | 31.71 | S | 68 | 15.35 | W |
| 36 | 18/12/21 | 1440 | 67 | 31.72 | S | 68 | 15.35 | W |
| 37 | 18/12/21 | 1559 | 67 | 31.17 | S | 68 | 15.38 | W |
| 38 | 18/12/21 | 1722 | 67 | 30.96 | S | 68 | 15.2 | W |

*Table 5.2.2 Bottle depths for which nutrients, O18, REE and sailinty were sampled. *=no REE taken.*

| CTD_Cast | Lat(Deg) | Lat(Min) | Lon(Deg) | Lon(Min) | J_Day | Time(UTC) | Water_Depth(m) | Niskin | Depth(m) |
|---|---|---|---|---|---|---|---|---|---|
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:38:58 | 95.0 | 11 | 85 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:35:39 | 95.0 | 12 | 77 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:37:40 | 95.0 | 13 | 62.4 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:29:00 | 95.0 | 14 | 47.4 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:40:21 | 95.0 | 15 | 36.4 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:41:20 | 95.0 | 16 | 31.4 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:42:50 | 95.0 | 17 | 21.5 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:44:18 | 95.0 | 19 | 16.4 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:45:50 | 95.0 | 21 | 11.5 |
| 3 | -62 | 13.058 | -58 | 47.348 | 342 | 03:48:05 | 95.0 | 23 | 2.3 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:40:41 | 103.2 | 11 | 93.3 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:42:17 | 103.2 | 12 | 84.7 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:43:43 | 103.2 | 13 | 70.9 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:44:58 | 103.2 | 14 | 61 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:46:28 | 103.2 | 15 | 51.1 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:48:00 | 103.2 | 16 | 36.1 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:49:22 | 103.2 | 17 | 26.1 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:51:14 | 103.2 | 19 | 16.1 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:52:47 | 103.2 | 21 | 11.1 |
| 6 | -62 | 12.774 | -58 | 46.116 | 342 | 09:54:28 | 103.2 | 23 | 6.1 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:29:02 | 105.6 | 11 | 101.5 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:30:09 | 105.6 | 12 | 85.1 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:32:07 | 105.6 | 13 | 75.2 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:33:36 | 105.6 | 14 | 60.2 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:34:38 | 105.6 | 15 | 55.2 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:35:48 | 105.6 | 16 | 50.3 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:37:24 | 105.6 | 17 | 30.4 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:38:59 | 105.6 | 19 | 20.4 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:40:45 | 105.6 | 21 | 7 |
| 10 | -62 | 12.492 | -58 | 44.893 | 342 | 23:41:01 | 105.6 | 23 | 1.9 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:51:02 | 117.5 | 11 | 106.84 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:52:18 | 117.5 | 12 | 100.99 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:53:18 | 117.5 | 13 | 89.4 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:54:53 | 117.5 | 14 | 74.46 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:56:22 | 117.5 | 15 | 59.44 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:58:01 | 117.5 | 16 | 44.61 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 01:59:30 | 117.5 | 17 | 29.74 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 02:00:44 | 117.5 | 18 | 19.61 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 02:02:19 | 117.5 | 20 | 9.45 |
| 11 | -62 | 12.362 | -58 | 44.393 | 343 | 02:03:49 | 117.5 | 22 | 1.55 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:44:44 | 99.0 | 11 | 87.77 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:47:01 | 99.0 | 12 | 74.33 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:48:23 | 99.0 | 13 | 62.47 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:49:44 | 99.0 | 14 | 52.55 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:50:46 | 99.0 | 15 | 47.6 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:51:59 | 99.0 | 16 | 39.6 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:53:18 | 99.0 | 17 | 29.8 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:54:57 | 99.0 | 18 | 14.81 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:56:19 | 99.0 | 20 | 6.66 |
| 13 | -62 | 12.118 | -58 | 44.096 | 343 | 06:58:18 | 99.0 | 22 | 1.7 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:50:26 | 260.8 | 11 | 240 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:52:00 | 260.8 | 12 | 180.4 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:55:07 | 260.8 | 13 | 120.4 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:56:48 | 260.8 | 14 | 90.5 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:58:19 | 260.8 | 15 | 60.7 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 15:59:57 | 260.8 | 16 | 30.8 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 16:00:51 | 260.8 | 17 | 20.8 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 16:02:05 | 260.8 | 18 | 15.8 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 16:03:42 | 260.8 | 20 | 7.7 |
| 19 | -64 | 44.315 | -63 | 27.8 | 347 | 16:05:26 | 260.8 | 22 | 1.2 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 18:57:44 | 249.0 | 11 | 235.65 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:00:05 | 249.0 | 12 | 170.25 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:02:17 | 249.0 | 13 | 130.3 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:04:03 | 249.0 | 14 | 100.36 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:05:12 | 249.0 | 15 | 80.44 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:11:23 | 249.0 | 16 | 50.35 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:12:27 | 249.0 | 17 | 35.4 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:13:59 | 249.0 | 18 | 25.7 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:15:18 | 249.0 | 20 | 8.75 |
| 21 | -64 | 43.567 | -63 | 27.145 | 347 | 19:16:40 | 249.0 | 22 | 2.79 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:32:58 | 288.2 | 11 | 286.3 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:35:13 | 288.2 | 12 | 199.9 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:37:40 | 288.2 | 13 | 100.7 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:39:03 | 288.2 | 14 | 66 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:43:31 | 288.2 | 15 | 50.9 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:44:33 | 288.2 | 16 | 35.9 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:45:23 | 288.2 | 17 | 25.9 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:46:27 | 288.2 | 18 | 16 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:47:29 | 288.2 | 20 | 11 |
| 22 | -64 | 43.074 | -63 | 27.448 | 347 | 20:49:35 | 288.2 | 22 | 3.3 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:15:47 | 280.3 | 11 | 266.31 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:17:53 | 280.3 | 12 | 200.44 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:19:31 | 280.3 | 13 | 160.57 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:21:14 | 280.3 | 14 | 100.69 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:22:51 | 280.3 | 15 | 70.79 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:22:28 | 280.3 | 16 | 50.99 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:28:35 | 280.3 | 17 | 30.97 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:29:37 | 280.3 | 18 | 15.98 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:31:05 | 280.3 | 20 | 8.01 |
| 23 | -64 | 42.190 | -63 | 27.022 | 347 | 22:32:15 | 280.3 | 22 | 3.03 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:20:34 | 265.2 | 11 | 251.1 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:23:21 | 265.2 | 12 | 180.9 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:25:14 | 265.2 | 13 | 121.1 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:26:43 | 265.2 | 14 | 81 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:29:19 | 265.2 | 15 | 55.1 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:30:20 | 265.2 | 16 | 41.2 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:32:45 | 265.2 | 17 | 30.3 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:33:47 | 265.2 | 18 | 21.4 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:35:00 | 265.2 | 20 | 11.4 |
| 24 | -62 | 42.647 | -58 | 27.269 | 347 | 23:36:16 | 265.2 | 22 | 2.6 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:01:36 | 512.0 | 11 | 505.4 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:04:26 | 512.0 | 12* | 400.1 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:07:00 | 512.0 | 13 | 300.5 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:10:37 | 512.0 | 14 | 157.6 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:12:20 | 512.0 | 15 | 120.8 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:13:41 | 512.0 | 16 | 90.9 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:15:29 | 512.0 | 17 | 41 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:16:58 | 512.0 | 18 | 20.4 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:18:26 | 512.0 | 20 | 10.4 |
| 29 | -67 | 34.187 | -68 | 13.602 | 354 | 19:22:54 | 512.0 | 22 | 1.2 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:48:31 | 182.0 | 11 | 176.3 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:49:50 | 182.0 | 12* | 120.7 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:51:21 | 182.0 | 13 | 120.7 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:52:49 | 182.0 | 14 | 100.9 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:53:49 | 182.0 | 15 | 80.8 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:55:24 | 182.0 | 16 | 51 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:56:30 | 182.0 | 17 | 35.2 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:57:30 | 182.0 | 18 | 20.2 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 21:59:15 | 182.0 | 20 | 10.3 |
| 31 | -67 | 33.131 | -68 | 16.058 | 354 | 22:00:40 | 182.0 | 22 | 0.8 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:02:10 | 329.0 | 11 | 284.5 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:04:49 | 329.0 | 12* | 248.0 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:08:49 | 329.0 | 13 | 151 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:10:54 | 329.0 | 14 | 111.2 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:13:10 | 329.0 | 15 | 81.4 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:15:28 | 329.0 | 16 | 60.4 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:16:03 | 329.0 | 17 | 50.4 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:22:34 | 329.0 | 18 | 25.5 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:24:42 | 329.0 | 20 | 10.3 |
| 33 | -67 | 32.983 | -68 | 16.061 | 354 | 00:27:14 | 329.0 | 22 | 0.8 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:20:02 | 259.9 | 11 | 250.2 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:22:23 | 259.9 | 12* | 200.5 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:25:10 | 259.9 | 13 | 151.7 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:27:13 | 259.9 | 14 | 111.7 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:28:39 | 259.9 | 15 | 88.8 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:30:06 | 259.9 | 16 | 62.1 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:32:23 | 259.9 | 17 | 26 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:33:31 | 259.9 | 18 | 16.2 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:34:51 | 259.9 | 20 | 9 |
| 34 | -67 | 34.179 | -68 | 17.117 | 355 | 12:37:19 | 259.9 | 22 | 1.4 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:00:06 | 200.0 | 11* | 190.2 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:02:55 | 200.0 | 12* | 156.6 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:05:07 | 200.0 | 13* | 115.7 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:06:34 | 200.0 | 14* | 80.8 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:07:57 | 200.0 | 15* | 60.7 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:09:15 | 200.0 | 16* | 40.8 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:09:59 | 200.0 | 17* | 31 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:14:50 | 200.0 | 18* | 20.9 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:16:10 | 200.0 | 20* | 11.1 |
| 37 | -67 | 31.167 | -68 | 15.356 | 355 | 16:18:10 | 200.0 | 22* | 0.8 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:23:00 | 200.4 | 1 | 186.1 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:26:46 | 200.4 | 12* | 140.7 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:28:10 | 200.4 | 13 | 125.5 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:29:07 | 200.4 | 14 | 112.7 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:33:06 | 200.4 | 15 | 80.8 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:35:06 | 200.4 | 16 | 60.8 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:36:31 | 200.4 | 17 | 35.9 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:37:46 | 200.4 | 18 | 20.9 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:38:51 | 200.4 | 20 | 10.9 |
| 38 | -67 | 30.954 | -68 | 15.344 | 355 | 17:41:39 | 200.4 | 22 | 0.8 |

*Table 5.2.3 Underway samples log for $O^{18}$ and diatom underway samples. At each station a salinity sample was also taken for underway conductivity calibration.*

| UW Number | YearDay | Date | Time UTC | 018bot | Diatom bottle | LAT | | LON | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 339 | 05-Dec | 11:34 | - | - | 54'57.9969 | S | 57'45.0419 | W |
| 2 | 339 | 05-Dec | 16:09 | - | - | 54'59.9977 | S | 57'40.8987 | W |
| 3 | 340 | 06-Dec | 11:25 | - | - | 58'29.9850 | S | 57'14.0838 | W |
| 4 | 340 | 06-Dec | 16:38 | - | - | 59'19.7691 | S | 57'08.4703 | W |
| 5 | 340 | 06-Dec | 22:59 | - | - | 60'18.6717 | S | 56'18.1003 | W |
| 6 | 341 | 07-Dec | 11:00 | - | - | 61'43.8893 | S | 55'37.6079 | W |
| 7 | 341 | 07-Dec | 17:21 | - | - | 62'03.2586 | S | 57'03.9121 | W |
| 8 | 341 | 07-Dec | 23:08 | - | - | 62'17.2454 | S | 58'16.2532 | W |
| 9 | 342 | 08-Dec | 07:04 | UW9 | UW9 | 62'12.9267 | S | 58'47.7424 | W |
| 10 | 342 | 08-Dec | 11:03 | UW10 | UW10 | 62'12.7191 | S | 58'45.9789 | W |
| 11 | 342 | 08-Dec | 17:03 | UW11 | UW11 | 62'12.5056 | S | 58'44.9482 | W |
| 12 | 342 | 08-Dec | 23:00 | UW12 | UW12 | 62'12.4438 | S | 58'45.1130 | W |
| 13 | 343 | 09-Dec | 01:55 | UW13 | UW13 | 62'12.3644 | S | 58'44.3952 | W |
| 14 | 343 | 09-Dec | 11:25 | UW14 | UW14 | 62'12.3470 | S | 58'44.3896 | W |
| 15 | 343 | 09-Dec | 17:23 | UW15 | UW15 | 62'12.2227 | S | 58'43.9064 | W |
| 16 | 343 | 09-Dec | 23:04 | UW16 | UW16 | 62'12.3620 | S | 58'44.3769 | W |
| 17 | 344 | 10-Dec | 05:07 | UW17 | UW17 | 62'12.4954 | S | 58'44.8741 | W |
| 18 | 344 | 10-Dec | 11:34 | UW18 | UW18 | 62'12.7539 | S | 58'47.2028 | W |
| 19 | 344 | 10-Dec | 17:37 | UW19 | UW19 | 62'12.7552 | S | 58'46.0737 | W |
| 20 | 344 | 10-Dec | 23:11 | UW20 | UW20 | 62'13.6323 | S | 58'50.5765 | W |
| 21 | 345 | 11-Dec | 01:58 | UW21 | UW21 | 62'12.3532 | S | 58'44.3847 | W |
| 22 | 345 | 11-Dec | 11:25 | UW22 | UW22 | 62'13.0594 | S | 58'47.3618 | W |
| 23 | 345 | 11-Dec | 14:00 | UW23 | UW23 | 62'12.8278 | S | 58'46.3628 | W |
| 24 | 346 | 12-Dec | 11:01 | UW24 | UW24 | 64'24.9485 | S | 62'03.5727 | W |
| 25 | 346 | 12-Dec | 17:00 | UW25 | UW25 | 64'44.5015 | S | 63'27.2072 | W |
| 26 | 346 | 12-Dec | 23:00 | UW26 | UW26 | 64'47.3152 | S | 63'31.4525 | W |
| 27 | 347 | 13-Dec | 05:00 | UW27 | UW27 | 64'43.9273 | S | 63'27.0374 | W |
| 28 | 347 | 13-Dec | 08:00 | UW28 | UW28 | 64'43.8211 | S | 63'27.4951 | W |
| 29 | 347 | 13-Dec | 14:00 | UW29 | UW29 | 64'43.9106 | S | 63'26.9228 | W |
| 30 | 347 | 13-Dec | 23:00 | UW30 | UW30 | 64'43.9106 | S | 63'26.9228 | W |
| 31 | 348 | 14-Dec | 05:00 | UW31 | UW31 | 64'44.0608 | S | 63'27.1898 | W |
| 32 | 348 | 14-Dec | 23:28 | UW32 | UW32 | 64'43.0940 | S | 63'27.5072 | W |
| 33 | 349 | 15-Dec | 11:07 | UW33 | UW33 | 64'44.5607 | S | 63'27.2053 | W |
| 34 | 349 | 15-Dec | 16:54 | UW34 | UW34 | 64'42.6415 | S | 63'27.2823 | W |
| 35 | 349 | 15-Dec | 23:10 | UW35 | UW35 | 64'44.0466 | S | 63'27.3501 | W |
| 36 | 350 | 16-Dec | 05:04 | UW36 | UW36 | 64'44.0491 | S | 63'26.7505 | W |
| 37 | 350 | 16-Dec | 16:27 | - | - | 65'26.6679 | S | 66'40.8302 | W |
| 38 | 351 | 17-Dec | - | UW38 | UW38 | - | - | - | - |
| 39 | 354 | 18-Dec | 17:26 | UW39 | - | 65'33.4480 | S | 66'58.0844 | W |
| 40 | 354 | 18-Dec | 23:57 | - | - | 66'30.0210 | S | 68'30.8316 | W |
| 41 | 355 | 19-Dec | 05:04 | UW40 | UW40 | 67'34.3261 | S | 68'07.8024 | W |
| 42 | 355 | 19-Dec | 11:00 | UW41 | UW41 | 67'34.3263 | S | 68'07.8020 | W |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 43 | 355 | 19-Dec | 17:00 | UW42 | - | 67'34.3253 | S | 68'07.8019 | W |
| 44 | 355 | 19-Dec | 23:04 | UW43 | UW43 | 67'34.3259 | S | 68'07.8027 | W |
| 45 | 356 | 23-Dec | 04:56 | UW45 | UW45 | 67'31.1983 | S | 68'15.2124 | W |
| 46 | 356 | 23-Dec | 13:17 | UW46 | - | 67'30.9708 | S | 68'15.1858 | W |
| 47 | 357 | 23-Dec | 05:01 | UW47 | - | 67'31.1979 | S | 68'15.2130 | W |
| 48 | 357 | 23-Dec | 08:07 | UW48 | - | 67'31.7147 | S | 68'15.3716 | W |

### 5.2.6 VMP250IR Turbulence profiler

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**Ben Lincoln,** University of Bangor UK
**George Dadd,** Kiote Ltd, Cornwall UK

#### Overview

A Vertical Microstructure Profiler (VMP) is an instrument used for the measurement of micro-scale (mms to tens of centimetres) temperature, conductivity and velocity shear. Vertical profiles of these properties allow us to estimate the Turbulent Kinetic Energy (TKE) dissipation rate, which acts to mix water, and the stratification strength ($N^2$), which acts to oppose this mixing. Eddy diffusivities can be calculated from these, and used to estimate vertical fluxes of properties or tracers within the water column. The specific goals for the VMP dataset are to:

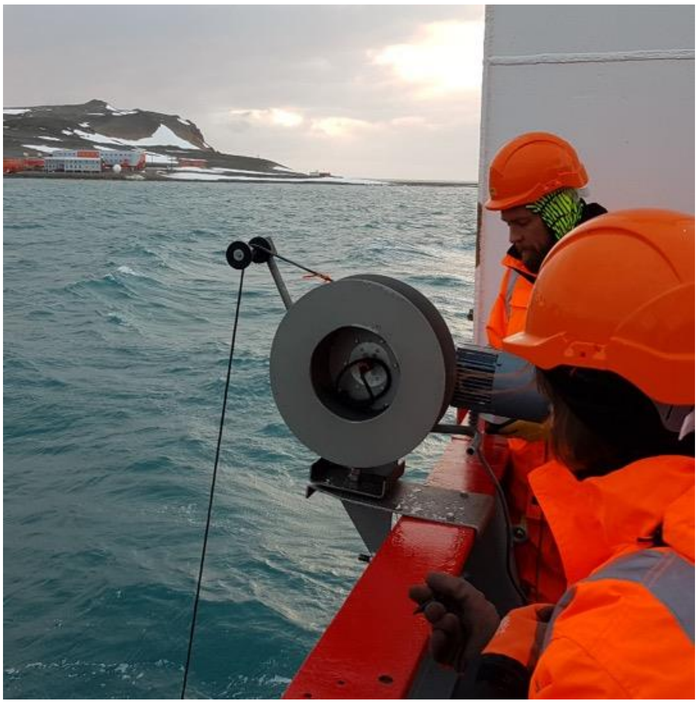
1. Characterise TKE dissipation rate and identify key forcing processes.
2. Calculate oceanic heat fluxes to understand their contribution to glacial melt.
3. Provide estimates of nutrient/chemical fluxes for biological processes.

#### Instrument and Setup

The VMP250IR is the smallest profiler manufactured by Rockland Scientific. It is designed for coastal zone work and records data internally. Its small size and internal power supply allows it to be operated out of small boats or away from power supplies, e.g. ice-camps.

The profiler is an aluminium tube containing a battery and single board computer for the recording of data from the attached probes on the head of the instrument. Four probes were utilised in this project; temperature and conductivity were recorded by fast responses probes (T1 and C1) whilst there were 2 shear probes recording micro scale velocity shear (S1 and S2).

The tail of the instrument has brushes attached to control the fall rate and stabilise it as it freefalls through the water column.



Recovery of the VMP from depth was achieved using an ISW electric winch, mounted on a swivel and bolted to the bulwark. Boltholes with correct spacing already existed at the stern, outboard of the A-frame on the port side. The electric winch requires 240V power, which was supplied from its associated RCD protection unit inside the mechanical workshop. The winch was wound with 500m of 4mm Dyneema line for instrument recovery, which worked very well, with no knots or tangles, although it had a tendency to be trapped on the drum, as it was played out.

## Deployment and Recovery

Internal recording was initiated through use of a magnetic switch, and this was completed on deck, using a spanner to tighten the bolt, while a flashing light on the tail indicated that recording had commenced.

The lightweight of the VMP250 meant that no crane was required for deployment as it could easily be manually handled over the bulwark and lowered into vertical position below the winch arm. The VMP was then lowered to the water from this position close to the hull, as the calm conditions meant that there was no risk of impact with the ship's hull.

Paying out of line during deployment and recovery of the instrument was controlled with the supplied speed controller. The ship steamed at 0.3kts in order to move away from the VMP and ensure that there was no risk to the ships propeller from the loose line. This meant that we needed to pay out 20% more line than was required to reach the bottom (or a maximum of 300m if the water depth was greater). The winch and swivel worked well during recovery, retrieving the instrument rapidly and allowing neat spooling of the line, thus avoiding uneven build up. However, when paying out the line, it was prone to become trapped and pulled under the drum, hauling the instrument in on the underside. This was overcome by having a second person, manually pulling line off the drum. Use of larger diameter, regular rope may reduce the tendency of this trapping.

As the device records internally, there was no need for a person recording data files, but accurate record keeping was key and so a third person was employed to do this. As live data quality checks were not possible, a visual inspection of the probes was carried out every few casts. This was important, as a large number of probes were damaged during impact with the seabed. The probe damage was unfortunate, due to the high expense of the probes; however, it was important to capture the strong mixing observed close to the bed over the rocky sill region, and the lack of live depth feed made it hard to avoid impact with the bed. The serial numbers of the probes used for each profile is given in the VMP data table and associated shear probe sensitivities are given in the probe table. After VMP recovery, it was carried into the mechanical workshop where it was secured to a custom stand and brush section removed. The deck cable was attached through the connector on the tail, to commence charging and data download through the proprietary software.

### Sampling Strategy & Data Table

Eight hours of time was allotted for VMP profiles at each survey site. It was decided that these should be used in a single block to generate a time series of data that captures tidal variability. This also gave time to the CTD water sampling team to catch up and process samples. However, the shallow water and complex bathymetry at the survey sites mean that there is significant spatial variability in turbulence generation, which would not be captured in a time series at one location. In an attempt to capture both the temporal and spatial variability a repeated series of transects were made over the sill region of the bays, with a 1000m transect taking 2-3 hours to complete, with 8-15 profiles completed depending on water depth. The exact position of the transect lines varied as the ship needed to avoid icebergs, or struggled to maintain position during strong winds. The timings and locations of transects are outlined in the table which follows. Opportunistic stations were also made during periods of inactivity between CTD casts, the details of these is also in the VMP data table.

*Table 5.2.4 VMP Data table*

| Station | File Number | # of Profiles | Date | Start Time (UTC) | Start Latitude | Start Longitude | End Time (UTC) | End Latitude | End Longitude | T1 | C1 | S1 | S2 | Bridge Event |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Marian Cove** | | | | | | | | | | | | | | |
| MC1 | 22 | 3 | 08/12/2018 | 04:17 | -62.2176 | -58.7892 | 04:46 | -62.2180 | -58.7976 | **T750** | **C154** | **M994** | **M993** | 11 |
| MC1 | 24 | 3 | 08/12/2018 | 06:30 | -62.2177 | -58.7891 | 07:00 | | | T750 | C154 | M994 | M993 | 14 |
| MC2 | 25 | 5 | 08/12/2018 | 10:15 | -62.2129 | -58.7686 | 10:50 | -62.2142 | -58.7809 | T750 | C154 | M994 | M993 | 18 |
| MC2 | 27 | 3 | 08/12/2018 | 11:38 | -62.2129 | -58.7686 | 12:04 | -62.2141 | -58.7756 | T750 | C154 | M994 | M993 | 20 |
| MC Transect 1 | 28 | 13 | 08/12/2018 | 13:32 | -62.2089 | -58.7506 | 14:53 | -62.2111 | -58.7609 | T750 | C154 | M994 | M993 | 23 |
| MC Transect 2 | 30 | 3 | 08/12/2018 | 15:40 | -62.2083 | -58.7480 | 16:00 | -62.2092 | -58.7522 | T750 | C154 | M994 | **M442** | 24 |
| MC Transect 3 | 31 | 8 | 08/12/2018 | 16:16 | -62.2106 | -58.7617 | 17:08 | -62.2082 | -58.7477 | T750 | C154 | M994 | M442 | 25 |
| MC Transect 4 | 32 | 9 | 08/12/2018 | 17:28 | -62.2082 | -58.7479 | 18:35 | -62.2114 | -58.7638 | **T667** | C154 | M994 | M442 | 26 |
| MC Transect 5 | 33 | 8 | 08/12/2018 | 19:05 | -62.2082 | -58.7476 | 19:59 | -62.2108 | -58.7608 | **T676** | C154 | M994 | M442 | 27 |
| MC Transect 6 | 34 | 9 | 08/12/2018 | 20:21 | -62.2080 | -58.7472 | 21:12 | -62.2108 | -58.7601 | T676 | C154 | M994 | **M787** | 28 |
| MC3 | 35 | 5 | 08/12/2018 | 22:33 | -62.2083 | -58.7478 | 22:54 | -62.2073 | -58.7524 | T676 | C154 | M994 | M787 | 31 |
| MC4 | 37 | 3 | 09/12/2018 | 00:33 | -62.2059 | -58.7398 | 01:06 | -62.2078 | -58.7469 | T676 | C154 | M994 | M787 | 33 |
| **Börgen Bay** | | | | | | | | | | | | | | |
| BB Transect 1 | 38 | 10 | 13/12/2018 | 02:40 | -64.7386 | -63.4633 | 04:32 | -64.7321 | -63.4505 | T676 | C154 | M994 | M787 | 113 |
| BB failed Transect | 39 | 1 | 13/12/2018 | 05:32 | -64.7311 | -63.4485 | 05:47 | -64.7322 | -63.4489 | T676 | **C129** | M994 | M787 | 114 |
| BB Transect 2 | 40 | 10 | 13/12/2018 | 06:06 | -64.7389 | -63.4624 | 07:59 | -64.7304 | -63.4582 | T676 | C129 | M994 | M787 | 115 |
| BB Transect 3 | 41 | 15 | 13/12/2018 | 08:38 | -64.7388 | -63.4359 | 11:35 | -64.7268 | -63.4595 | T676 | C130 | M994 | M787 | 116 |
| BB1 | 42 | 2 | 13/12/2018 | 16:30 | -64.7413 | -63.4538 | 17:00 | -64.7374 | -63.4538 | T676 | C131 | **M434** | **M785** | 118 |
| BB Transect 4 | 44/45/47/50-56 | 10 | 14/12/2018 | 03:27 | -64.7380 | -63.4535 | 06:43 | -64.7271 | -63.4504 | T676 | C132 | M434 | M785 | 128-137 |
| BB Transect 5 | 57/58/60/61/62 | 11 | 14/12/2018 | 07:15 | -64.7382 | -63.4527 | 10:05 | -64.7278 | -63.4513 | T676 | C133 | **M793** | **M438** | 138-141 |
| BB Sill | 63 | 1 | 14/12/2018 | 10:24 | -64.7337 | -63.4543 | 10:32 | -64.7331 | -63.4556 | T676 | C134 | M793 | M438 | 142 |
| **Ryder Bay** | | | | | | | | | | | | | | |
| SC1 | 66 | 1 | 20/12/2018 | 18:00 | -67.5698 | -68.2249 | 18:19 | -67.5696 | -68.2289 | T676 | **C129** | M793 | M438 | 211 |
| SC1 | 67 | 2 | 20/12/2018 | 19:35 | -67.5700 | -68.2253 | 20:01 | -67.5686 | -68.2299 | T676 | C129 | M793 | M438 | 213 |
| SC2 | 68 | 2 | 20/12/2018 | 17:10 | -67.5497 | -68.2679 | 22:29 | -67.5486 | -68.2708 | T676 | C129 | M793 | M438 | 216 |
| SC Transect 1 | 69 | 8 | 21/12/2018 | 01:16 | -67.5509 | -68.2554 | 03:03 | -67.5445 | -68.2715 | T676 | C129 | M793 | M438 | 219 |
| SC Transect 2 | 70 | 8 | 21/12/2018 | 03:39 | -67.5518 | -68.2517 | 06:05 | -67.5446 | -68.2726 | T676 | C129 | M793 | M438 | 220 |
| SC Transect 3 | 72 | 9 | 21/12/2018 | 04:00 | -67.5495 | -68.2732 | 08:58 | -67.5453 | -68.2769 | T676 | C129 | **M445** | M438 | 221-222 |

*Table 5.2.5 VMP Probe Table*

| Probe Type | Serial # | Sensitivity | Condition |
|---|---|---|---|
| Temperature | T750 | - | Damaged |
| Temperature | T676 | - | Survived |
| Temperature | T677 | - | Damaged |
| Conductivity | C154 | - | Damaged |
| Conductivity | C129 | - | Damaged |
| Shear | M434 | 0.1121 | Damaged |
| Shear | M438 | 0.1268 | Survived |
| Shear | M442 | 0.928 | Damaged |
| Shear | M445 | 0.0823 | Survived |
| Shear | M787 | 0.0625 | Damaged |
| Shear | M785 | 0.0959 | Damaged |
| Shear | M793 | 0.0675 | Damaged |
| Shear | M993 | 0.0661 | Damaged |
| Shear | M994 | 0.0836 | Damaged |

## Results

A total of 162 profiles were collected at the 2 survey sites, with 6 transects at Marian Cove, 5 at Börgen Bay and 3 at Sheldon Cove. Initial analysis of the data show strongly enhanced turbulence over the sill regions, with significant variability throughout the time of the survey. An example transect from Börgen Bay is plotted below, showing TKE dissipation rate in $log_{10}[Wkg^{-1}]$ vs depth for 15 casts collected on 13/12/2018.

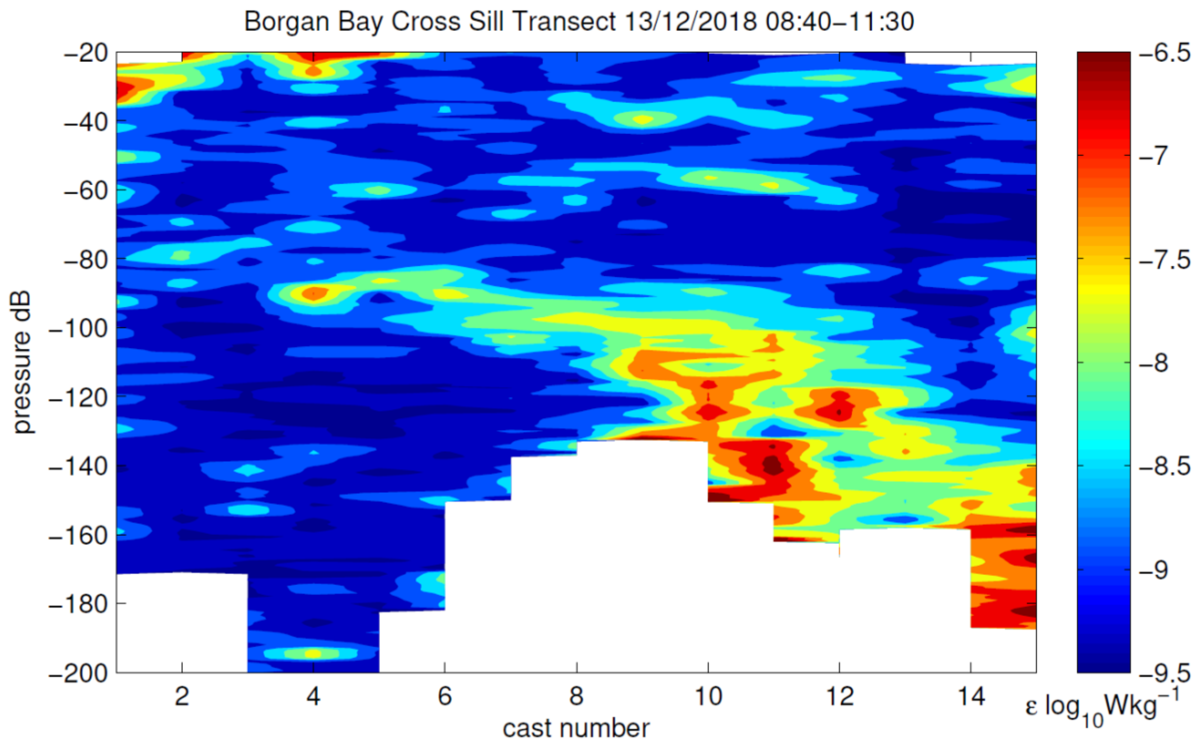



*Figure 5.2.7 Visualisation of VMP results of multiple Sill crossing transects in Börgen Bay*

## Issues and Recommendations

After the first profile of File 44, the indication light on the VMP stopped flashing and stayed constantly on. We proceeded to bring the VMP onto deck and check that data was being logged before resuming profiling. Rockland Scientific were contacted, and the log file was sent to them. They confirmed that there was no problem with the data logging, but that the error message related to a fall rate issue and that the fall rate of our VMP250 was significantly below the expected value. WE attempted to address the fall rate issue by removing additional brushes from the tail assembly. However, despite the moderate increase in fall rate, the error light continued to be triggered. Perhaps the cold dense waters of the survey sites caused this fall rate issue. Further investigation and consultation with Rockland is required to resolve this issue.

There was also significant turbulence generated by the ship during profiling, which generally contaminated the upper 20m. However, at times this contamination reached 40m deep. This issue has been noted before on the James Clark Ross (JR288) and would be hard to resolve.

## 5.3 Marine Geochemistry

### 5.3.1 RACETRAX

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#### Radium isotopes in seawater

Ra sampling requires very large volumes of water, as Ra activities are typically very low away from sediment sources. Samples of ~150 L were collected from the CTD and the trace-metal clean towfish. The towfish was deployed from the aft starboard boom, at a depth of ~4m (when stationary), and ~2m when underway. The pump was run continuously while the fish was underwater, towing at speed up to 6 knots.

Samples were transferred using 20 L collapsible plastic containers into 160L bins for processing. Using a submersible pump, the samples were then passed through a column holding 20 g of $MnO_2$-coated acrylic fiber, which strongly binds Ra. The fibers were then rinsed with Milli-Q and loaded into a Ra Delayed Coincidence Counter (RaDeCC; Scientific Computer Instruments, USA) system purged with He gas, and decay of Ra was counted for 6-10 h to quantify $^{223}$Ra and $^{224}$Ra content. Following decay of these short-lived isotopes, the fibers will be re-analysed using the RaDeCC to determine the activity of the parent isotopes ($^{227}$Ac and $^{228}$Th). Discrete 250mL samples were collected for 226Ra calibration, to determine extraction efficiency on the fibers.

#### Radium isotopes in sediment and porewaters

Five cores from the multicorer were collected at stations 1 and 4 in each bay. Three were used for extraction of porewaters, and 2 were used for sediment processing. Porewaters were collected from depths of 0-0.5, 0.5-1, 1-1.5, 1.5-2.5, 2.5-3.5, 3.5-4.5, 6-7 and 9-10cm within the cores, using rhizon samplers (Rhizosphere) which filter the porewater at ~0.18µm, and pooled before subsampling to obtain the 30-70ml total volume at each depth interval needed for Ra analysis. 2mL of porewater were subsampled for trace metal analysis and determination of nutrient concentrations, which will be performed back in the UK. Cores were sectioned at the same depths, with half of each sample being used for porosity determinations and the other half for precipitation of Ra isotopes. Sediments were then filtered onto 142mm GF/F filters and Ra and Th content determined using the RaDeCCs. Full methodology followed (Cai, Shi, Moore, & Dai, 2012).

#### Trace metal sample collection

Trace metal samples were collected from the trace-metal clean towfish system when the ship was moving at >0.5 kts. The water flow was directed into the clean bubble with laminar flow filtered air supply. A 0.2µm acropak cartridge filter was attached and flushed with at least 0.5L of seawater. Dissolved trace metal (dTM) samples were then collected into acid-washed 250mL HDPE bottles. Unfiltered water was also collected for nutrient analysis, immediately filtered at 0.2µm with a fresh acrodisk filter, and then frozen. Samples for oxygen isotopes ($\delta^{18}$O) and salinity were also collected from the unfiltered towfish water. All sampling and handling was performed following clean lab protocols, wearing tyvek lab coats, hair nets, and class-100 particle-free gloves.

## Samples collected:

A total of 84 water samples were collected for Ra isotopes, from all three embayments, totaling ~9500 kg. Of these, 7 were surface samples collected from the towfish. Six were near-bottom samples collected from the Niskin bottle mounted on the multicore frame. Six were coretop water samples were collected from water overlying the cores, in these cases the water was collected from the three cores used for porewater extraction, and was pooled prior to filtration over the fiber.

*Table 5.3.1: Summary of seawater Ra sampling events., Sample names are given as "Stn-ddd" where Stn = station name and ddd = depth. Mass is estimated from the average sample weight recovered from each Niskin (19 L) multiplied by the number of Niskin bottles collected at that depth. Smaller volume samples (coretop water and ~10L samples from the Niskin attached to the multicorer frame) were weighed using a beam scale and are accurate to ~0.2kg.*

| Sample | CTD num | Date | Time (in water) | Lat (S) | Lat (min S) | Long (W) | Long (min W) | Mass (kg) | Bottom Depth |
|---|---|---|---|---|---|---|---|---|---|
| MC1-5 | 5 | 08/12/2018 | 07:36 | 62 | 13.056 | 58 | 47.336 | 187 | 96 |
| MC1-20 | 5 | 08/12/2018 | 07:36 | 62 | 13.056 | 58 | 47.336 | 222 | 96 |
| MC1-50 | 4 | 08/12/2018 | 05:55 | 62 | 13.061 | 58 | 47.346 | 195 | 95 |
| MC1-70 | 4 | 08/12/2018 | 05:55 | 62 | 13.061 | 58 | 47.346 | 203 | 95 |
| MC1-87 | 3 | 08/12/2018 | 03:20 | 62 | 13.057 | 58 | 47.349 | 148 | 96 |
| MC1-coretop | MUC | 11/12/2018 | 18:46 | 62 | 13.057 | 58 | 47.349 | 6 | |
| MC2-5 | 8 | 08/12/2018 | 12:27 | 62 | 12.771 | 58 | 46.113 | 148 | 104 |
| MC2-35 | 8 | 08/12/2018 | 12:27 | 62 | 12.771 | 58 | 46.113 | 201 | 104 |
| MC2-70 | 7 | 08/12/2018 | 11:11 | 62 | 12.772 | 58 | 46.561 | 177 | 103 |
| MC2-85 | 7 | 08/12/2018 | 11:11 | 62 | 12.772 | 58 | 46.561 | 148 | 103 |
| MC2-93 | 6 | 08/12/2018 | 09:30 | 62 | 12.774 | 58 | 46.116 | 185 | 103 |
| MC3-20 | 9 | 08/12/2018 | 22:07 | 62 | 12.496 | 58 | 44.867 | 123 | 108 |
| MC3-60 | 9 | 08/12/2018 | 22:07 | 62 | 12.496 | 58 | 44.867 | 148 | 108 |
| MC3-85 | 9 | 08/12/2018 | 22:07 | 62 | 12.496 | 58 | 44.867 | 148 | 108 |
| MC3-96 | 10 | 08/12/2018 | 23:17 | 62 | 12.492 | 58 | 44.893 | 148 | 106 |
| MC4-75 | 12 | 09/12/2018 | 03:08 | 62 | 12.352 | 58 | 44.387 | 123 | 115 |
| MC4-90 | 12 | 09/12/2018 | 03:08 | 62 | 12.352 | 58 | 44.387 | 148 | 115 |
| MC4-100 | 12 | 09/12/2018 | 03:08 | 62 | 12.352 | 58 | 44.387 | 148 | 115 |
| MC4-107 | 11 | 09/12/2018 | 01:37 | 62 | 12.362 | 58 | 44.393 | 148 | 117 |
| MC4-116 | MUC | 09/12/2018 | 01:50 | 62 | 12.362 | 58 | 44.393 | 10.05 | 117 |
| MC4-coretop | MUC | 09/12/2018 | 01:50 | 62 | 12.362 | 58 | 44.393 | 7.09 | 117 |
| MC5-0 | 14 | 09/12/2018 | 08:05 | 62 | 12.246 | 58 | 44.153 | 141 | 118 |
| MC5-30 | 14 | 09/12/2018 | 08:05 | 62 | 12.246 | 58 | 44.153 | 148 | 118 |
| MC5-75 | 14 | 09/12/2018 | 08:05 | 62 | 12.246 | 58 | 44.153 | 129 | 118 |
| MC5-89 | 13 | 09/12/2018 | 06:31 | 62 | 12.201 | 58 | 44.126 | 148 | 99 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BB1-65 | 20 | 13/12/2018 | 17:36 | 64 | 44.315 | 63 | 27.8 | 141 | 260 |
| BB1-120 | 20 | 13/12/2018 | 17:36 | 64 | 44.315 | 63 | 27.8 | 148 | 260 |
| BB1-180 | 20 | 13/12/2018 | 17:36 | 64 | 44.315 | 63 | 27.8 | 129 | 260 |
| BB1-215 | 18 | 12/12/2018 | 17:50 | 64 | 44.302 | 63 | 27.21 | 148 | 260 |
| BB1-235 | 18 | 12/12/2018 | 17:50 | 64 | 44.302 | 63 | 27.21 | 148 | 260 |
| BB1-250 | 19 | 13/12/2018 | 11:11 | 64 | 44.315 | 63 | 27.8 | 146 | 260 |
| BB1-259 | MUC | 14/12/2018 | 14:36 | 64 | 44.315 | 63 | 27.8 | 10.02 | 260 |
| BB1-coretop | MUC | 14/12/2018 | 14:36 | 64 | 44.315 | 63 | 27.8 | 6.32 | 260 |
| BB2-65 | 21 | 13/12/2018 | 18:47 | 64 | 43.567 | 63 | 27.234 | 148 | 255 |
| BB3-65 | 22 | 13/12/2018 | 20:12 | 64 | 43.06 | 63 | 27.55 | 148 | 148 |
| BB4-20 | 26 | 14/12/2018 | 00:58 | 64 | 42.64 | 63 | 27.265 | 148 | 265 |
| BB4-30 | 26 | 14/12/2018 | 00:58 | 64 | 42.64 | 63 | 27.265 | 148 | 265 |
| BB4-60 | 25 | 14/12/2018 | 00:09 | 64 | 42.648 | 63 | 27.263 | 123 | 266 |
| BB4-180 | 25 | 14/12/2018 | 00:09 | 64 | 42.648 | 63 | 27.263 | 111 | 266 |
| BB4-220 | 25 | 14/12/2018 | 00:09 | 64 | 42.648 | 63 | 27.263 | 129 | 266 |
| BB4-255 | 24 | 13/12/2018 | 23:10 | 64 | 42.64 | 63 | 27.265 | 148 | 265 |
| BB4-264 | MUC | 15/12/2018 | 13:39 | 64 | 42.64 | 63 | 27.265 | 10.52 | 265 |
| BB4-coretop | MUC | 15/12/2018 | 13:39 | 64 | 42.64 | 63 | 27.265 | 6.67 | 275 |
| BB5-70 | 23 | 13/12/2018 | 21:59 | 64 | 42.19 | 63 | 27.025 | 148 | 280 |
| SC1-coretop | MUC | 21/12/2018 | | 67 | 34.196 | 68 | 13.367 | 6 | 521 |
| SC1-520 | MUC | 21/12/2018 | | 67 | 34.196 | 68 | 13.367 | 9.68 | 521 |
| SC1-510 | 29 | 20/12/2018 | 18:47 | 67 | 34.196 | 68 | 13.367 | 123.5 | 521 |
| SC1-485 | 28 | 20/12/2018 | 17:18 | 67 | 34.196 | 68 | 13.367 | 150 | 512 |
| SC1-460 | 28 | 20/12/2018 | 17:18 | 67 | 34.191 | 68 | 13.535 | 133 | 514 |
| SC1-225 | 28 | 20/12/2018 | 17:18 | 67 | 34.196 | 68 | 13.367 | 152 | 512 |
| SC1-157 | 30 | 20/12/2018 | | 67 | 34.196 | 68 | 13.522 | 152 | 521 |
| SC1-100 | 30 | 20/12/2018 | | 67 | 34.191 | 68 | 13.535 | 133 | 514 |
| SC1-40 | 30 | 20/12/2018 | | 67 | 34.191 | 68 | 13.535 | 152 | 514 |
| SC2-180 | 31 | 20/12/2018 | | 67 | 33.237 | 68 | 15.379 | 171 | 187 |
| SC2-145 | 32 | 20/12/2018 | | 67 | 32.991 | 68 | 16.053 | 152 | 181 |
| SC2-43 | 32 | 20/12/2018 | | 67 | 32.991 | 68 | 16.053 | 171 | 181 |
| SC3-50 | 33 | 21/12/2018 | 23:50 | 67 | 32.983 | 68 | 16.06 | 171 | 329 |
| SC4-249 | 34 | 21/12/2018 | 00:07 | 67 | 34.179 | 68 | 17.117 | 152 | 260 |
| SC4-240 | 35 | 21/12/2018 | 13:32 | 67 | 34.179 | 68 | 17.117 | 114 | 260 |
| SC4-200 | 35 | 21/12/2018 | 13:32 | 67 | 34.179 | 68 | 17.117 | 133 | 260 |
| SC4-125 | 35 | 21/12/2018 | 13:32 | 67 | 34.179 | 68 | 17.117 | 133 | 260 |
| SC4-110 | 36 | 21/12/2018 | 14:36 | 67 | 34.179 | 68 | 17.117 | 152 | 260 |
| SC4-87 | 36 | 21/12/2018 | 14:36 | 67 | 34.179 | 68 | 17.117 | 152 | 260 |
| SC4-40 | 36 | 21/12/2018 | 14:36 | 67 | 34.179 | 68 | 17.117 | 152 | 260 |
| SC4-259 | MUC | 22/12/2018 | | 67 | 34.179 | 68 | 17.117 | 8.94 | 260 |
| SC4-coretop | MUC | 22/12/2018 | | 67 | 34.179 | 68 | 17.117 | 4.6 | 260 |
| SC5-50 | 37 | 21/12/2018 | 15:43 | 67 | 31.167 | 68 | 15.384 | 152 | 201 |
| SC6-112 | 38 | 21/12/2018 | 17:13 | 67 | 30.952 | 68 | 15.324 | 152 | 193 |

## Trace metals:

A total of 8 sampling events were undertaken for surface water trace metal sampling. In Börgen Bay, all five sites were sampled for trace metals. In Marian Cove, problems with the towfish pump prevented sample collection at station 2 and ice cover was too heavy to use the towfish at site 5, but all other sites were sampled. The towfish was not deployed in Ryder Bay (Sheldon Cove) as surface sampling in this area will be undertaken from Rothera Research Station over the weeks following the cruise.

## Preliminary results:

As two of the Ra isotopes of interest are very short-lived (i.e. 3.66 d for $^{224}$Ra; 11.6 d for $^{223}$Ra), they must be measured at sea and preliminary results are available. Figure 1 shows the water column profiles of these shortest-lived isotopes at the RaTS sampling site, although in both cases the activities shown also include the activity supported by the parent isotope in the water column and so results will need corrected based on subsequent analyses to determine this parent activity. Current results are therefore only a qualitative reflection of Ra activity, but show a promising increase towards the sediment as well as a significant signal at ~190m where transmissivity data indicated a particle-rich layer above a nearby sill. Also shown in Figure 1 (right hand plot) are profiles of $^{224}$Ra, $^{228}$Th, and $^{224}$Ra:$^{228}$Th in sediments at the same site. Note that both parameters are preliminary and will change with correction for longer-lived isotopes, but these results show a clear disequilibrium between the particle-associated parent isotope (Th) and soluble daughter (Ra) indicating recent efflux of solutes into the overlying waters. Additional analyses will refine these results and permit estimation of micro and macro-nutrient fluxes based on Fe:Ra and nutrient:Ra ratios in sediment pore waters.

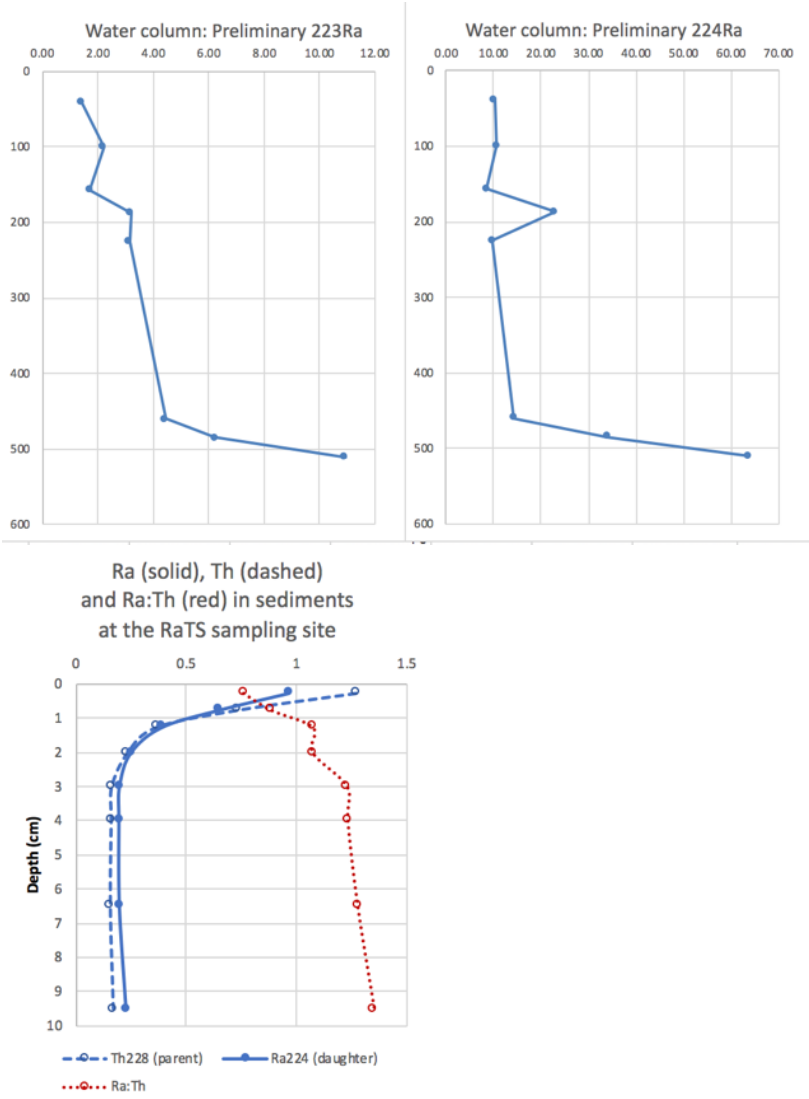


*Figure 5.3.1 Water column profiles of uncorrected activities of $^{223}$Ra (left) and $^{224}$Ra (centre). Units are dpm/m$^{3}$. Right-hand plot shows preliminary estimates of $^{224}$Ra and its parent $^{228}$Th (in dpm/g) in sediments, with a deficit of $^{224}$Ra towards the sediment-water interface (in red).*

## Acknowledgements

Thank you to the officers, engineers and crew of RRS James Clark Ross. I'm very grateful to the many people who helped me with lugging around endless bottles of water and preparing sampling fiber, this dataset would not exist without the huge amount of help. A special thank-you to the technicians, crew and SAERI volunteers for keeping CTD operations running, for the towfish deployments and recoveries, and multicore sampling. Finally, I'm very grateful to the ICEBERGS project for the opportunity to sample this remote, understudied and important region! This work is funded by NERC Independent Research Fellowship NE/P017630/1.

### 5.3.2 Glacial meltwater signals from Rare Earth Elements (GLARE)

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Glacial meltwater signals from Rare Earth Elements (GLARE) aimed to measure water column concentrations of rare earth elements (REE) across meltwater gradients to assess the application of REEs in tracing meltwater input along the Antarctic Peninsula. In total, 145 samples (77.5 L) were taken from 15 stations (see Table 5.2.2).

Seawater from selected depths (chosen based on the CTD downcast data at each station) was collected into 500 ml HDPE bottles. Sample bottles were rinsed with seawater three times prior to filling and dried with a Kimtech wipe. Bottled seawater was then taken to the on-board ‘chemistry laboratory’, where the seawater was vacuum filtered through a 0.4 µm Whatman nucleopore filter and decanted into previously acid cleaned 500 ml HDPE bottles. Samples were labelled with the appropriate CTD cast number and Niskin bottle number. Samples were later acidified in the ‘clean lab’ by adding 500 µl of 12 M HCl to each sample. This acidification process prevents the adsorption of metals to the bottle surface. Bottles were sealed using parafilm and placed within two Ziploc bags before being stored in +4 °C refrigerator. Samples will be analysed at Southampton University using the iron precipitation method.

It had originally been intended that samples would be filtered using an inline filter (i.e. directly from the Niskin to the acid cleaned HDPE bottle) thus greatly reducing the potential for contamination. However, it became apparent during the first ICEBERGS CTD (CTD_003) that the in-line filtering process was too time consuming given the science schedule and it was decided that filtering be transferred to a vacuum filtration method in the ‘chemistry laboratory’. This method proved successful and all samples were collected within the allocated time. The vacuum filter housing was rinsed with Milli-Q water between samples to reduce contamination issues. Changing to the vacuum filtration method meant that 10 acid cleaned bottles had to be used strictly for the purpose of collecting and transporting seawater from the Niskin bottle to the filter. Consequently, only 9 samples were collected from 5 of the sample sites at Sheldon Cove (in contrast to 10 samples from each station at Marian Cove and Börgen Bay).


PALEOMAP — ICEBERGS — RACETRAX — OCTONAUT — GLARE — MMA —
JR18003
MUDBUSTERS

## 5.4 Mud glorious mud

### 5.4.1 Hamon Grab

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**Ander De Lecea,** South Atlantic Environment Research Institute
**Marina Costa,** South Atlantic Environment Research Institute
**Amber Chadwick,** (Ship's Doctor)

**Aim**: Sample benthic infauna along a gradient from the glacier face outward along each of 3 fjords at Sheldon Cove, Marian Cove, Börgen Bay. Preserve samples for subsequent taxonomic and genetic analysis with the goal to describe any change in community structure with distance from glacier face.

A Hamon Grab with a 20 x 40 x 40 cm bucket was used to sample benthic infauna at three locations: Marian Cove, Börgen Bay and Sheldon Cove. Fauna retained on a 1mm sieve were preserved in alcohol.

The sites sampled at Marian Cove and Börgen Bay were the same as those sampled in 2017 (ICEBERGS 1) with the addition of sites X and XB (located on the sill) and site 5 (located closest to the glacier mouth) at Börgen Bay, and site 1 (located farthest from the glacier mouth) at Marian Cove. Site 1 at Marian Cove was not sampled last year because of time constraints. Site 5 at Börgen Bay was not sampled last year because of difficulties triggering the grab. Site X was added to Börgen Bay to target the communities living on the sill located between BB2 and BB1. BBXB was added as a replicate site to assess the degree to which sites at similar distance from the glacier mouth supported similar communities. At Sheldon Cove 6 sites were selected by the ICEBERGS team using similar criteria to that for Börgen Bay and Marian Cove (ie to give a sequence of increasing sea bed age seaward from the glacier mouth).

Deployment of the Hamon Grab followed the same procedure as outlined in the Cruise Report from 2017 (Barnes et al 2017). Initially (at Marian Cove) the grab was deployed from the stern of the vessel. Afterwards deployment was switched to the starboard side of the vessel which speeded up deployment and retrieval considerably. In general there were very few failed deployments. At site 5 of Börgen Bay the grab initially failed to trigger (as in 2017). However in discussions between crew and scientists it was perceived that insufficient cable had been deployed—ie the grab was being lowered to the depth indicated by the echosounder rather than ensuring that sufficient cable was deployed until tension clearly was reduced (ie the grab had bottomed out). Once this was done, deployments of the grab were 100% successful at this site. The contents of the grab at BB5 were liquid mud, which matches with the observations from SUCS images in 2017 of a highly liquid mud seabed.

Once retained the contents of each grab were sieved on deck over a 10mm sieve placed over a 1mm sieve. The fauna and sediment retained on the 1mm sieve were then moved to the wet lab where fauna were separated from the sediment and preserved in alcohol 98.7%. NB See Table 5.4.1 for the procedure adopted during sieving and sorting.

Following a workshop in Bangor in May 2018 it was decided to attempt to increase the number of replicate grabs deployed at each site (as well as to increase the number of sites and to sample at the third target location - Sheldon Cove). The target replication level was 5. This was achieved at all sites with an additional extra grab at 5 sites at Börgen Bay. In total 95 grabs were successfully sampled compared to 24 in 2017 (Table 5.4.2). This was achieved by using the experience gained in 2017 and increasing the number of personnel involved. At Marian Cove the team consisted of 5 (SJ, CMR, PB, MB, FH) but this was increased to 7 at Börgen Bay (SJ, CMR, PB, MB, FH, AC, ADL) and 7 at Sheldon Cove (SJ, CMR, PB, MB, FH, ADL, MC). We also took the decision to preserve fauna unsorted in sample pots (ie extracted from gravel but not sorted to morphotype) when it was not possible to keep pace with the rate of grabbing. In most cases the rate of grabbing was the limiting factor (especially when we took the 'unsorted' approach, but at some of the shallower sites, especially when a large amount of gravel and fauna were retained on the 1mm sieve, sieving and sorting were limiting. Thus in any future grabbing a team of 7 (or 8 if possible) should be planned for.

*Table 5.4.1 Instructions printed and laminated and given to all personnel involved in the grabbing operation*

**Sieving on deck**

We use 2 sieves together – a coarse sieve (which removes large stones and rocks) over a 1mm sieve which retains our sample. Important points:

1) Although higher water pressure makes sieving quicker- it potentially destroys delicate organisms. Don't use a very high pressure. A dispersed spray rather than a narrow jet works best
2) Check the 10mm sieve before discarding retained stones to ensure fauna, especially worm-like organisms are not retained on the sieve. Also check stones for any organisms living on them.

**Sorting**

We plan to sort most samples on board. However some samples may be preserved entire (if sorting doesn't keep pace with grabbing). These samples would then be sorted in the lab at our home bases. There is a danger of different sorting accuracy onboard versus in our labs at home. Also different sorters may sort to different degrees of accuracy. Thus here are our sorting criteria which we should all try and conform to:

1) Each sample will wherever possible be divided into 3 when it enters the lab and 3 different people will sort it. Place a label on each tray immediately, to keep track of the site and grab information at all times.
2) Remember: fauna are potentially very small (they are retained on a 1mm sieve)
3) Use a white tray for sorting to increase detectability of small animals (e.g. very small worms)

4) Use a pair of fine metal tweezers if available and try avoid the very large plastic ones
5) Assemble your sample at one end of the tray. Move the sediment from one side of the tray to the other and pick out all biological material.
6) Always ensure you are moving material across a white background – this allows small animals like very thin polychaetes to be detected. Beware moving material through muddy opaque water.
7) Ensure small animals do not dry out when picked and placed on tray prior to preserving
8) As well as live animals, also pick out dead shells (not very broken valves)

*Table 5.4.2 Summary of grabs successfully deployed at each of the three locations*

| Location | Date | Site N° | N° of grabs | Sediment description |
|---|---|---|---|---|
| Marian Cove | 10-12-2018 | 1 | 5 | Mud cohesive (ie not liquid) with moderate amounts of gravel |
| Marian Cove | 10-12-2018 | 2 | 5 | Mud cohesive (ie not liquid) with moderate amounts of gravel |
| Marian Cove | 9-12-2018 | 3 | 5 | Mud cohesive (ie not liquid) with moderate amounts of gravel |
| Marian Cove | 9-12-2018 | 4 | 5 | Mud cohesive (ie not liquid) with moderate amounts of gravel |
| Marian Cove | 9-12-2018 | 5 | 5 | Mud cohesive (ie not liquid) with moderate amounts of gravel |
| Börgen Bay | 16-12-2018 | 1 | 5 | Quite stiff mud. Moderate amount of large stones (up to 5cm) |
| Börgen Bay | 16-12-2018 | BBXb | 6 | Mud more solid. Lots of gravel. More stones 1-5cm than other sites |
| Börgen Bay | 15-12-2018 | BBX | 5 | Quite stiff mud with some very large drop stones (25 x 20cm) |
| Börgen Bay | 15-12-2018 | 2 | 6 | Mud intermediate consistency (ie between liquid and solid) - used shovel |
| Börgen Bay | 14-12-2018 | 3 | 6 | Liquid mud (similar to BB5) ie it pours into sieve. Slightly more gravel and small stones than BB5 |
| Börgen Bay | 15-12-2018 | 4 | 6 | Mud intermediate between BB5 and BB2. It will pour into sieve, but only just |
| Börgen Bay | 14-12-2018[1] | 5 | 6 | Liquid mud with small gravel |
| Sheldon Cove | 22-12-2018 | 1 | 5 | Not liquid. Quite easy to sieve. Little gravel. Little life. |
| Sheldon Cove | 22-12-2018 | 2 | 5 | Loads of gravel 5-10mm. Hard to sieve, cohesive mud with high clay content. Loads of small polychaetes. Some larger stones. 2 or 3 deployment failures |
| Sheldon Cove | 24-12-2018 | 3 | 5 | |
| Sheldon Cove | 23-12-2018 | 4 | 5 | Normal mud consistency. Moderate-low gravel |
| Sheldon Cove | 23-12-2018 | 5 | 5 | Normal mud consistency ie not liquid. Not too much gravel |

| | | | | |
|---|---|---|---|---|
| Sheldon Cove | 23-12-2018 | 6 | 5 | Mud is not liquid but easy to sieve. Variable amounts of gravel among replicates. Very little small life, but plenty of sipunculids and brittle stars |

[1]BB5 grabs were finalized the following day (during the second shift)

### 5.4.2 Multicore

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The BAS Oktopus 12-core multi-corer was deployed at Marian Cove, Börgen Bay and Sheldon Cove (Figure 5.4.1). This instrument enables high quality, undisturbed, samples of bottom water and seabed sediments. The core tubes are 0.5 m in length and on successful recovery during JR18003 typically the top 15-25 cm of each tube consists of bottom water and the remaining 25-35 cm of the uppermost sediment column and seabed.

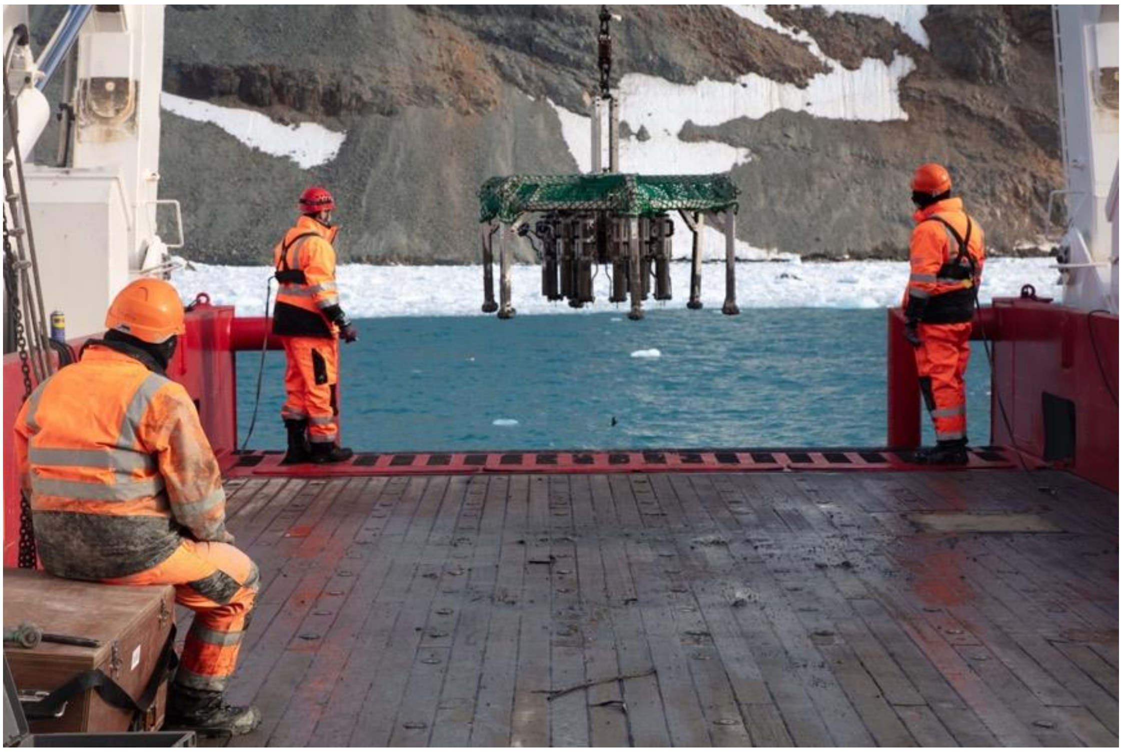

*Figure 5.4.1. Deploying the multicorer from the aft gantry in Marian Cove. Following the failed deployments the multicorere was deployed from the starboard gantry.*

The 5-6 sample stations for each site were arranged in a transect from fjord mouth (1) to glacier terminus at each of the three sampling sites (see Tables below). The sites occupied by multi-corer in 2017 in Marian Cove and Börgen Bay were reoccupied in 2018. In Sheldon Cove, prior to deployment careful assessment of seabed conditions at the target sites was undertaken using the multibeam swath bathymetric data, TOPAS sub-bottom profiling data, and images from the shallow underwater camera system. The multi-corer can only be successfully deployed in soft sediments with significant mud content, so terrain with large numbers of boulders (moraines) and dropstones, and bedrock, was avoided. Although this necessarily results in habitat bias, deployment of the multi-corer in inappropriate terrain can result in shattered core tubes and damage to the array structure.

In advance of recovery a subsampling protocol was established and all bags, tin foils, plastic pots and glass vials were pre-labelled to save time during subsampling. This preparatory phase proved to be essential to enable the team to process core samples quickly and efficiently, and to keep up with the flow of cores requiring extrusion. High resolution subsampling was undertaken using two plastic extrusion columns and slicing of the emergent subsample by metal or plastic slicer as appropriate (Figure 5.4.2).

*Figure 5.4.2 Using plastic slicer to subsample multicores.*

Several cores per deployment were sieved in bulk (at 1 mm) for macrofauna and at all sites samples were also taken for particle size analysis at 0.5 cm intervals; particle size samples were not taken in 2017. Bottom water was siphoned off. The initial protocol devised for each deployment recovery was as follows:

Core 1: Organic carbon. Subsample USING METAL SLICER every 0.5 cm to 2 cm core depth, then every 1 cm to 10 cm core depth, then every 2 cm to core base. Subsamples to be placed in pre-labelled foil trays, place inside a pre-labelled plastic petri dish with lid. Store in freezer at -80 degrees C.

Core 2: Inorganic carbon. Subsample USING PLASTIC SLICER every 0.5 cm to 2 cm core depth, then every 1 cm to 10 cm core depth, then every 2 cm to core base. Subsamples to be placed in pre-labelled foil trays, place inside a pre-labelled plastic petri dish with lid. Store in freezer at -80 degrees C.

Core 3: Sedimentation rate: Subsample full length of core at 1 cm resolution. Subsamples to be placed in pre-labelled silver foil and stored at -80 degrees C.

Core 4: Micropalaeontology. Subsample top 5 cm at 1 cm resolution and place in pre-labelled glass vials and frozen at -20 degrees C. Then sample 1 cm sample every 10 cm from 5 cm core depth, place in a pre-labelled plastic bag and store at -20 degrees C.

Core 5: Micropalaeontology. Subsample top 10 cm at 1 cm resolution, one 1 cm sample every 5 cm below that. Place subsamples in pre-labelled plastic pots, add mixed ethanol and Rose Bengal. Store in fridge 4 degrees C. These samples ultimately to be placed in UN barrel for transport of hazardous samples.
Core 6: Microplastics. Subsample USING METAL SLICER top 10 cm at 1 cm resolution. The microplastic samples are stored in pre-labelled plastic petri dishes, but negative controls should account for any contamination. Store in ethanol at 4 degrees C.

Core 6: Microplastics. Subsample USING METAL SLICER top 10 cm at 1 cm resolution. The microplastic samples are stored in pre-labelled plastic petri dishes, but negative controls should account for any contamination. Store in ethanol at 4 degrees C.

Core 8: Pigments. Subsample top 1 cm only. Store at -80 degrees C.

Cores 9 to 14: whole tubes to be washed out for macrofauna.

Core 15: Particle size: Subsample full length of the core at 0.5 cm resolution. Subsamples placed in pre-labelled petri dishes and stored at -80 degrees C.

In addition, any whole cores remaining unsampled were bunged at both ends and stored at -20 degrees C.

All the multi-core sampling stations visited in Marian Cove and Börgen Bay in 2017 were re-sampled (MC/BB #2, 3, 4) plus MC#5 and new sites in Maxwell Bay, MAX#1, and Börgen Bay, BB0. Six sites were sampled for the first time in ICEBERGS in Sheldon Cove (SC#1-6). Due to human error the number of subsamples recorded for MC#4, MAX#1 and BB#4 prior to packing onboard is incomplete; these subsamples have been taken and can be totalised when unpacked in BAS Cambridge. The microplastics series were subsampled from one of the micropalaeontology cores hence the null subsamples recorded in the tables. Two whole multicores were collected unsubsampled from MAX#1, one from BB and one from SC. Three multicore housing frames were lost during deployments at Marian Cove reducing the maximum number of cores to 9 per deployment at Börgen Bay and Sheldon Cove**.** The following tables below detail the subsamples collected from the multi-corer.

A Health and Safety hazard was identified during the operation of the multi-corer during the 2017 ICEBERGS cruise. The core tube lids are cocked prior to deployment by placing a coarse wire through a groove in the lid assembly. These wires protrude outwards from the assembly at the same height as operators' heads when preparing for deployment, or recovering tubes following deployment. The wires have rough cut ends and cannot be easily seen when wearing hard hats. There is a real danger that these could seriously damage eyes. In response to this report the wire ends had been crimped prior to deployment in 2018 and this reduced the potential hazard.

*Table 5.4.3 Cores collected at each site*

| | MC#1 | MC#2 | MC#3 | MC#4 | MAX#1 | TOTAL |
|---|---|---|---|---|---|---|
| EVENT NUMBER (UNSUCCESSFUL) | | | 67, 68, 70, 71 | 62, 63, 65, 87, 88, 89, 90 | | 11 |
| EVENT NUMBER (SUCCESSFUL) | 95, 96, 102, | 100, 101, | 66, 69, 103 | 61, 64, 86 | 104, | 12 |
| Organic carbon | 0-30 cm (0-2 in 0.5 steps) | 0-28 cm (0-2 in 0.5 steps) | 0-26 cm (0-2 in 0.5 steps) | 0-12 cm (0-2 in 0.5 steps) | **Not recorded** | >76 |
| Inorganic carbon | 0-30 cm (0-2 in 0.5 steps) | 0-30 cm (0-2 in 0.5 steps) | 0-28 cm (0-2 in 0.5 steps) | 0-12 cm (0-2 in 0.5 steps) | **Not recorded** | >78 |
| Sedimentation rate | 0-30 cm | 0-28 cm | 0-5 cm | **Not recorded** | **Not recorded** | >59 |
| Micropalaeontology # 1 (Foraminifera) | 0-26 cm | 0-24 cm | 0-29 cm and 0-9 cm (duplicate set from different core) | 0-20 cm | 0-14 cm | 90 |
| Micropalaeontology #2 (Biomarkers) | 0-28 cm | 0-26 cm | 0-30 cm | 0-12 cm | 0-23 cm | 85 |
| Microplastics #1 | 0-26 cm | 0-26 cm | 0-16 cm | 0-12 cm | 0-23 cm | 103 |
| Microplastics #2 | 0-28 cm | NO | NO | NO | NO | 28 |
| Pigments | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | **Not recorded** | >4 |
| Macrofauna | 6 bulk | 6 bulk | 6 bulk | 7 bulk | **Not recorded** | >25 bulk |
| Particle size | 0-23.5 cm (in 0.5 steps) | 0-25 cm (in 0.5 steps) | 0-25 cm (in 0.5 steps) | **Not recorded** | 0-13.5 cm (in 0.5 steps) | >170 |
| Number of filled cores during successful deployments | 25 | 20 | 17 | 15 | 9 | 86 (59.7%) |
| Number of unfilled cores during successful deployments | 11 | 4 | 19 | 21 | 3 | 58 (40.3%) |

| | BB#0 | BB#1 | BB#2 | BB#3 | BB#4 | TOTAL |
|---|---|---|---|---|---|---|
| EVENT NUMBER (UNSUCCESSFUL) | | | | | 151 | 1 |
| EVENT NUMBER (SUCCESSFUL) | 174, 175 | 143, 144 145 | 146, 147 | 148, 149 | 150, 152, 177, 178 | 13 |
| Organic carbon | 0-28 cm (0-2 in 0.5 steps) | 0-28 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 0-24 cm (0-2 in 0.5 steps) | 0-26 cm (0-2 in 0.5 steps) | 98 |
| Inorganic carbon | 0-26 cm (0-2 in 0.5 steps) | 0-26 cm (0-2 in 0.5 steps) | 0-26 cm (0-2 in 0.5 steps) | 0-30 cm (0-2 in 0.5 steps) | 0-20 cm (0-2 in 0.5 steps) | 99 |
| Sedimentation rate | 0-20 cm | 0-22 cm | 0-24 cm | 0-30 cm | **Not recorded** | >68 |
| Micropalaeontology # 1 (Foraminifera) | 0-18 cm | 0-24 cm | 0-20 cm | 0-36 cm | 0-20 cm | 84 |
| Micropalaeontology #2 (Biomarkers) | 0-18 cm | 0-26 cm | 0-20 cm | 0-30 cm | 0-22 cm | 83 |
| Microplastics #1 | 0-18 cm | 0-24 cm | 0-20 cm | 0-30 cm | 0-20 cm | 81 |
| Microplastics #2 | NO | NO | NO | NO | NO | 0 |
| Pigments | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | 5 |
| Macrofauna | 6 bulk | 6 bulk | 6 bulk | 6 bulk | 6 bulk | 30 bulk |
| Particle size | 0-17.5 cm (in 0.5 steps) | 0-21 cm (in 0.5 steps) | 0-17.5 cm (in 0.5 steps) | 0-28 cm (in 0.5 steps) | 0-17 cm (in 0.5 steps) | 202 |
| Number of filled cores during successful deployments | 19 | 24 | 18 | 14 | 28 | 103 (86.6%) |
| Number of unfilled cores during | 1 | 3 | 0 | 4 | 8 | 16 (13.4%) |

successful deployments

| | SC#1 | SC#2 | SC#3 | SC#4 | SC#5 | SC#6 | TOTAL |
|---|---|---|---|---|---|---|---|
| EVENT NUMBER (UNSUCCESSFUL) | | 254, 256 | | 286 | | 291 | 4 |
| EVENT NUMBER (SUCCESSFUL) | 252, 253, | 255, 257 | 258, 259 | 260, 284, 285, | 287, 288, | 289, 290, 292, | 14 |
| Organic carbon | 0-30 cm (0-2 in 0.5 steps) | 0-18 cm (0-2 in 0.5 steps) | 0-24 cm (0-2 in 0.5 steps) | 0-24 cm (0-2 in 0.5 steps) | 0-18 cm (0-2 in 0.5 steps) | 0-26 cm (0-2 in 0.5 steps) | 112 |
| Inorganic carbon | 0-30 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 0-22 cm (0-2 in 0.5 steps) | 112 |
| Sedimentation rate | 0-30 cm | 0-22 cm | 0-20 cm | 0-24 cm | **0**-18 cm | 0-30 cm | 102 |
| Micropalaeontology # 1 (Foraminifera) | 0-34 cm | 0-24 cm | 0-24 cm | 0-24 cm | 0-24 cm | 0-20 cm | 105 |
| Micropalaeontology #2 (Biomarkers) | 0-30 cm | 0-24 cm | 0-24 cm | 0-24 cm | 0-24 cm | 0-18 cm | 102 |
| Microplastics #1 | 0-30 cm | 0-24 cm | 0-24 cm | 0-22 cm | 0-24 cm | 0-18 cm | 101 |
| Microplastics #2 | NO | NO | NO | NO | NO | NO | 0 |
| Pigments | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | 0-1 cm | 6 |
| Macrofauna | 12 bulk | 18 bulk | 35 bulk | 38 bulk | 32 bulk | 27 bulk | 192 bulk |
| Particle size | 0-18 cm (in 0.5 steps) | 0-17.5 cm (in 0.5 steps) | 0-22.5 cm (in 0.5 steps) | 0-20.5 cm (in 0.5 steps) | 0-17.5 cm (in 0.5 steps) | 0-18.5 cm (in 0.5 steps) | 229 |
| Number of filled cores during successful deployments | 17 | 11 | 12 | 19 | 14 | 15 | 88 (69.8%) |
| Number of unfilled cores during successful deployments | 1 | 7 | 6 | 8 | 4 | 12 | 38 (30.2%) |

## Multicore macrofauna

The multicore was used to sample macrofauna across the fjordic glacial retreat sites. It was considered that six replicate cores across three deployments should be sufficient to capture within station variability. Samples from Marian Cove and Börgen Bay were processed one core at a time in the following protocol; each core was individually sieved over a 1 mm sieve under gentle washing. All animals present in the sieve were then preserved together as an assemblage sample in 100% Ethanol. A further level of detail was piloted in one core at Börgen Bay, in which the core was sectioned into 5 cm sections starting from the top to the bottom. The success of this at partitioning where living and dead fauna lead to this technique being adopted for all Sheldon Cove (Ryder Bay) sampling. [When the results of all sections for each of these cores are combined they are then equivalent of previous cores, thereby compatable]. Each section of each core was individually sieved over a 1 mm sieve and all present animals were preserved in 100 % Ethanol. Any empty calcareous components (e.g. bivalve shells) found in any of the samples were also collected and preserved with the sample.

No analysis has been undertaken to date but preliminary observations suggest show that the macrofaunal assemblages were very patchy, differing substantially in terms of density, richness and eveness within the same station. Bivalves (Mollusca) and polychaetes (Anellida) were the most abundant taxonomic groups represented in the cores and would seem to have important roles in the colonisation of this newly emerging environment. Various echinoderms (Asteroidea, Ophiuroidea and Holothuroidea), bryozoans and other groups were also present. During the sampling process we noted that communities in Marian Cove seemed to approximately follow an expected successional pattern of increasing richness and density with increasing distance to the glacier terminus. This is expected for a number of reasons, such as increased habitat age, decreased environmental stress and great variety of habitat type away from glacier terminus. Assemblages in Börgen Bay, however seemed to follow a different pattern with some sites close to the glacier showing high richness and density. At this site it was especially notable that assemblages closest to the glacier were more likely to contain bivalves than those further away which tended to be dominated by polychaetes. At Ryder Bay, the site furthest away from the glacier was especially low in species richness which might be related to its location at 500 m depth. Greatest number of species could be found in the top 5 cm of each sediment core at this location decreasing in abundance with increasing depth. However, species abundance patterns along depth gradients varied between but were consistent within stations. Details can be found in section 5.5.2.

### Marian Cove:

Multicorer deployed 27 times, 12 unsuccessful.
Most of these deployments were unsuccessful as the multicorer did not fire, or the cores were too few and too shallow. However, after calling the manufacturers they suggested completely removing the damper piston. After this nearly all deployments were successful. It is still however, very important to properly clean the Multicorer, especially the spring mechanism, and the top lid latch. It is also necessary to keep the bottom latch spring in the correct position, to keep it from catching on the bottom lid. Another item to keep an eye on is the firing latch (connected to the bungee cords) itself. It was discovered that these may move and completely overshoot the top lids, and hence not activate the firing mechanism.
Lost three core holders. We were removing them each time to clean initially but it is not necessary and clearly introduces the risk of incorrect reinstallation.

### Börgen Bay:

Deployed 15 times, 1 unsuccessful.
After the unsuccessful deployment wooden “skis” were fitted to the legs to prevent excessive sinking into the sea bed and allow the mechanism to fire. The skis stayed on for the remainder of deployments in Börgen Bay.

### Sheldon Cove:

Deployed 17 times, 4 unsuccessful
On one deployment the rope became caught under one of the legs and the corer came out almost sideways. It was landed on the deck but one corer tube and one of the firing latches (attached to bungee) is bent. We have spares. Three firing latches seem to have moved and now foul the trigger when installing core holders. Needs checking and re-rigging and a thorough once-over to ensure everything else is ok.

On a few occasions the corer fired but the mechanisms were not closing with enough force to create a good seal and samples were being lost. The sliding surfaces and spring cylinders were greased and this seemed to make a significant improvement. It also made the cores easier to remove. If the corer remains unmodified we need to take spray grease on its next cruise.

Cambridge Maintenance:

- One of the legs is bent.
- Build suitable platform
- Develop “skis/legs” that can be attached, unattached.
- Full inspection and torque of all fasteners.
- There is a lot of friction in the sliding mechanism; maybe it can be modified.

Recommendations for future use:

1. One member of staff should be designated record keeper and make sure that the wet lab spreadsheets are completed properly and kept up to date.
2. Watch-keepers should ensure that they record the number of filled cores on each deployment.
3. Do not remove core holder frames after each deployment.

### 5.4.3 Gravity Core

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Expedition JR18003 carried a British Geological Survey gravity corer, which was successfully deployed in good weather at 16 sites, returning a total of 41 m of sediment (Table 1). The gravity corer is a simple mechanism that consists of a weight attached to the top of a metal tube or pipe. A one-way valve within the weight allows water to travel up the inside of the tube and weight, but not down it during retrieval of the corer. A plastic tube ‘liner’ (labelled with the BAS protocol) was slid into the metal tube before each deployment, and a 'corecatcher' consisting of a metal ring with metal strips bent over (allowing only one-way sediment movement) was placed at the end of the liner. Over this, the metal cutting ring was screwed onto the end of the tube, holding the internal liner and corecatcher in place. The gravity corer was lifted out of its metal cradle by both winches on the side of the ship (Fig. 1), and carefully manoeuvred over the side with the winches and by crew members using ropes. Once in the overboard position, one the winches was lowered and then disconnected, such that the gravity corer was in a vertical position held by just one winch (Fig. 2). The gravity corer was then lowered into the sediment at a speed of less than 1 m $s^{-1}$, and left in the sediment for between 30 seconds and 2 minutes. Once lifted to the side of the ship, the procedure was reversed whereby the second winch was reconnected and the gravity corer was placed back into its cradle. The metal cutter was unscrewed and the plastic liner was removed whilst being careful to avoid any contamination. End caps were immediately placed over each end, and the core liner was then moved inside before being cut into <1 m sections with a hacksaw. The metal tube was cleaned out with a seawater hose between deployments, before being reloaded with another core liner. Several of the deployments were unsuccessful, which was thought due to either a lack of soft sediments on the sea floor, or the presence of pebbles and/or boulders.

*Figure 5.4.3 The gravity corer was initially raised from its basket with both side winches whilst being held steady by two crew members.*

*Figure 5.4.4 Once overboard, the gravity corer was lowered by one winch and disconnected, before being deployed by the second winch. The process was carried out in reverse once the sediment was collected.*

*Table 5.4.4 List of the successful gravity cores collected during expedition JR18003.*

| Core Number | Location | Latitude | Longitude | Water depth (m) | Core thickness (cm) |
|---|---|---|---|---|---|
| MC2-GC01 | Marian Cove | -62.21251 | -58.76787 | 98.97 | 235 |
| MAXB1-GC02 | Marian Cove | -62.22715 | -58.84246 | 418.2 | 300 |
| MAXB2-GC03 | Marian Cove | -62.22718 | -58.84275 | 419.92 | 300 |
| MC1-GC05 | Marian Cove | -62.21765 | -58.78938 | 94.43 | 211 |
| MC1-GC06 | Marian Cove | -62.21764 | -58.7895 | 96.5 | 266 |
| MC3-GC07 | Marian Cove | -62.20826 | -58.74773 | 106.67 | 103 |
| BB3-GC08 | Börgen Bay | -64.71843 | -63.45823 | 294.8 | 226 |
| BB0-GC10 | Börgen Bay | -64.75787 | -63.44814 | 284.78 | 300 |
| BB0-GC11 | Börgen Bay | -64.75784 | -63.44814 | 285.31 | 300 |
| SC7-GC17 | Ryder Bay | -67.5427 | -68.26469 | 289.64 | 300 |
| SC7-GC18 | Ryder Bay | -67.54272 | -68.26464 | 289.71 | 300 |
| SC8-GC19 | Ryder Bay | -67.57071 | -68.21149 | 506.04 | 270 |
| SC8-GC20 | Ryder Bay | -67.57069 | -68.21132 | 505.14 | 282 |
| SC9-GC21 | Ryder Bay | -67.56901 | -68.28751 | 467.62 | 107 |
| SC10-GC22 | Ryder Bay | -67.54947 | -68.29311 | 334.56 | 300 |
| SC10-GC23 | Ryder Bay | -67.54946 | -68.29311 | 335.12 | 300 |

## 5.5 Biology

### 5.5.1 Burdwood Bank

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The fine scaling of the Marine Management Areas project will provide biological and economic knowledge as well as policy and legislation for the creation of special management areas. This will allow for the better management of important areas within the Falkland territorial and the Falklands Outer Conservation Zone waters. As a result management of areas such as the inland waters and the AFCAS (Assessment of Fishing Closure Areas as Sites) regions will be brought up to the highest international standards, and consequently gain international recognition. Simultaneously, work will be conducted on the offshore region of the Burdwood Bank, an area known to be important for seabirds and mammals, and believed to house high benthic biodiversity according to some studies, e.g. high diversity of cold-water coral species. Despite the benthic biodiversity on the Bank being poorly described or understood, the area is likely to be very important in the face of ongoing climate change, not least due to its location as a hard boundary for species range shifts and its likely provision of blue carbon ecosystem services. Response to past and present warming has typically resulted in species moving to increasingly higher latitudes along linear coastline (for example the Americas). The Bank marks the (eastern side of the) southern continental shelf limit, and thus a hard stop for organisms shifting southwards. Further work in this region will develop understanding of whether the benthos and water column are as important to manage as the surface waters.

To move towards achieving the above, the British Antarctic Survey, as a partner in the project, helped to make preliminary sampling on the Burdwood Bank a reality. During 48h work on board of the James Clark Ross, multibeam and TOPAS data were collected as well as mini Agassiz Trawls (AGT).

#### Multibeam and TOPAS work

Multibeam data collection was the main focus of the 48h work on the Burdwood Bank. The aim was to obtain high-resolution bathymetry data from the southern slopes of the Burdwood Bank, an area poorly studied due to remoteness, strength of the currents and depths. Overall, a 6,096.44 km$^2$ area was mapped at high definition (25 m$^2$ per pixel; Figure 5.5.1 A and B) in anticipation that next year when more ground-truthing can occur, we can use it for benthic habitat prediction. The original ship path had to be modified *in situ* in order to maximise the data obtained, while at the same time close any large gaps (original path design can be seen in Fig. 5.5.1 B). TOPAS data was also collected with the intention of identifying a suitable location for the collection of a gravity core. Unfortunately, due to technical difficulties with high swells the gravity core could not be deployed on this occasion. Nevertheless, the TOPAS data was collected and is available in the event that a gravity core can be collected on next year's cruise. For full details on the methods, see multibeam section 5.1.

## Mini Agassiz Trawl

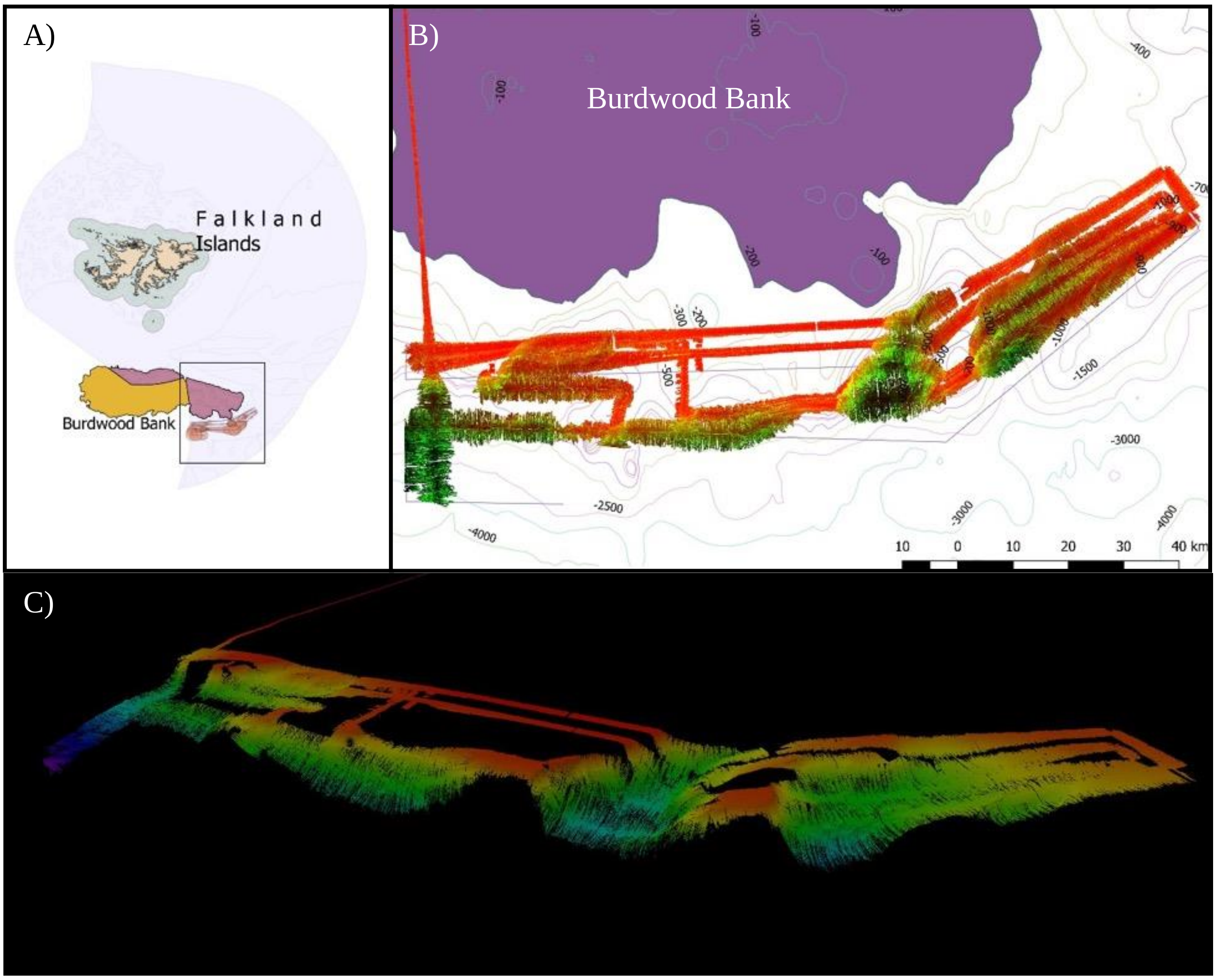


*Figure 5.5.1 Multibeam data collected on the Burdwood Bank. A) Shows the Bank and data collection locations with respect to the Falkland Islands, B and C indicate the multibeam swath and data collection. Figure B shows bathymetry depth in meters and the planned ship's path.*

The AGT (Figure 5.5.2) provides a means of collecting epibenthos specimens, but unlike commercial trawling, it has a mouth width of 1.25 m and a mesh size of 1 cm. The small mouth gap allows for minimal destruction of the benthic environment, as each trawl is only deployed for a few minutes at a time (see Table 5.5.1 for trawling location, time and depth). Simultaneously, the small mesh size allows the collection of smaller organisms, which otherwise might avoid collection.

*Figure 5.5.2 Agassiz Trawl being returned to deck while on the Burdwood Bank. Picture courtesy of S. Jenkins.*

*Table 5.5.1 Mini Agassiz Trawl start and end information for time, location, as well as ship event number and ship's heading.*

| Time - Start | Time – End | Latitude - Start | Longitude - Start | Latitude - Start | Longitude - Start | Depth start (m) | Depth end (m) | Ship event No. | Heading |
|---|---|---|---|---|---|---|---|---|---|
| 04/12/2018 16:58 | 04/12/2018 17:09 | -54.9702 | -57.2001 | -54.9686 | -57.2001 | 392.79 | 388.09 | 5 | 176.21 |
| 04/12/2018 19:36 | 04/12/2018 19:42 | -55.0684 | -57.1974 | -55.0676 | -57.1976 | 1165.52 | 1182.5 | 6 | 169.62 |
| 05/12/2018 11:55 | 05/12/2018 12:00 | -54.9666 | -57.7565 | -54.9666 | -57.7553 | 395.4 | 395 | 7 | 270.51 |
| 05/12/2018 14:05 | 05/12/2018 14:11 | -55.0016 | -57.7715 | -55.0017 | -57.7703 | 1265.66 | 1269.45 | 8 | 280.95 |

From the four trawls, a total of 365 samples were collected. Of these, 81 samples have been put aside to be sent to the British Antarctic Survey (BAS), a partner organisation in the Marine Management Project of the Falkland Islands. BAS will be in charge of conducting DNA barcoding analysis. Another 131 samples will be sent to the Natural History Museum (NHM), London, UK, for identification and permanent preservation of samples. Similarly, 111 vials with specimens will be sent to the Italian National Antarctic Museum, Genoa, Italy. A further 37 samples will be kept temporarily in the Falkland Islands, because the specimens within these samples are mainly stony corals, for which CITES permits for exports and imports are required. Once these have been obtained, the samples will be shipped to the UK, to both BAS and NHM.

From the four trawls a total of 24 taxonomic Classes of organisms were obtained (Table 5.5.2). Although the samples are yet to be identified to species level, this high number of Classes already highlights the potentially high biodiversity in the Burdwood Bank. Ship event number

5 (i.e. trawl 1) saw the highest count of organisms (484 individuals in total), but simultaneously had the lowest number of Classes, only 15. This trawl was dominated by Cheilostomata (217 individuals), followed by the Class Ophiuroidea and Anthozoa (81 and 78 individuals, respectively). Trawl 2 (ship event 6) had the highest number of Classes, 21 in total, as well as the third highest number of individuals collected, 361 individuals in total. Unlike trawl 1, trawl 2 was strongly dominated by Ophiuroidea (122 individuals), followed by Demospongia (40 individuals). Trawl 3 (ship event no. 7) had a total of 19 Classes, but the lowest count of individuals, with only 254 individuals in total. Ophiuroidea was once again the dominant Class, followed by Anthozoa (78 and 42 individuals, respectively). Finally, Trawl 4 (ship event no. 8) had a total of 366 individuals divided into 18 Classes. Unlike the other trawls, this trawl was strongly dominated by the Class Malacostraca, with 177 individuals, or what equals to 48.4% of the total organisms caught, Anthozoa followed this with 64 individuals (See table 2 for further details). See Figure 3 for an example of organisms collected in the trawls.

*Table 5.5.5 Animals (by taxonomic Class) collected during the four Agassiz Trawling events on the Burdwood Bank.*

| **Class** | **Ship event No. 5** | **Ship event No. 6** | **Ship event No. 7** | **Ship event No. 8** |
|---|---|---|---|---|
| Anthozoa | 78 | 34 | 42 | 64 |
| Ascidiacea | 0 | 5 | 1 | 3 |
| Asteroidea | 0 | 5 | 7 | 2 |
| Bivalvia | 9 | 8 | 1 | 3 |
| Brachiopoda | 9 | 3 | 6 | 3 |
| Bryozoa | 0 | 9 | 7 | 1 |
| Cephalopoda | 0 | 1 | 0 | 0 |
| Cheilostomata | 217 | 16 | 24 | 1 |
| Cirripedea | 3 | 2 | 0 | 0 |
| Crinoidea | 0 | 2 | 0 | 0 |
| Demospongia | 1 | 41 | 16 | 11 |
| Echinoidea | 8 | 0 | 18 | 3 |
| Gastropoda | 13 | 38 | 4 | 14 |
| Hexactinellidae | 0 | 3 | 2 | 0 |
| Holothuroidae | 2 | 1 | 5 | 1 |
| Hydrozoa | 0 | 21 | 3 | 2 |
| Malacostraca | 5 | 17 | 9 | 177 |
| Ophiuroidea | 81 | 122 | 78 | 35 |
| Pisces | 0 | 1 | 1 | 1 |
| Polychaeta | 49 | 27 | 22 | 41 |
| Pterobranchia | 5 | 2 | 6 | 0 |
| Pycnogonida | 3 | 4 | 2 | 2 |
| Scaphopoda | 1 | 0 | 0 | 0 |
| Thaliacea | 0 | 0 | 0 | 2 |

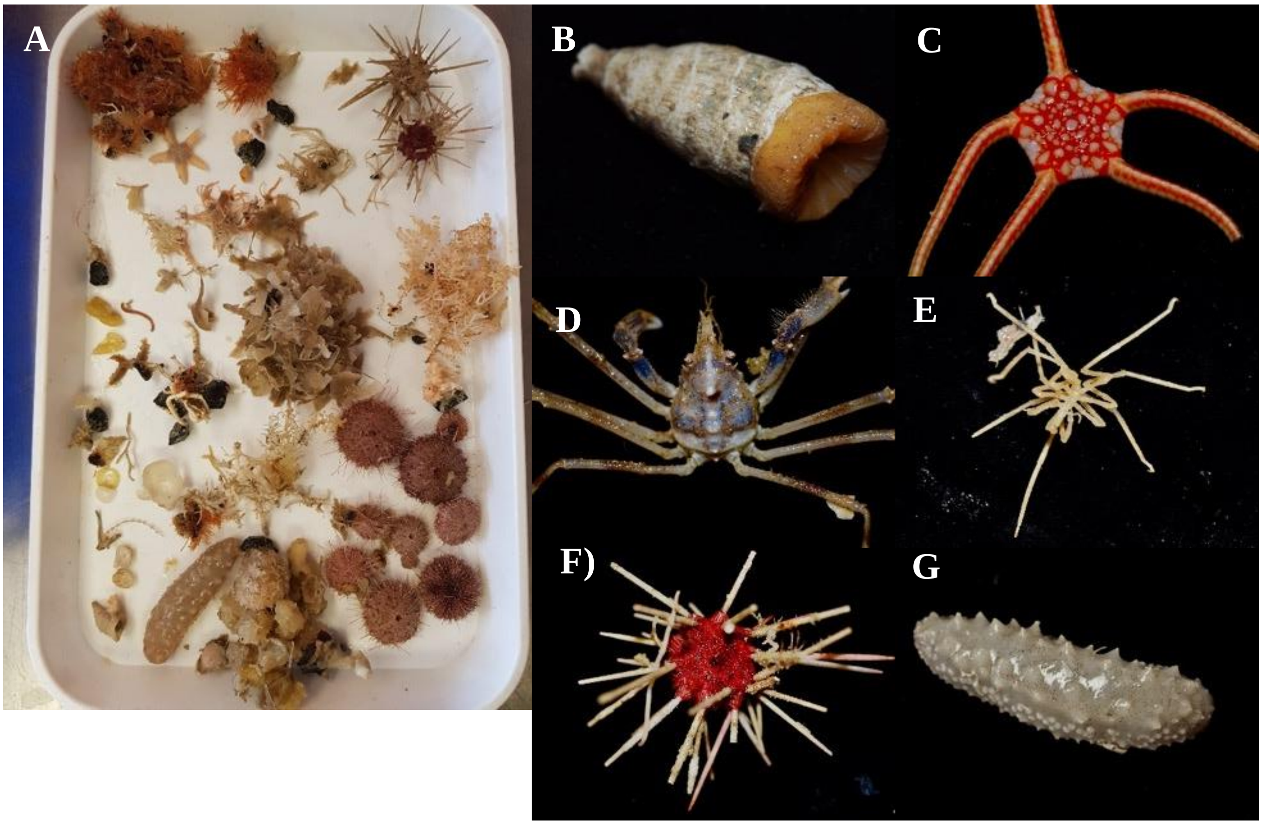


*Figure 5.5.3 Example of specimens separated from the gravel in the trawl (A), as well as a small example of preserved individuals. These organisms are, by class, an Anthozoan (B), an Ophiuroidean (C), a Malacostracan (D), a Pycnogonid (E), an Echinoid (F) and a Holothuroidaen (G). Figure A courtesy of A. Roman Gonzalez, pictures B to G taken by C.J. Sands.*

### 5.5.2 Macrofauna

The multicore (MuC) was used to sample macrofauna across the fjordic glacial retreat sites. It was considered that 6 replicate cores across 3 deployments should be sufficient to capture within station variability. Our 5-6 sample stations were arranged in a transect from fjord mouth (1) to glacier terminus at each of the three sampling sites (Table 5.5.6). Samples from Marian Cove and Börgen Bay were processed one core at a time in the following protocol; each core was individually sieved over a 1 mm sieve under gentle washing. All animals present in the sieve were then preserved together as an assemblage sample in 100% Ethanol. A further level of detail was piloted in one core at Börgen Bay, in which the core was sectioned into 5 cm sections starting from the top to the bottom. The success of this at partitioning where living and dead fauna lead to this technique being adopted for all Sheldon Cove (Ryder Bay) sampling. [When the results of all sections for each of these cores are combined they are then equivalent of previous cores, thereby compatible]. Each section of each core was individually sieved over a 1 mm sieve and all present animals were preserved in 100 % Ethanol. Any empty calcareous components (eg bivalve shells) found in any of the samples were also collected and preserved with the sample.

*Table 5.5.6 Number of samples collected from each station. Often station 5 (closest to the glacier) could not be sampled without endangering the equipment – thus no samples were collected at these instances.*

| Sites | Station 1 | Station 2 | Station 3 | Station 4 | Station 5 | Station 6 |
|---|---|---|---|---|---|---|
| Marian Cove | 6 | 6 | 6 | 7 | 7 | 0 |
| Börgen Bay | 6 | 6 | 6 | 6 | 5 | 0 |
| Ryder Bay | 8 | 5 | 6 | | | |

No analysis has been undertaken to date but preliminary observations suggest show that the macrofaunal assemblages were very patchy, differing substantially in terms of density, richness and eveness within the same station. Bivalves (Mollusca) and polychaetes (Anellida) were the most abundant taxonomic groups represented in the cores and would seem to have important roles in the colonisation of this newly emerging environment. Various echinoderms (Asteroidea, Ophiuroidea and Holothuroidea), bryozoans and other groups were also present. During the sampling process we noted that communities in Marian Cove seemed to approximately follow an expected successional pattern of increasing richness and density with increasing distance to the glacier terminus. This is expected for a number of reasons, such as increased habitat age, decreased environmental stress and great variety of habitat type away from glacier terminus. Assemblages in Börgen Bay, however seemed to follow a different pattern with some sites close to the glacier showing high richness and density. At this site it was especially notable that assemblages closest to the glacier were more likely to contain bivalves than those further away which tended to be dominated by polychaetes. At Ryder Bay, the site furthest away from the glacier was especially low in species richness which might be related to its location at 500 m depth. Greatest number of species could be found in the top 5 cm of each sediment core at this location decreasing in abundance with increasing depth. However species abundance patterns along depth gradients varied between but were consistent within stations.

### 5.5.3 MiniAgassiz Trawl

**David Barnes,** British Antarctic Survey, NERC, Cambridge, UK, dkab@bas.ac.uk

Agassiz trawls (AGT) are used to sample benthic assemblages of macro- and mega epifauna on relatively flat substrata.  Catches are qualitative but they give a good presence-absence record of what fauna occurs in a particular habitat and they can collect physical specimens to identify species seen in seafloor images from SUCS,  We use a "mini" AGT (originally designed for the small winch and A-frame on the Russian ship *Akademic Tryoshnikov*) during the Antarctic Circumpolar Expedition, because it collects good quality specimens (ie low damage) whilst minimizing environmental impact.  We used it with additional 160kg of weights on the RRS *James Clark Ross*.  It has a mesh size of 1 cm and a mouth width of 1.25 m.

We used a deployment protocol of lowering the wire at max of 50 m/min whilst steaming at 0.5 knots until the AGT reached the seabed.  We let out 2x depth in trawling wire length.  The net was then trawled at 0.5 knots for 5 minutes or less.  With the ship speed kept at 0.5 knots the AGT was hauled at 30 m/min in order to avoid damaging the gear. When the AGT had left the seafloor, the hauling speed was increased to 45 m/min. Following large catches the technical trawl period was even reduced to zero minutes (meaning it only trawled on haul in). When catches included a substantial amount of mud fire hoses were used to wash most of the mud out of the net which reduced sieving time on the deck. When clean the net was held over a stacked series of 1cm mesh sieve on top of the 1mm mesh sieve. The cod end was then released so the catch was dropped into the sieves where any remaining mud was rinsed through.

Samples were sorted to class and where possible to morphotype. Most specimens were preserved in pre-chilled 99.8% ethanol (total vial volume at least 80% ethanol) and stored in the -20°C freezer. A shortage of ethanol resulted in most catches being frozen at -20C directly for later transfer to ethanol.

A total of ten deployments were made during the expedition, six for the ICEBERGS project and four for SAERIs marine spatial planning work on Burdwood Bank. Marian Cove (MC) and Börgen Bay (BB) were previously trawled during the JR17001 cruise so only Sheldon Cove (Ryder Bay) was trawled in 2018. We trawled sites from the glacier terminus (SG6) through to the middle of Ryder Bay (SG1). Surprisingly SG6 brought up abundant benthos, albeit little diversity – seemingly dominated by the Scallop *Adamusium colbecki*.

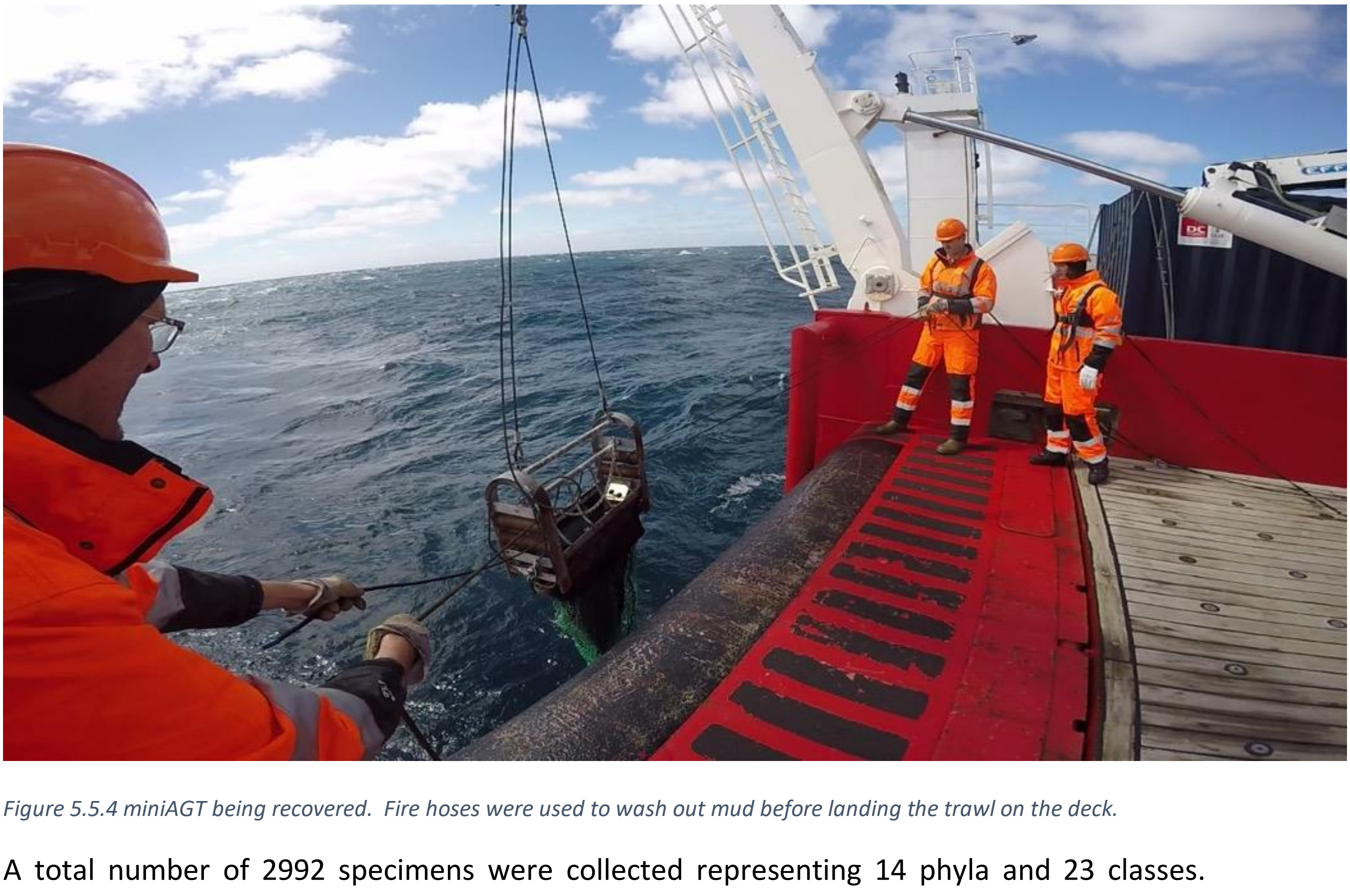

*Figure 5.5.4 miniAGT being recovered. Fire hoses were used to wash out mud before landing the trawl on the deck.*

A total number of 2992 specimens were collected representing 14 phyla and 23 classes. Bivalves (488), polychaetes (197 and ophiuroids (189) were most abundantly represented in catches. Sheldon Cove was similar in overall richness to Marian Cove (JR17001) which were both better represented than samples from Börgen Bay. With quantitative apparatus meaningful comparisons could made, for example using rarefaction curves, but this is not intended for this data. Crucially the trawl samples give potential to identify individuals seen in SUCS images and for work on age, growth and explore information within organism skeletons. The trawl samples also indicate an approx. increase in richness and abundance both away from the glacier terminus and towards moraines. The data summary is presented in Table 5.5.7.

*Table 5.5.7 Richness of sampled stations according to class.*

| | Polychaete | Echiura | Priapula | Nemertean | Sipunculan | Echiuran | Anthozoa | Hydrozoa | Asteroid | Ophiuroid | Crinoidea | Echinoid | Holothuroid | Bivalve | Gastropod | Polyplacophora | Scaphopod | Hexactinellida | Demospongiae | Cirripedia | Malacostraca | Pycnogona | Articulata | Gymnolaemata | Stenolaemata | Ascidiacea | Pisces |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sc6** | **1** | | | **1** | | | | | | **1** | | **1** | | **1** | | | | | | | **1** | | | | | | |
| **Sc5** | **1** | | | | **1** | | | | | **1** | | **1** | | **1** | | | **1** | | | | **1** | | | | | | |
| **Sc4** | **1** | | | **1** | **1** | | **1** | **1** | | **1** | | | **1** | **1** | **1** | | **1** | | | | **1** | | | **1** | | | |
| **Sc3** | **1** | **1** | | | **1** | | **1** | | **1** | **1** | | | **1** | **1** | **1** | | **1** | | | | **1** | **1** | | | | **1** | |
| **Sc2** | **1** | | | | | | **1** | **1** | **1** | **1** | | **1** | **1** | **1** | **1** | **1** | | | **1** | | **1** | | **1** | **1** | | **1** | **1** |
| **Sc1** | **1** | **1** | | | **1** | | | | | **1** | | | | **1** | **1** | | **1** | | **1** | | **1** | **1** | | **1** | **1** | | **1** |
| BB4 | 1 | | | | | | | | | 1 | | | | | | | | | | | 1 | 1 | | 1 | | | |
| BB3 | | | | | | | | 1 | | 1 | | | | 1 | | | | | | | | 1 | | 1 | | | |
| BB2 | 1 | | | | | | | | | | | | | | | | | | 1 | | | 1 | | 1 | | 1 | |
| BBx | 1 | | | | | | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | | | | | | 1 | 1 | | 1 | | 1 | 1 |
| BB1 | 1 | | | | | | | 1 | | 1 | | | | | | | | | | | 1 | | | | | | |
| MC 5 | 1 | | | | | | 1 | | | | | | | 1 | | | | | | | | 1 | | 1 | | 1 | |
| MC 4 | 1 | | | | | | 1 | 1 | | | | | | 1 | 1 | | | | | | 1 | | | | | 1 | |
| MC 3 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | | | | 1 | | 1 | 1 | | 1 | | 1 | |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MC 2 | 1 | | 1 | | | | | | 1 | 1 | 1 | | | 1 | 1 | | | 1 | | | 1 | | 1 | 1 | 1 | 1 | 1 |
| MC 1 | 1 | | 1 | | | | 1 | | 1 | 1 | | | 1 | 1 | 1 | | | 1 | | 1 | 1 | | 1 | 1 | 1 | 1 | |

## 5.5.4 Plankton Sampling

**Anna J. Pieńkowski,** University Centre in Svalbard, Norway
**Justine Whitaker,** University of West Florida
**Nadescha Zwerschke,** British Antarctic Survey

### Rationale

The primary rationale of plankton sampling was to identify the major planktonic components of the water column above each of the core benthic research stations investigated as part of the ICEBERGS 2018 cruise, with a particular emphasis on the identification of planktonic organisms that preserve as microfossils (e.g., dinoflagellate cysts, foraminifera) in seabed sediments (AJP; all study sites). Plankton samples were also taken for use in genetic and ingested microplastic analyses (JW; all study sites), as well as plankton culturing (NZ; selected sites at Sheldon Cove).

### Gear

An N70 net was used for plankton sampling; this device has a 70cm diameter mouth opening, 445µm upper mesh and 195µm lower mesh. It is a BAS reconstruction of pelagic sampling nets used during the Discovery Investigations - described in detail by Ward *et al.* 2012 (Polar Biology DOI 10.1007/s00300-012-1163-x). The N70 was set up for simple vertical hauls, and consequently, the throttling rope and messenger system for sampling discrete depth horizons was not used. As in previous expedition (JR17001), a jubilee clip, rather than the brass fitting ring, was used to fit the net to the cod end because the latter was challenging to pull over the net seam (Figure 5.5.5). The brass wires were attached to a short section of rope to facilitate handling of the lead weight (Figure 5.5.6).

*Figure 5.5.5*

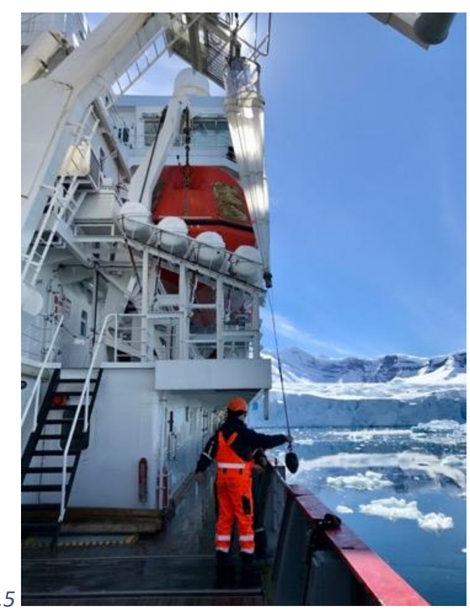

*Fig. 5.5.6*

## Sampling sites

Three fjords were sampled during expedition JR18003: Marian Cove (MC) at King George Island, Börgen Bay (BB) at Anvers Island, and Sheldon Cove (SC) at Adélie Island. Vertical N70 hauls were made in transect within each fjord, corresponding to the ICEBERGS 2018 research stations that occur at successive distances from the fjord mouth (Station 1) in toward to glacier edge. One to two hauls were made at each station. Details for all 18 of the N70 deployments are given in Table 5.5.8.

*Table 5.5.8 N70 plankton net hauls in West Antarctic Peninsula fjords. Time refers to date and time of deployment; em122 depth denotes water depth derived by multibeam. Abbreviations: SST = sea surface temperature; SSS = sea surface salinity; MF = Microfossils; MP = Microplastics and genetics; PC = plankton culturing*

| Sampling Code | Time | Latitude | Longitude | em122 depth (m) | SST (°C) | SSS | Bridge Event | Haul Depth | No. of hauls | Purpose of hauls |
|---|---|---|---|---|---|---|---|---|---|---|
| MC-1 | 08/12/2018 08:36 | -62.21763 | -58.78894 | 101.68 | 0.5003 | 33.7735 | 16 | 80 | 1 | MF, MP |
| MC-2 | 08/12/2018 12:58 | -62.20880 | -58.75003 | 101.68 | 0.5677 | 33.6122 | 22 | 80 | 1 | MF, MP |
| MC- 3 | 08/12/2018 21:40 | -62.20826 | -58.74777 | 101.68 | 0.5144 | 33.5461 | 29 | 80 | 1 | MF, MP |
| MC-4 | 09/12/2018 03:48 | -62.20557 | -58.73961 | 101.68 | 0.4230 | 33.2216 | 36 | 80 | 1 | MF, MP |
| BB-1 | 12/12/2018 18:31 | -64.74169 | -63.45374 | 247.70 | 0.76740 | 33.7305 | 107 | 180 | 1 | MF, MP |
| BB-2 | 12/12/2018 19:05 | -64.72606 | -63.45259 | 224.47 | 0.56280 | 33.3530 | 108 | 180 | 1 | MF, MP |
| BB-3 | 12/12/2018 19:35 | -64.71825 | -63.45803 | 294.07 | -0.08650 | 33.7815 | 109 | 180 | 1 | MF, MP |
| BB-4 | 12/12/2018 20:05 | -64.71052 | -63.45496 | 257.91 | 0.02850 | 33.5356 | 110 | 180 | 1 | MF, MP |
| BB-5 | 12/12/2018 20:32 | -64.70335 | -63.45039 | 272.79 | 0.19970 | 33.6991 | 111 | 180 | 1 | MF, MP |
| SC-1 | 21/12/2018 21:51 | -67.57017 | -68.22293 | 506.95 | 0.2268 | 33.2336 | 238 | 200 | 2 | PC |
| SC-1 | 21/12/2018 21:32 | -67.57019 | -68.22299 | 507.33 | 0.4394 | 33.1594 | 237 | 200 | 2 | MF, MP |
| SC-2 | 21/12/2018 20:34 | -67.54973 | -68.26708 | 175.25 | -0.0921 | 33.1748 | 236 | 150 | 2 | PC |
| SC-2 | 21/12/2018 20:19 | -67.54977 | -68.2671 | 175.91 | -0.2496 | 33.0729 | 235 | 150 | 2 | MF, MP |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SC-3 | 21/12/2018 19:48 | -67.53940 | -68.26399 | 288.80 | -0.1201 | 33.2691 | 234 | 200 | 2 | PC |
| SC-3 | 21/12/2018 19:30 | -67.53932 | -68.26384 | 287.79 | 0.9005 | 33.1122 | 233 | 200 | 2 | MF, MP |
| SC-4 | 21/12/2018 19:00 | -67.52906 | -68.25584 | 255.44 | 0.8524 | 33.0238 | 232 | 200 | 1 | MF, MP |
| SC-5 | 21/12/2018 18:31 | -67.51970 | -68.25550 | 194.91 | 0.1010 | 33.2806 | 231 | 180 | 1 | MF, MP |
| SC-6 | 21/12/2018 18:02 | -67.51571 | -68.25352 | 0.2308 | 0.2308 | 33.2874 | 230 | 100 | 1 | MF, MP |

### N70 catch processing and initial assessment

The contents of each N70 catch were split to be used for microfossil analyses and microplastics/genetic analyses (see below). At selected sites at Sheldon Cove (Table 5.5.8), a second haul was taken for plankton culturing.

All of the N70 catches were dominated by phytoplankton (diatoms). The density of these was lower at Marian Cove stations compared to Börgen Bay stations, which appeared much richer, potentially due to blooming. Zooplankton comprised a very small component of all the catches, though stations at Sheldon Cove contained frequent ctenophores.

### Micropalaeontology

Microfossils – preserved remnants of microscopically small organisms living in the plankton and the benthos - constitute the backbone of the study of Earth's past climate. However, in order to confidently use microfossils as palaeoenvironmental indicators, present-day distribution and population patterns need to be characterized and related to measured environmental parameters. For this project, planktonic organisms that are known to be potentially important in these deglaciating fjord settings (foraminifera, diatoms, dinoflagellate cysts) will be identified and their distribution will be related to measured environmental parameters (e.g., from CTD casts) via multivariate statistics to identify proxies that successfully reconstruct 1. ocean temperature, 2. sea ice cover, and 3. distance from the ice front.

Collected samples (100 cc) from the N70 casts were split, with ~50cc of material preserved in ethanol (30%; for foraminifera) and ~50 cc of material preserved in Lugol's solution (iodine; for dinoflagellates and diatoms). Preliminary scans of the samples under low power microscopy indicate that the majority of planktonic organisms found in both fjords consist of diatoms, particularly spores of *Chaetoceros*. However, more detailed scanning under high power (light microscopy) will elucidate the distribution of other targeted planktonic organisms (e.g., dinoflagellates and their cysts).

## Microplastics

Mounting evidence suggests that plastic pollution and adhered chemicals associated with plastics are causing dramatic environmental and organismal consequences, especially when ingested. Ingestion of plastic has been documented in both vertebrates (e.g. birds and marine turtles) and invertebrates (e.g. zooplankton, polychaetes, and barnacles). Microplastics (<5 um) are now being identified as a concern to zooplankton and filter feeders. Due to the ubiquitous nature of microplastic pollution, and increasing concerns about the associated hazards, characterizing microplastics in aquatic ecosystems is of great importance. The fjords targeted for ICEBERGS are especially of importance because as animals colonize the fjords newly formed by glacial retreat, microplastics present an additional stressor.

Zooplankton were opportunistically sampled (six 1.5 µl microfuge tubes per station) for the analysis of ingested microplastics. Laboratory work and analyses will be performed at the University of West Florida. Zooplankton will be sorted, barcoded for species identification, enzymatically digested. Total digested volume will be filtered with a 0.45 micron gridded filter. Microplastics will be quantified and composition will be determined with micro-fourier transform infrared spectroscopy.

## Plankton culturing

The West Antarctic Peninsula is one of the regions most severely affected by global warming. The alterations in climatic conditions means that less and less sea ice is forming during the winter month causing the phytoplankton bloom to arrive earlier in the year in these regions. Marine Antarctic organisms generally have low metabolic rates, thus quantity of phytoplankton bloom might be less important than duration. This project aims to culture phytoplankton as a food source to mimic an early onset of phytoplankton blooms under climate change conditions and quantify how these would affect species interactions of highly abundant benthic filter feeders, such as bryozoans and polychaetes.

Phytoplankton was sampled in Ryder Bay from 3 vertical trawls using the stations furthest away from Sheldon glacier. Zooplanktonic predators were removed from small subsamples which were then used to start a phytoplankton culture.

### 5.5.5 Cetacean Survey

**Marina Costa,** SAERI, Falkland Islands, mcosta@env.institute.ac.fk

#### Background

The waters between the Falkland Islands and the Western side of the Antarctic Peninsula host a diverse community of cetaceans including at least twenty-five species including eight species of mysticetes or baleen whales (blue whale, *Balaenoptera musculus*; fin whale, *Balaenoptera physalus*; sei whale, *Balaenoptera borealis*; minke whale species, either Antarctic minke whale *Balaenoptera bonaerensis* or dwarf minke whale[4] *Balaenoptera* acutorostrata; humpback whale, *Megaptera novaeangliae*; southern right whale, *Eubalaena australis*; pygmy right whale, *Caperea marginata*), seven species of beaked whales (southern bottlenose whale, *Hyperoodon planifrons*; Andrew's beaked whale, *Mesoplodon bowdoini*; strap-toothed whale, *Mesoplodon layardii*; Gray's beaked whale, *Mesoplodon grayi*; Hector's beaked whale, *Mesoplodon hectori*; Cuvier's beaked whale, *Ziphius cavirostris*; Arnoux's beaked whale, *Berardius arnuxii*), eight species of delphinids (Commerson's dolphin, *Cephalorhynchus commersonii*; Peale's dolphin, *Lagenorhynchus australis*; hourglass dolphin, *Lagenorhynchus cruciger*; dusky dolphin, *Lagenorhynchus obscurus*; orca, *Orcinus orca*; long-finned pilot whale, *Globicephala melas*; southern right whale dolphin, *Lissodelphis peronii*; common bottlenose dolphin, *Tursiops truncatus*), one species of porpoise (spectacled porpoise, *Phocoena dioptrica*) and the sperm whale, *Physeter macrocephalus* (Perrin et al. 2009). Commerson's dolphin has been observed only around the Falkland Islands waters and Peale's dolphin has been observed in the continental waters around the Falkland Islands, including the Burdwood Bank.

#### Study area

The waters surveyed during this trip encompass four areas including the cold temperate and sub-Antarctic zone surrounding the Falkland Islands and the Burdwood Bank, the offshore waters and the southern polar Antarctic zone west of the Antarctic Peninsula, whose boundary is defined by an oceanic frontal feature known as Polar Front (PF) (Figure 5.5.7). The PF is the most important feature of a system of fronts and currents created by the Antarctic Circumpolar Current (ACC) circulating around Antarctica from west to east. Across the front the temperature can change dramatically, up to 10˚C, over few kilometers affecting marine wildlife distribution including cetacean. The convergence zone is a highly productive region driven by local mixing and

[4] The Dwarf Minke whale is a form of *B. acutorostrata* that occurs in the southern hemisphere (Reilly *et al.* 2008e). The identification between *B. acutorostrata* and *B. bonaerensis* is ambiguous because the two species are partially sympatric and hard to distinguish. In this document there is no future reference to *B. acutorostrata.*

upwelling caused when cold, northward-flowing, Antarctic waters meet and sink under the relatively warmer waters of the Sub-Antarctic.

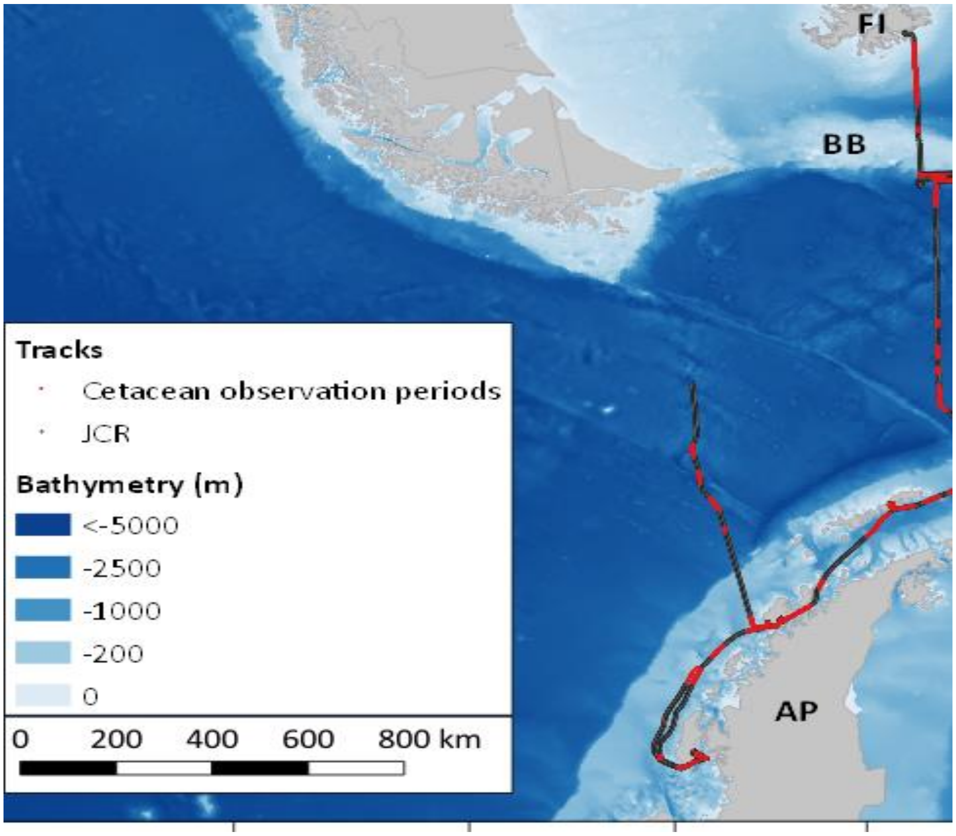


*Figure 5.5.7 The study area surveyed during the ICEBERGS 2 cruise including the Falkland Islands (FI), the Burdwood Bank (BB), and the Antarctic Peninsula (AP). Observation period from the 2nd to the 27th of December 2017.*

The area surveyed included highly productive environments waters around the Burdwood Bank, Falkland Islands, the offshore waters between the Bank and the Antarctic Peninsula and the waters off the western Antarctic Peninsula until the 67° parallel of latitude. These waters support high densities of Antarctic krill (*Euphasia superba*), which constitutes a key species in Antarctic food-webs, and thereof are highly important feeding ground for recovering baleen whales populations in polar waters (Atkinson et al. 2008).

## Data Collection

One observer collected opportunistic cetacean navigation and sighting data when the ship was moving from the Falkland Islands to the Antarctic Peninsula and among the three sampling stations (i.e. Marian Cove, Börgen Bay and Sheldon Bay). Observation was conducted from the open platform called *Monkey Island* located at 15 meters above sea level on top of the navigation bridge deck (Figure 5.5.8 A). When weather conditions were unsuitable for observation outside (i.e. during winds stronger than 7 Beaufort) observation was conducted inside the navigation bridge (Figure 5.5.8 B).


*Figure 5.5.8 A. The platform Monkey island where cetacean observation was carried out (red arrow) in good sea condition; B. The navigation bridge where observation was carried out with bad sea conditions.*

The observer searched with naked eyes 180 degrees directly ahead of the track-line with 70% of the effort concentrated in the central 90 degrees. A waterproof 7x50 binocular was used to confirm species identification and whale direction. The bearing was measured using the protractor available on the observation platform. On the bridge, the bearing was measured as difference from the ship heading and the true bearing of the group spotted. Distances were estimated and verified measuring the time from when the animal was spotted and its position abeam the ship (considering a speed of 300m per minute).

Photographs were taken when possible using a CANON EOS 7D Mark II, equipped with a lens EF 70-200mm f/2.8 L IS II USM. The pictures were used to verify species identification.

Navigation data, including local date and time, effort, observer name, platform, environmental conditions were recorded at the beginning and at the end of each survey block and every time there was a change in weather conditions. The following data were recorded:

- Time (i.e. format hh:mm).
- Effort – Positive: when observer was searching for cetaceans; Negative: when observation was interrupted.
- Observer location (Monkey Island or the bridge).
- Sea state in Beaufort scale.
- Swell high (in meters).
- Cloud and ice cover (in %).
- Glare, rain, snow and fog (none, mild, moderate and severe).
- Glare sector (in degrees).
- Visibility (poor, less than 1km; moderate, 1-5km; good, 5-10kmand excellent, >10km).
- Sightability (subjective code: 1 poor, 2 moderate, and 3 good).

When cetaceans were sighted, the following data were tape recorded:

- Species.
- Species certainty (likely, possibly, certain).
- Bearing when sighted.
- Distance to the animal(s).
- Cue (i.e. fin, body, body underwater, splash, blow, etc.).
- Observer's name who sighted it.
- Group size (best, minimum and maximum).
- Swimming direction for baleen whales.
- Animal reaction to the ship.
- Animal behaviour (travelling, feeding, resting, undetermined).
- Pictures taken (yes or no and number)

Time and geographical position were recorded automatically by ship system *SeaPath 320+ fitted June 2011* (http://wiki.jcr.nerc-bas.ac.uk/Seatex). Wind speed and direction were recorded automatically by the ship anemometers (http://wiki.jcr.nerc-bas.ac.uk/JCR_Anemometer_Knowledge). Data were downloaded in an excel sheet and positions were populated with the observation tape-recorded.

The animal(s) position at sighting (lat2 and lon2) was calculated using the following formulas:

$$lat2 = \arcsin(\sin(lat1)*\cos(d/R) + \cos(lat1)*\sin(d/R)*\cos(\theta))$$

$$lon2 = lon1 + \mathrm{arc\,tan2}(\sin(\theta)*\sin(d/R)*\cos(lat1), \cos(d/R)-\sin(lat1)*\sin(lat2))$$

Where lat1 and lon1 was the initial position, d the estimated distance of animal (in meters), R the radius of the earth (in meters), and θ the animal bearing (in radians, clockwise from north).

## Results

A total of 88 hours and 45 minutes of observation was carried out from the 2nd to the 27th of December 2018. Sightability conditions were 'good' in 14.4% of the time, 'moderate' in 36.1%, and 'poor' in 38.3%.

Cetaceans were spotted in 125 occasions including the following five species: humpback whale (83 sightings), fin whale (15 sightings), sei whale (4 sightings), pilot whale and killer whale (1 sighting each) (Table 5.5.9). Furthermore 18 sightings of unknown baleen whales, 2 of unknown cetaceans and 1 of either a killer or a pilot whale were made. Species identification was not always possible (17% of the sightings). This was particularly true for the baleen whales. The baleen blow that was the cue for the animal sighting in 87% of the occasions, was in fact visible at great distances (maximum distance estimated was 10km) and/or in bad weather conditions and often animals moved away before the ship could approach for identification.

*__Table 5.5.9__ – Observation (Obs) hours and number of sightings in total and per species for each day.*

| Date | Obs hours | No of sight | Fin | Humpback | Sei | Killer | Pilot | Unknown baleen | Unknown cetacean | Killer or pilot |
|---|---|---|---|---|---|---|---|---|---|---|
| 20181202 | 3:44 | 1 | | | | | | | | 1 |
| 20181203 | 7:26 | 6 | 1 | | 3 | | | 1 | 1 | |
| 20181204 | 2:15 | 1 | | | | | 1 | | | |
| 20181205 | 3:52 | 6 | 2 | | 1 | | | 3 | | |
| 20181206 | 7:54 | 5 | 3 | | | | | 2 | | |
| 20181207 | 10:18 | 6 | 1 | 1 | | | | 4 | | |
| 20181208 | 0:01 | 1 | | 1 | | | | | | |
| 20181210 | 13:39 | 2 | | 2 | | | | | | |
| 20181211 | 5:15 | 56 | 2 | 51 | | | | 3 | | |
| 20181212 | 4:19 | 5 | | 5 | | | | | | |
| 20181214 | 0:24 | 1 | | 1 | | | | | | |
| 20181215 | 0:33 | 2 | | 1 | | 1 | | | | |
| 20181216 | 8:31 | 8 | | 7 | | | | | 1 | |
| 20181217 | 3:41 | | | | | | | | | |
| 20181221 | 0:47 | | | | | | | | | |
| 20181225 | 3:27 | 9 | | 6 | | | | 3 | | |
| 20181226 | 6:22 | 9 | | 8 | | | | 1 | | |
| 20181227 | 6:20 | 7 | 6 | | | | | 1 | | |
| **Total** | **88:48** | **125** | **15** | **83** | **4** | **1** | **1** | **18** | **2** | **1** |

Humpback whale (Figure 5.5.10 A, B) was the most encountered species (66% of the sightings), followed by fin (12%) and sei (3%) whales. Only 3 sightings of delphinids were made (Table 5.5.10).

*__Table 5.5.10__ – Number of sighting, number of individuals, group size average and standard deviation for each species/group encountered.*

| Species | No of Sight | No of individuals | Average group size | Group size standard deviation |
|---|---|---|---|---|
| Fin whale | 15 | 27 | 1.8 | 0.833 |
| Humpback whale | 83 | 147 | 1.8 | 0.826 |
| Killer or Pilot whale | 1 | 1 | 1 | 0 |
| Killer whale | 1 | 8 | 8 | 0 |
| Pilot whale | 1 | 8 | 8 | 0 |
| Sei whale | 4 | 6 | 1.5 | 0.500 |
| Unknown baleen whale | 18 | 22 | 1.2 | 0.416 |
| Unknown cetacean | 2 | 2 | 1 | 0 |
| **Total** | **125** | **221** | - | - |

Fin (Figure 5.5.10 C) and sei (Figure 5.5.10 D) whales were observed around the Burdwood bank and/or in open waters while all the humpback whales were all encountered off the Antarctic Peninsula northern of the 66 parallel of latitude south (Figure 5.5.9). The sightings of killer and pilot whales were made in Burgan Bay and in the waters around the Burdwood bank respectively.

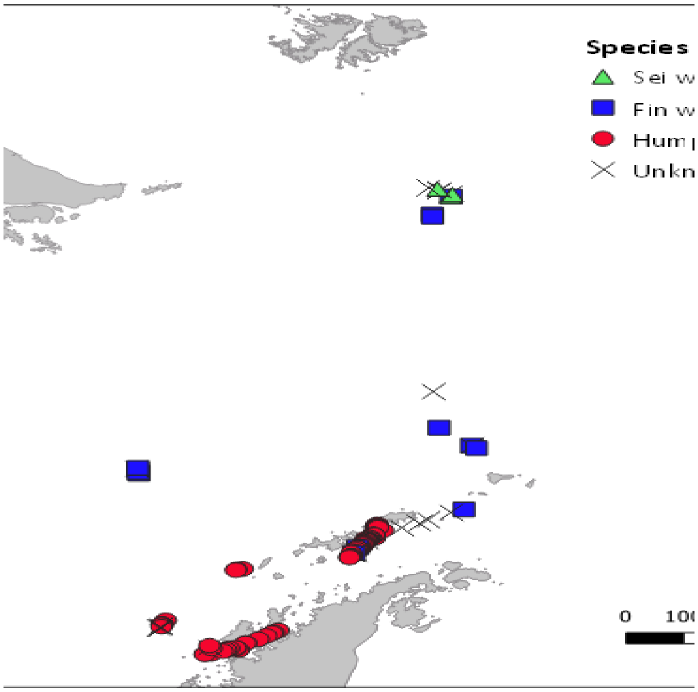


***Figure 5.5.9*** *Sighting positions of the baleen whales encountered during the cruise ICEBERGS 2.*

Information about time, position, species and group size for the 125 encounters are listed in Table 5.5.11.

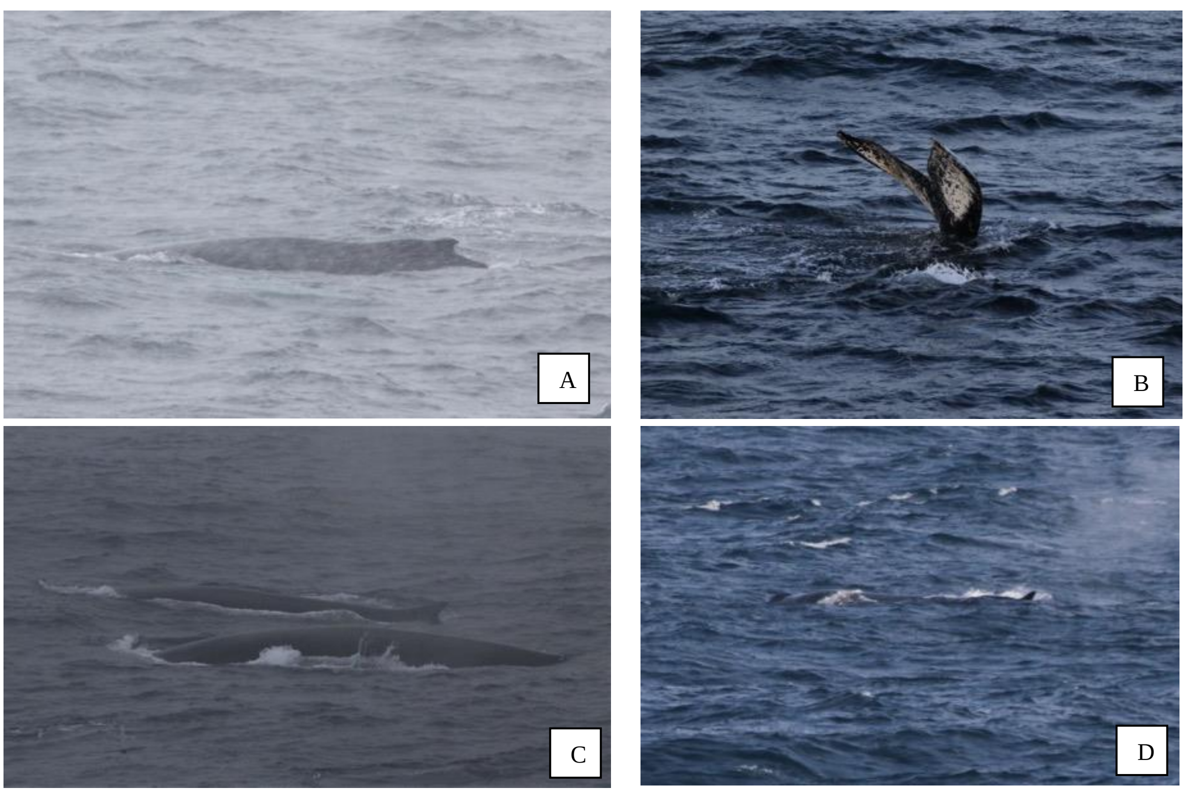


***Figure 5.5.10** – A., B. Humpback whale, C. fin whale, D. sei whale.*

*Table 5.5.11 Date, time, sighting number, bearing, distance, position, species, species certainty, spotter, cue, group size (minimum, maximum and best), whale swimming direction, animal reaction at sight, and pictures for the 125 encounters.*

| DateUTC | Time UTC | SightingNumber | TRUEBearing | DistanceMeters | LatCeta | LonCeta | Species | SpeciesQuality | Spotter | Cue | Min | Max | Best | WhaleSwimDirection | ReactionAtSight | Pictures |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 02/12/2018 | 14:23:00 | 1 | Na | 15 | -52.25391 | -58.19831 | Killer or Pilot whale | Certain | MCOS | Body underwater | 1 | 1 | 1 | | Attracted to the boat | No |
| 03/12/2018 | 18:07:00 | 2 | 359 | 3704 | -55.02453 | -56.97309 | Unknown baleen whale | | MCOS | Blow | 2 | 3 | 2 | | | No |
| 03/12/2018 | 19:02:00 | 3 | 166 | 1852 | -55.07394 | -56.97282 | Sei whale | Possibly | MCOS | Blow | 2 | 2 | 2 | 135 | No reaction | No |
| 03/12/2018 | 19:08:00 | 4 | 164 | 1852 | -55.07374 | -56.97282 | Fin whale | Certain | MCOS | Blow | 2 | 2 | 2 | 135 | No reaction | Yes |
| 03/12/2018 | 19:25:00 | 5 | 1 | Na | -55.06188 | -56.98491 | Sei whale | Possibly | MCOS | Blow | 1 | 1 | 1 | 45 | No reaction | No |
| 03/12/2018 | 19:35:00 | 6 | 356 | 2778 | -55.02536 | -56.94142 | Sei whale | Possibly | KRET | Blow | 2 | 2 | 2 | 40 | No reaction | Yes - Ask Katy |
| 03/12/2018 | 20:06:00 | 7 | 8 | 4630 | -54.98799 | -56.80465 | Unknown cetacean | | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 04/12/2018 | 09:53:00 | 8 | 181 | 50 | -54.95212 | -57.80184 | Pilot whale | Certain | MCOS | Fin | 7 | 8 | 8 | 266 | Attracted to the boat | Yes |
| 05/12/2018 | 09:14:00 | 9 | 323 | 1000 | -54.94205 | -57.27729 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | 230 | Change direction to 195 | Yes |
| 05/12/2018 | 09:16:00 | 10 | Na | 6000 | -54.94964 | -57.28898 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | | | Yes |
| 05/12/2018 | 09:23:00 | 11 | 338 | 4000 | -54.91727 | -57.31900 | Sei whale | Likely | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes |
| 05/12/2018 | 10:15:00 | 12 | 31 | 8000 | -54.89660 | -57.56456 | Unknown baleen whale | | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes |
| 05/12/2018 | 20:05:00 | 13 | 39 | 3000 | -55.46303 | -57.43032 | Fin whale | Likely | MCOS | Blow | 2 | 2 | 2 | | No rection | Yes |
| 05/12/2018 | 20:14:00 | 14 | 95 | 6000 | -55.51155 | -57.41892 | Fin whale | Likely | CSAN | Blow | 1 | 1 | 1 | | No rection | Yes |
| 06/12/2018 | 16:16:00 | 15 | 34 | 70 | -59.26846 | -57.17025 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | 170 | Dive when abeam | No |
| 06/12/2018 | 20:33:00 | 16 | 325 | 100 | -60.05345 | -56.97277 | Fin whale | Certain | MCOS | Blow | 3 | 3 | 3 | 300 | Change direction to pass behind the ship | Yes |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/12/2018 | 00:00:00 | 17 | 350 | 80 | -60.42043 | -55.96651 | Fin whale | Likely | MCOS | Blow | 1 | 1 | 1 | | Surface very close and last dive when abeam | No - Ask Katy |
| 07/12/2018 | 00:04:00 | 18 | 351 | 150 | -60.42668 | -55.94425 | Unknown baleen whale | | KRET | Blow | 1 | 1 | 1 | | Surface very close and last dive when abeam | No - Ask Katy |
| 07/12/2018 | 00:27:00 | 19 | 352 | 80 | -60.47032 | -55.80877 | Fin whale | Likely | MCOS | Blow | 1 | 1 | 1 | | Surface very close and last dive when abeam | Yes |
| 07/12/2018 | 12:41:00 | 20 | 350 | 60 | -61.82335 | -56.04769 | Fin whale | Possibly | MCOS | Blow | 1 | 1 | 1 | 68 | Surface very close and dive when abeam | No |
| 07/12/2018 | 14:15:00 | 21 | 349 | 10 | -61.89464 | -56.43409 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | | Surface when ship was passing by and dive immediately | No |
| 07/12/2018 | 17:48:00 | 22 | 332 | 140 | -62.07039 | -57.14830 | Unknown baleen whale | | MCOS | Blow | 2 | 2 | 2 | 205 | Surface once when close, dive and disappear | No |
| 07/12/2018 | 19:15:00 | 23 | 34 | 400 | -62.14267 | -57.43219 | Unknown baleen whale | | James | Blow | 1 | 1 | 1 | | Only 1 surfacing and seemed to move away from the ship | No |
| 07/12/2018 | 22:09:00 | 24 | 46 | 800 | -62.25460 | -57.98289 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | NA | | No |
| 08/12/2018 | 01:00:00 | 25 | 72 | 2000 | -62.31342 | -58.60925 | Humpback whale | Possibly | MCOS | Blow | 2 | 2 | 2 | Na | No reaction | No |
| 08/12/2018 | 12:30:00 | 26 | Na | Na | -62.21296 | -58.76887 | Humpback whale | Certain | SJEN | NA | 1 | 1 | 1 | NA | NA | Yes |
| 10/12/2018 | 11:00:00 | 27 | Na | Na | -62.21931 | -58.82164 | Humpback whale | Certain | KRET | NA | 2 | 2 | 2 | NA | Inspecting the ship at some point | Yes |
| 10/12/2018 | 12:21:00 | 28 | 7 | 1500 | -62.20406 | -58.77412 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 340 | No reaction | Yes |
| 11/12/2018 | 13:16:00 | 29 | 313 | 5000 | -62.18674 | -58.80660 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | NA | No reaction | No |
| 11/12/2018 | 20:04:00 | 30 | 69 | 6000 | -62.20740 | -58.81517 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 20:05:00 | 31 | 83 | 5000 | -62.22179 | -58.81778 | Humpback whale | Certain | ADLE | Blow | 2 | 2 | 2 | | No reaction | Yes |
| 11/12/2018 | 20:35:00 | 32 | 289 | 2500 | -62.23296 | -58.83580 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes |
| 11/12/2018 | 20:39:00 | 33 | 287 | 4000 | -62.24052 | -58.82688 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | 170 | No reaction | Yes |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/12/2018 | 20:42:00 | 34 | 301 | 5000 | -62.23612 | -58.81496 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | No |
| 11/12/2018 | 20:45:00 | 35 | 288 | 5000 | -62.25281 | -58.80199 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 20:47:00 | 36 | 316 | 6000 | -62.23250 | -58.78786 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 20:50:00 | 37 | 298 | 5800 | -62.25450 | -58.77808 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 21:56:00 | 38 | 160 | 5500 | -62.48341 | -58.88126 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 295 | No reaction | Yes_jammed |
| 11/12/2018 | 22:02:00 | 39 | 322 | 6000 | -62.40764 | -58.93720 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:03:00 | 40 | 41 | 5400 | -62.41522 | -58.89734 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:04:00 | 41 | 40 | 6000 | -62.41288 | -58.89954 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:05:00 | 42 | 49 | 6500 | -62.41797 | -58.89754 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:27:00 | 43 | 78 | 6000 | -62.48646 | -59.00281 | Humpback whale | Possibly | MCOS | Blow | 2 | 3 | 3 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:31:00 | 44 | 284 | 3800 | -62.49460 | -59.08442 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:34:00 | 45 | 6 | 1900 | -62.49065 | -59.07422 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:36:00 | 46 | 39 | 6000 | -62.46917 | -59.06112 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:41:00 | 47 | 6 | 2778 | -62.49817 | -59.10495 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:44:00 | 48 | 41 | 1852 | -62.51728 | -59.10770 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:45:00 | 49 | 93 | 1500 | -62.53211 | -59.10787 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 22:48:00 | 50 | 301 | 7408 | -62.50477 | -59.17042 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes_jammed |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/12/2018 | 22:53:00 | 51 | 38 | 1200 | -62.54388 | -59.14045 | Humpback whale | Certain | MCOS | Blow | 2 | 3 | 3 | 350 | No reaction | Yes_jammed |
| 11/12/2018 | 22:56:00 | 52 | 51 | 5000 | -62.53123 | -59.12780 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 11/12/2018 | 23:00:00 | 53 | 58 | 6700 | -62.53726 | -59.12911 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:01:00 | 54 | 30 | 4630 | -62.53665 | -59.15614 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:09:00 | 55 | 261 | 1500 | -62.59551 | -59.21089 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:15:00 | 56 | 32 | 1100 | -62.60215 | -59.21844 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 343 | No reaction | No |
| 11/12/2018 | 23:18:00 | 57 | 31 | 7000 | -62.56304 | -59.20591 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:22:00 | 58 | 38 | 5556 | -62.58831 | -59.21960 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:23:00 | 59 | 32 | 3704 | -62.60165 | -59.23351 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 278 | No reaction | No |
| 11/12/2018 | 23:36:00 | 60 | 22 | 6482 | -62.60919 | -59.27269 | Humpback whale | Certain | MCOS | Blow | 4 | 4 | 4 | | No reaction | No |
| 11/12/2018 | 23:38:00 | 61 | 348 | 600 | -62.66328 | -59.29912 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 308 | No reaction | Yes_jammed |
| 11/12/2018 | 23:42:00 | 62 | 34 | 6482 | -62.63066 | -59.28561 | Humpback whale | Certain | MCOS | Blow | 2 | 3 | 3 | | No reaction | Yes_jammed |
| 11/12/2018 | 23:54:00 | 63 | 59 | 2778 | -62.70003 | -59.34014 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 11/12/2018 | 23:56:00 | 64 | 20 | 5556 | -62.66988 | -59.34980 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 12/12/2018 | 00:00:00 | 65 | 331 | 5556 | -62.68414 | -59.40144 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:01:00 | 66 | 334 | 7408 | -62.67027 | -59.40853 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:06:00 | 67 | 324 | 7408 | -62.68996 | -59.43674 | Fin whale | Possibly | MCOS | Blow | 3 | 3 | 3 | | No reaction | Yes_jammed |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/12/2018 | 00:08:00 | 68 | 329 | 6482 | -62.69942 | -59.43651 | Humpback whale | Certain | MCOS | Blow | 2 | 3 | 3 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:09:00 | 69 | 333 | 7408 | -62.69250 | -59.43984 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:10:00 | 70 | 334 | 6700 | -62.70059 | -59.44065 | Humpback whale | Certain | MCOS | Blow | 2 | 3 | 3 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:25:00 | 71 | 21 | 6482 | -62.74135 | -59.45819 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | Yes_jammed |
| 12/12/2018 | 00:27:00 | 72 | 350 | 900 | -62.79317 | -59.48742 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | No |
| 12/12/2018 | 00:32:00 | 73 | 314 | Na | -62.81400 | -59.50836 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | 190 | No reaction | No |
| 12/12/2018 | 00:34:00 | 74 | 41 | 700 | -62.81437 | -59.51347 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 4 | No reaction | No |
| 12/12/2018 | 00:37:00 | 75 | 297 | 2778 | -62.81554 | -59.55317 | Fin whale | Certain | MCOS | Blow | 3 | 3 | 3 | 173 | No reaction | No |
| 12/12/2018 | 00:49:00 | 76 | 340 | 1700 | -62.84186 | -59.59546 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 12/12/2018 | 00:55:00 | 77 | 348 | 1100 | -62.86004 | -59.62036 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 240 | No reaction | No |
| 12/12/2018 | 00:58:00 | 78 | 344 | 7408 | -62.81262 | -59.65074 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | 220 | No reaction | No |
| 12/12/2018 | 00:59:00 | 79 | 321 | 500 | -62.87541 | -59.64015 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 113 | No reaction | No |
| 12/12/2018 | 01:05:00 | 80 | 15 | 1600 | -62.87904 | -59.66213 | Humpback whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 12/12/2018 | 01:06:00 | 81 | 63 | 650 | -62.89257 | -59.66539 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | Yes |
| 12/12/2018 | 01:09:00 | 82 | 18 | 1300 | -62.89098 | -59.68136 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | No |
| 12/12/2018 | 01:14:00 | 83 | 295 | 1500 | -62.90798 | -59.72268 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | No |
| 12/12/2018 | 01:15:00 | 84 | 57 | 1400 | -62.90905 | -59.70317 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | No |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/12/2018 | 11:37:00 | 85 | 266 | 220 | -64.48392 | -62.25995 | Humpback whale | Certain | MCOS | Body | 1 | 1 | 1 | 55 | Dive when passing by | No |
| 12/12/2018 | 12:05:00 | 86 | 16 | 40 | -64.52570 | -62.42593 | Humpback whale | Certain | MCOS | Body | 2 | 3 | 2 | 229 | Dive when passing by | Yes |
| 12/12/2018 | 12:12:00 | 87 | 10 | 60 | -64.53775 | -62.47522 | Humpback whale | Certain | MCOS | Body | 1 | 1 | 1 | 202 | Dive when passing by | Yes |
| 12/12/2018 | 12:49:00 | 88 | 261 | 730 | -64.59653 | -62.70690 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 178 | No reaction | No |
| 12/12/2018 | 13:32:00 | 89 | 32 | 800 | -64.66332 | -62.98314 | Humpback whale | Likely | MCOS | Splash | 1 | 1 | 1 | | No reaction | No |
| 15/12/2018 | 08:29:00 | 90 | Na | Na | -64.73331 | -63.45276 | Humpback whale | Certain | ARGO | Fin | 1 | 1 | 1 | | No reaction | Yes |
| 15/12/2018 | 05:00:00 | 91 | Na | Na | -64.71908 | -63.45751 | Killer whale | Certain | Bridge | Fin | 6 | 8 | 8 | | No reaction | Yes |
| 15/12/2018 | 23:35:00 | 92 | Na | Na | -64.73410 | -63.45583 | Humpback whale | certain | Other | Body | 1 | 1 | 1 | | Inspecting | Yes (video) |
| 16/12/2018 | 07:54:00 | 93 | 314 | 600 | -64.87788 | -63.72037 | Humpback whale | certain | MCOS | Blow | 2 | 2 | 2 | 360 | No reaction | Yes |
| 16/12/2018 | 08:07:00 | 94 | 347 | 4630 | -64.83596 | -63.80804 | Humpback whale | certain | MCOS | Blow | 3 | 3 | 3 | 111 | No reaction | |
| 16/12/2018 | 08:08:00 | 95 | 5 | 5556 | -64.82651 | -63.84229 | Humpback whale | certain | MCOS | Blow | 1 | 1 | 1 | 111 | No reaction | No |
| 16/12/2018 | 08:52:00 | 96 | 22 | 670 | -64.86633 | -64.14433 | Humpback whale | possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 16/12/2018 | 09:34:00 | 97 | 302 | 3704 | -64.89050 | -64.34702 | Unknown cetacean | | MCOS | Blow | 1 | 1 | 1 | | No reaction | |
| 16/12/2018 | 10:27:00 | 98 | 266 | 2000 | -64.92662 | -64.71385 | Humpback whale | possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | No |
| 16/12/2018 | 10:50:00 | 99 | 36 | 3000 | -64.91463 | -64.94254 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | No |
| 16/12/2018 | 10:56:00 | 100 | 31 | 1500 | -64.92778 | -64.95853 | Humpback whale | Possibly | MCOS | Blow | 2 | 2 | 2 | 188 | No reaction | No |
| 25/12/2018 | 09:00:00 | 101 | Na | 30 | -66.76884 | -69.38195 | Humpback whale | Likely | Deylen | NA | 1 | 1 | 1 | Na | Na | No |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25/12/2018 | 17:43:00 | 102 | 310 | 800 | -65.88204 | -67.88567 | Humpback whale | Certain | MCOS | Fin | 2 | 2 | 2 | 30 | No reaction | |
| 25/12/2018 | 18:36:00 | 103 | 319 | 780 | -65.79471 | -67.75625 | Humpback whale | Certain | MCOS | Blow | 3 | 4 | 3 | 10 | No reaction | No |
| 25/12/2018 | 18:39:00 | 104 | 319 | 2500 | -65.77803 | -67.72403 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | No |
| 25/12/2018 | 18:53:00 | 105 | 358 | 4000 | -65.73238 | -67.70010 | Humpback whale | Possibly | MCOS | Blow | 3 | 3 | 3 | 90 | Change direction | Yes |
| 25/12/2018 | 18:54:00 | 106 | 320 | 800 | -65.76115 | -67.69438 | Unknown baleen whale | Possibly | MCOS | Blow | 1 | 1 | 1 | | No reaction | |
| 25/12/2018 | 19:03:00 | 107 | 55 | 800 | -65.75087 | -67.68889 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | | No reaction | |
| 25/12/2018 | 19:17:00 | 108 | 51 | 750 | -65.72575 | -67.65324 | Unknown baleen whale | Certain | MCOS | Blow | 1 | 1 | 1 | 70 | No reaction | |
| 25/12/2018 | 19:22:00 | 109 | 297 | 4630 | -65.70107 | -67.58577 | Unknown baleen whale | Certain | MCOS | Blow | 1 | 1 | 1 | | No reaction | |
| 26/12/2018 | 07:51:00 | 110 | 318 | 750 | -64.89665 | -64.72283 | Humpback whale | Certain | MCOS | Splash | 1 | 1 | 1 | 30 | No reaction | No |
| 26/12/2018 | 08:36:00 | 111 | 2 | 1700 | -64.86972 | -64.52124 | Humpback whale | Certain | MCOS | Blow | 3 | 3 | 3 | | No reaction | No |
| 26/12/2018 | 08:44:00 | 112 | 53 | 1500 | -64.87188 | -64.50831 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 10 | No reaction | No |
| 26/12/2018 | 18:52:00 | 113 | Na | Na | -64.83021 | -64.06639 | Humpback whale | Certain | MCOS | Body | 1 | 1 | 1 | | No reaction | Yes |
| 26/12/2018 | 19:15:00 | 114 | 334 | 1200 | -64.85567 | -64.17611 | Humpback whale | Certain | MCOS | Blow | 3 | 5 | 4 | 210 | No reaction | Yes |
| 26/12/2018 | 19:27:00 | 115 | 130 | 2200 | -64.88372 | -64.29766 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 180 | No reaction | |
| 26/12/2018 | 20:36:00 | 116 | 20 | 5000 | -64.80607 | -64.68924 | Humpback whale | Certain | MCOS | Blow | 2 | 2 | 2 | 230 | No rection | Yes |
| 26/12/2018 | 20:55:00 | 117 | 37 | 2000 | -64.78680 | -64.73023 | Unknown baleen whale | | MCOS | Blow | 2 | 2 | 2 | | Na | No |
| 26/12/2018 | 21:13:00 | 118 | 36 | 1400 | -64.74304 | -64.73821 | Humpback whale | Certain | MCOS | Blow | 1 | 1 | 1 | 260 (compass) | Na | |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27/12/2018 | 22:13:00 | 119 | 27 | 4000 | -60.84816 | -66.12383 | Fin whale | Possibly | MCOS | Blow | 2 | 2 | 2 | 27 | No reaction | Yes |
| 27/12/2018 | 22:15:00 | 120 | 53 | 3600 | -60.85668 | -66.12655 | Fin whale | Possibly | MCOS | Blow | 1 | 1 | 1 | 350 | No reaction | Yes |
| 27/12/2018 | 22:35:00 | 121 | 22 | 9260 | -60.75927 | -66.13945 | Fin whale | Possibly | MCOS | Blow | 2 | 2 | 2 | 80 (respect to ship course) | No reaction | Yes |
| 27/12/2018 | 22:37:00 | 122 | 5 | 9260 | -60.74924 | -66.13418 | Fin whale | Possibly | MCOS | Blow | 1 | 1 | 1 | 80 (respect to ship course) | No reaction | Yes |
| 27/12/2018 | 22:38:00 | 123 | 349 | 800 | -60.82314 | -66.13247 | Fin whale | Possibly | FHOW | Body | 1 | 1 | 1 | 70 (respect to ship course) | No reaction | Yes |
| 27/12/2018 | 22:51:00 | 124 | 33 | 7408 | -60.74700 | -66.14950 | Unknown baleen whale | | MCOS | Blow | 1 | 1 | 1 | 80 (respect to ship course) | No reaction | No |
| 27/12/2018 | 23:29:00 | 125 | 90 | 130 | -60.72977 | -66.12429 | Fin whale | Possibly | Michael | Body | 3 | 3 | 3 | same direction of the ship | No reaction | Yes |

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# 6. Chilean Collaboration

**Carlos Munoz-Ramirez** Universidad Catolica de la Santisíma Concepción (carmunoz@umich.edu)
**Miguel Bascur** Universidad Catolica de la Santisíma Concepción (mabascur@bmciencias.ucsc.cl)
**Paulina Brunning** Laval University, Canada (paulinabruning@gmail.com)

ICEBERGS is a UK-Chilean collaboration, supported by a NERC-CONICYT grant, with Dr. Antonio Brante from Universidad Catolica de la Santisíma Concepción (UCSC) as the PI in the Chilean group. The Chilean team includes (as associated researchers) Dr. Patricio Camus (UCSC), Dr. Florence Tellier (UCSC), Dr. Angel Urzua and Dr. Carlos Munoz (UCSC). The project aims a multidisciplinary approach to evaluate the role of climate change on Antarctic benthic ecosystems. The Chilean collaborators will aid this project with their experience in ecological, genetics and bioenergetics analyses that will contribute to the understanding of relevant processes at the individual and population levels within the main frame of the project. In addition to Dr. Carlos Munoz (UCSC), two new Chilean researchers, the master student Miguel Bascur (UCSC) and the PhD student Paulina Bruning (IDEAL) have joined this year's cruise to collaborate with the sampling process.

## 6.1 Bioenergetics

As glaciers retreat due to the increase in temperatures, meltwater discharge from glaciers is causing physical changes in the sea that may impact on benthic fauna as environmental stressors. At the individual level, stressors affect physiological processes and bioenergetic components that may be translated in a deficiency in the individual performance directly impacting population dynamics and community structure. Hence, these changes in environmental conditions in Antarctic waters may influence fitness traits of individuals such as growth, survival and reproductive output. In this situation it is expected that organisms inhabiting localities impacted by ice loss and deglaciation may show a decrease in bioenergetic constituents, nutritional condition and reproductive output. In this project we will evaluate the effects of these perturbations on the bioenergetic, nutritional quality and reproductive output of Antarctic marine invertebrate organisms. We will examine such physiological parameters in the context of temporal disturbance revealed through sclerochronological analyses of mollusc shells as well as multiple environmental variables provided by CTD data.

## 6.2 Genetics

Extreme perturbation events, such as ice loss and deglaciation, not only may produce important effects at individual and ecological levels but also at the genetic level, with implications for the long-term sustainability of local benthic ecosystems. Decrease in species abundances as a result of perturbations may produce a genetic bottleneck increasing genetic drift and negatively impacting genetic diversity. In addition, both theory and experiments indicate that allelic richness is more sensitive to the effects of short, severe bottlenecks than is haplotype diversity. These genetic changes would affect viability of populations at two temporal scales: (1) over the short term it is expected that a reduction in genetic diversity will lead to an increase in the susceptibility of populations to pathogens and parasites, and fastening the fixation of deleterious alleles. (2) Over the long term, the diminished population would reduce capacity to respond to changing selection pressures if genetic reduction is associated with adaptive genes and so the absence of genetic variation may increase the risk of extinction. Increasing local fecundity may not be an effective strategy to compensate for abundance reduction because glacier perturbations strongly affect mortality of benthic species locally. By contrast, abundance and genetic population diversity may be maintained by immigration (dispersal), the "rescue effect". In this situation genetic diversity would be maintained or would be less impacted through genotype immigration from neighbouring populations. The significance of the rescue effect depends on the extent of the perturbation effect and the dispersal potential of the species. In this context we predict a reduction of genetic diversity in localities impacted by ice loss and deglaciation with higher effects in species with low dispersal potential than those with high dispersal potential. In addition, disturbed localities will show less population connectivity (higher population genetic distance) and higher inbreeding levels than less impacted localities.

### 6.3 Sampling on the JCR

Samples for both goals, the bioenergetics and the genetics studies, were obtained from the Hamon Grab sampling (see section 5.4.1). This year's cruise was highly successful in terms of sampling, with the completion of 95 successful grabs from three different fjords: Marian Cove, Börgen Bay, and the newly sampled Sheldon Cove. To make the best use of these samples in terms of rapid availability and distribution, the samples are to be taken to Chile as soon as we reached port in Punta Arenas instead of being kept in the ship for months. In this manner, they can be readily processed, sorted, identified, and distributed to the different researchers as needed in a much shorter period of time.

# 7. Outreach activities

**Alice Guzzi**, U. Genoa, Italy
**Alejandro Román González**, U. Exeter, UK
**Nadescha Zwerschke**, BAS, UK

The activities carried out during the expedition were promoted through social media, following the suggestions from the scientific report campaign JR17001 - NERC ICEBERGS & ORCHESTRA projects 2017 (9. ICEBERGS Outreach by Alexis Janosik, James Scourse, Katy Sheen & Marlon Clark) this year Twitter has been joined by Instagram as the main platforms to communicate with the public. The creation of a hashtag dedicated to the cruise (#ICEBERGS2) allowed to collect all the contents and to simplify the sharing on different social media. One of the main problems faced during the cruise regarding the sharing of online content is the absence of internet connection in some sampling sites, in these cases the publication of materials has been postponed.

## Twitter

As for last year, Twitter was used as the main social media for the promotion of activities. The profile, active since September 2017, has reached 645 subscribers (we've gained around 5 new followers for day in December by Twitter analytics tools), with an average of 2.9K impressions per day. During the scientific cruise time, we achieved 80.4K total impressions. The sharing of material related to the cruise from the crew members on their own private social media pages allowed to keep high the frequency of tweets. Thanks to the internationality of the ICEBERGS2 team, the interest generated is distributed all over the globe (see figure 7.1) with United Kingdom and USA as areas of greatest activity (respectively 60.3% and 13.1%), followed in smaller proportion by Italy, France, Germany, Spain, Australia, Canada, Ireland and Brazil.

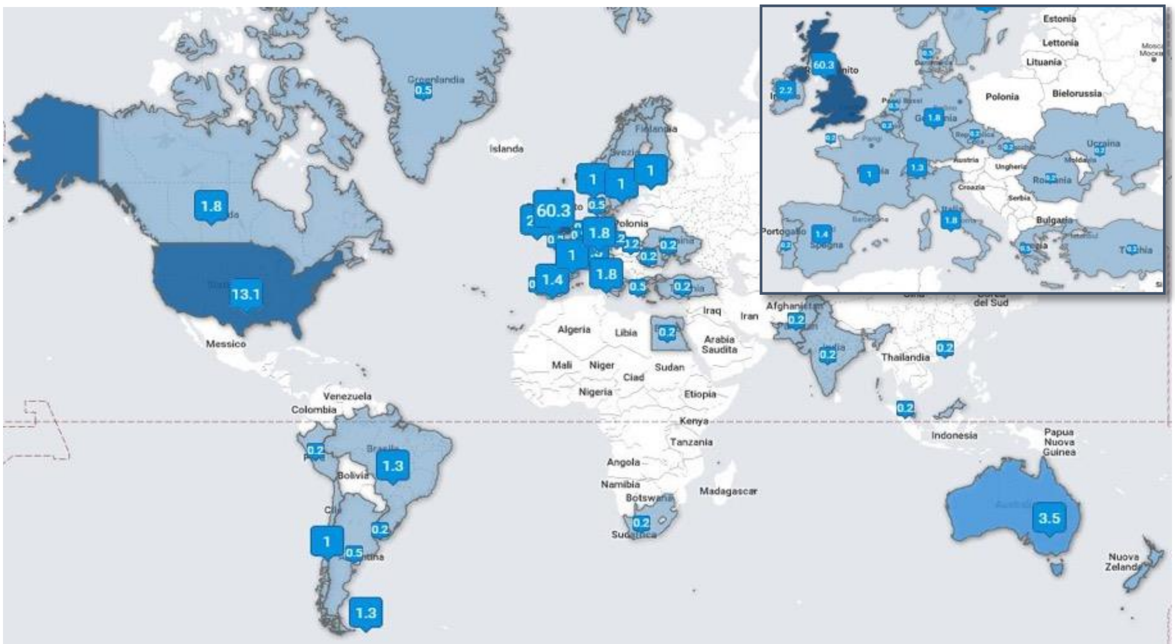


*Figure 7.1 Percentages of Twitter interactions by country*

### Instagram

The sharing of material through this social network has allowed to expand public profile and involve different age groups. The Instagram profile, active since October 2018, has quickly reached 164 followers, with an average of 40 likes for each shared photo. From the response obtained by the public, Instagram seems to be a good tool of communication for the scientific activities and also in this case the sharing of photographic material among the team members was essential to maintain quality content.

### Blog

During the expedition the activities on board and the highlights were told through blogs. The most technical approach has been maintained regarding the blog present at the following link:

https://www.bas.ac.uk/blogpost/a-research-cruise-and-my-gateway-to-antarctica/

For the personal blogs Nadescha Zwerschke contributed by presenting her personal point of view at the following links:

https://67-degrees-south.blog/

### School-linkup

As for ICEBERGS 2017, the interest in scientific activities by the public and especially schools has been remarkable. James Scouse continued his outreach project with a phone call with pupils at Fox Primary School, Tooting, London on Wednesday 19th December. The children were provided in advance with photographic material and during the phone call they showed considerable interest by asking questions for about 40 minutes. David Barnes with Anna Pienkowski gave answers to questions posed by school children through a phone call on December 4th with the Red Rose Primary School lasting about 50 minutes. The children have been provided previously with information and photographs and during the call they asked numerous questions including "Can you describe the Antarctic Sea bed and how is it different to European sea bed?”. The children also had fun by producing a series of masterpieces for an Antarctic flag (Figure 7.2). David Barnes also conducted a second phone call interview with the Grosvenor Road Primary School together with Nadescha Zwerschke. In this call the enthusiastic children asked numerous questions including "Where does plankton end during the winter?". The children of the Grosvenor Road Primary School later produced a school newspaper where they summarized the interview and sent a copy to Nadescha for a fun reading in Rothera.

After the end of the cruise, many of the participants will be involved in interviews with schools and other outreach activities to talk about the scientific activities carried out on board and their personal experience.

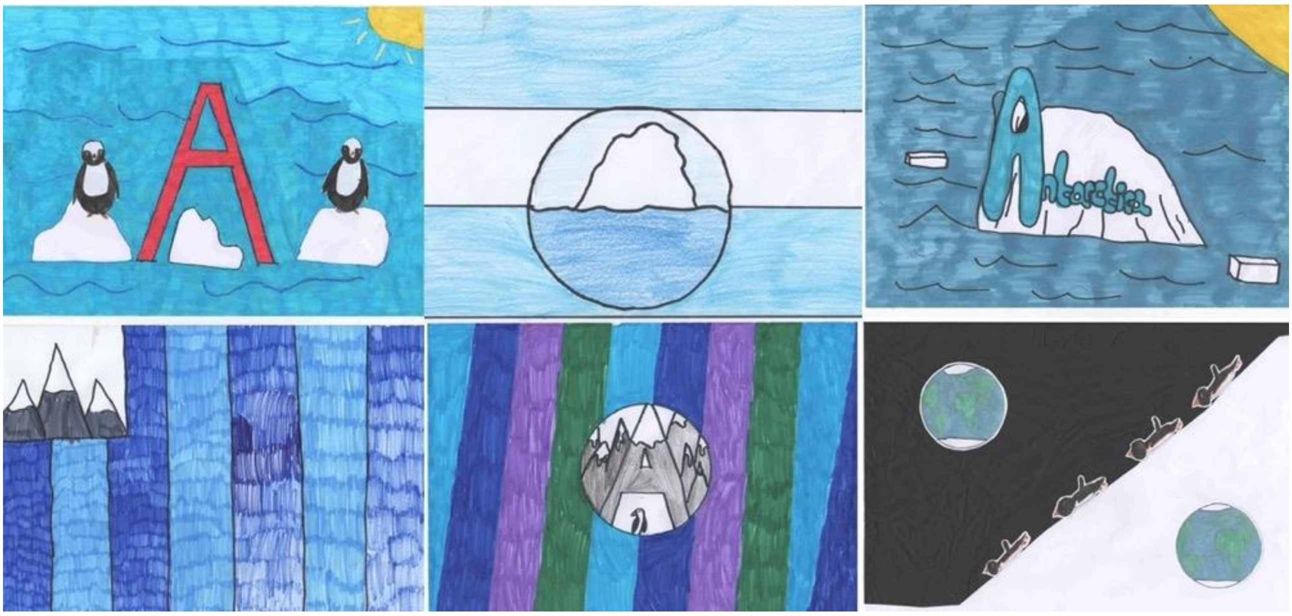

*Figure 7.2 Some of the flags designed by children from Red Rose Primary School*

## Podcasting

A radio interview was carried out at University of Exeter (UoE) prior to cruise departure. This interview was supported by an ample range of social media managed by UoE and it can be accessed at: https://blogs.exeter.ac.uk/exetermarine/2018/12/20/icebergs-with-dr-alejandro-roman-gonzalez/

During the interview, the rationale of the project, experiences from 2017/18 (JR17001) cruise were discussed as well as the planned activities for the current cruise (JR18003). It was also agreed that a follow-up interview will be carried out at some point in the first half of 2019 regarding the outcomes from JR18003.

## Photography

As in the case of JR17001, photographs taken during JR18003 will be presented to national and international photography competitions and promoted through photography social media platforms (e.g. Flickr, Facebook 500px, photoblogs). Any results from these competitions will be communicated to the members of the team and will mostly likely generate an outreach stream on their own that will be linked to ICEBERGS general media stream.

# 8. AME Electronic technical report

**David Goodger,** Ship Science Engineer davodg@bas.ac.uk

## 8.1 Cruise Summary

| Cruise | Departure | Arrival | AME Engineer(s) |
|---|---|---|---|
| JR18003 | 01/12/18 (MH FLK) | 31/12/18 (Punta) | David Goodger (davodg@bas.ac.uk) |

This cruise is part of the Icebergs science program, with sediment coring, Multibeam and CTDs to determine the effect of glacial retreat and meltwater on life in the sediment.
Systems used on cruise

## 8.2 Instrumentation

### 8.2.1 systems used on cruise

| Instrument | #SN if Used | Make and Model | Comments |
|---|---|---|---|
| Lab Instruments | | | |
| AutoSal | 65763 | OSIL 8400B | See "autosal section" |
| Scintillation counter | No | PERKINELMER TRI-CARB 2910TR | Not Used, Tested for Future Cruises |
| XBT | No | | Set up but not used. |
| Acoustic | | | |
| ADCP | Yes | | |
| EM122 | Yes | | |
| TOPAS | Yes | | |
| EK60/80 | Yes | | |
| K-Sync | Yes | | |
| SSU | No | | |
| USBL | Yes | Sonardyne Ranger 2 | Beacons 1 and 2 attached at never needed |
| 10kHz IOS Pinger | No | | |
| Benthos 12kHz Pinger | No | | |
| Benthos 14kHz Pinger | No | | |
| Mors 10kHz Transponder | No | | |
| EA600 | Yes | | Bridge Equipment but logged |
| Oceanlogger | | | |
| Barometer1 | V145002 | VAISALA PTB210B1A2B | Inside the UIC |

| | | | |
|---|---|---|---|
| Barometer2 | V145003 | VAISALA PTB210B1A2B | Inside the UIC |
| Air humidity & temp1 | 61019333 | Rotronic Hygroclip 2 | On Foremast |
| Air humidity & temp2 | 61019251 | Rotronic Hygroclip 2 | On Foremast |
| TIR1 sensor (pyranometer) | 172882 | Kipp & Zonen Sp Lite2 | On Foremast |
| TIR2 sensor (pyranometer) | 172883 | Kipp & Zonen Sp Lite2 | On Foremast |
| PAR1 sensor | 160959 | Kipp & Zonen PQS-1 | On Foremast |
| PAR2 sensor | 160960 | Kipp & Zonen PQS-1 | On Foremast |
| Thermosalinograph | 0018 | SBE45 | PrepLab |
| Transmissometer | 1497DR | CST-846DR | PrepLab |
| Fluorometer | 1498 | WSCHL-1498 | PrepLab |
| Flow meter | 05/811950 | LitreMeter F112-P-HC-AP-OR-PP | PrepLab |
| Seawater temp 1 | 0765 | SBE38 | Sea Inlet |
| Seawater temp 2 | 0771 | SBE38 | Sea Inlet |
| Instrument<br><br>CTD | #SN if Used | Make and Model | Comments |
| Deck unit 1 | 0548 | SBE11plus | |
| Underwater Comms/ Depth | 1225 | SBE9plus | |
| Temp1 | 5645 | SBE3plus | |
| Temp2 | 2191 | SBE3plus | |
| Cond1 | 3248 | SBE 4C | |
| Cond2 | 4126 | SBE 4C | |
| Pump1 | 1807 | SBE5T | |
| Pump2 | 7966 | SBE5T | |
| Standards Thermometer | 0061 | SBE35 0024 | |
| Transmissometer | 527DR | C-Star | |
| Oxygen sensor | 0620 | SBE43 | |
| PAR sensor | 70442 | QCP2350 | |
| Fluorometer | 12.8513-001 | CTG Aqua Tracker MkIII | |
| Altimeter | 10127.244739 | Tritech S10127 232 | |
| CTD swivel linkage | 1961018 | Focal Technologies Group | |
| LADCP Master Down | 14443 | TeleDyne WHM300 | |
| LADCP Slave Up | No | TeleDyne WHM300 | |
| Pylon | 0636 | SBE32 | |
| Other ship's systems (non-AME) | | | |

| | | | |
|---|---|---|---|
| Anemometer | 1511001 | Gill Instruments Windobserver 70 | Bridge Equipment, logged by Oceanlogger. On Foremast all of cruise |
| Ships Gyro | Yes | | Bridge Equipment, logged |

### 8.2.2 Notes for Heading and Course Instruments

#### Seatex

Changes were made so that seatex could log raw data, this was done to enable post corrections using the RINEX 2 raw data format. The changes involved using telegrams 14, 15, and 16 (previously unused) to log raw; binary, RTK and IMU data respectively. This functioned well for the duration of the cruise although when transferring data off the system using the provided interface only 24h can be removed at a time. If more than this is attempted the system will error until the HMI is rebooted. The logging was disabled and enabled regularly to reduce data space used and unwanted data creating. The additional logging was off at the end of the cruise.

### 8.2.3 Notes for Lab Instruments used

#### AutoSal

Upon arrival I was briefed on the current state of autosal which I could summarise as, “one is un-calibrated and gives bad readings, the other has faulty pumps”. Autosal 65763 was used for the duration of the cruise although both pumps are intermittent. Fortunately the original “bottle pump” is unused by our Autosal due to the external pump so this was attached when the flush pump failed midway through the cruise. It is still intermittent when starting.

#### Scintillation Counter

The Mechanical test was carried out during this cruise and documentation was produced on how to carry it out. There was no scientific need for this system to be used.

### 8.2.4 Notes for Deck Systems

#### Winch Counter

Repairs were carried out to one of the metering sheaves, which now works well. It should be noted that the frequency needs to be changed on the receive unit for the two different units (red and blue).

#### XBT

| Basic Stats | | | |
|---|---|---|---|
| Number Deployed | 0 | Number of Successful Casts | 0 |
| | | Number of Failures | 0 |

The XBT was setup at the start of the cruise but not needed due to synthetic SVP’s and use of the CTD. At the end of the cruise it was left in place as it will be needed on JR18004 and has been tested.

### 8.2.5 Notes for Acoustic Systems used

### ADCP

Used on cruise with no issues, a small number of software crashed occurred but this is not unusual for the system.

### EM122

EM122 was used extensively on the cruise with an external operator, Kate doing the vast majority of the operation. The new dimensional survey was greatly appreciated and the system was pushed beyond what it has been with what appears to be good results. See her report for details

### Topas

Topas was used and started by following the keycards. Floyd, a ex-BAS data manager controlled and operated the system for the duration of the cruise. It ran as expected.

### EK60/80

EK80 was used by the Bangor university turbulence team and run opportunistically. It was started using the key cards and some assistance from IT. It ran as expected.

### EA600

EA600 is the bridge  Ran all cruise and ran without issue, some data is unreliable due to passive receive from EM122 not being started or disabled at the correct time.

## 8.2.6 Notes about the Oceanlogger

The Oceanlogger ran without issue through the cruise, some doubt was cast on the data from some of the coves as conductivity appeared to be noisy. The data between coves was as expected and noise free. The noise in the coves was put down to fresh water from ice sheets and seawater mixing.

## 8.2.7 Notes about the CTD

| Basic Stats | | | |
|---|---|---|---|
| Number Of Casts | 39 | Number of Successful Casts | 37.5 |
| Max Depth | 3012 | Min Depth | 180 |
| Cable Removed (m) | 291m | Number of Re-terminations (elect.) | 3 |

### LADCP Cable Damage

Just after leaving FLK I noticed that the LADCP was not charging, the cause was found to be the LADCP cables closed in the cable gland hatch, despite me checking that the “safety” wooden block was still there some time before. The cable damage was only to the "com 7" yellow line not the "Com 8" blue line as we are only using 1 LADCP I just switched cable. The Comms part of the yellow cable is working so only charging is affected.

### Retermination of CTD Cable

The CTD Cable Failed and needed to be re-terminated 3 times on the cruise. The first of these was nothing unusual, with the termination mealy failing because of flex and age. The second was needed due to a twist in the mechanical termination pulling on the pigtail, in the end causing an intermittent short in the pigtail itself. The third was needed due to a manufacturing fault in the cable.

In this third case the inner core was not central in the dielectric and after some assumed use and wear and tear through the rollers it was failing a mega test and communications failure. Cutting off 250m got past the issue and the CTD seems to be functioning well again.

### CTD Deployment Procedure

Prior to deployment all bottles are cocked and the deionised water is vented from the T/C sensors. Pre-deployment technical tests are carried out on the LADCP's and are logged. The LADCP is then activated and starts logging.

Once the Deck crew and winch operator are ready the CTD is lifted into the water and lowered to 10m, where power is started and logging begins. It is held here until the operator sees the difference between T1 and T2 stabilize. This can take some time, especially if the air temperature and sea temperature are far apart. In some circumstances, mainly turbulent surface waters it can be necessary to lower the CTD to 20m or further where the temperature is more stable, this is at the operator's discretion. Once stable, the CTD is lifted to as near to the surface as the winch op deems safe then is lowered to the required depth or bottom without stopping. The bottom depth is an approximation from the best echo sounder available, commonly the EM122. If bottom depth is required then the altimeter will start working from under 100m of the sea bed and is used to stop approximately 10m from the sea bed. From here some adjustment can be made to get closer, this is done at the operator's discretion. Once the down cast is complete bottles are fired at requested depths, in order, deepest first. When each bottle is fired 15 seconds are given to ensure that the independent standards thermometer has time to take a reading.

Once on the surface the CTD is returned to the vessel, the C/T sensors are filled with deionised water to avoid damage. All data is backed up as soon as possible.

### Information about CTD configuration

| Name | Purpose | Distance from Base of Frame to sensor |
|---|---|---|
| Altimeter | Distance to sea bed (max 100m) | |
| LADCP Master | Downward Facing LADCP | |
| Temp1/Temp2 | Temperature at 24Hz | |
| Fluorimeter | Measures Florescence | |

| | |
|---|---|
| 9+ | Communications and Pressure measurement |
| C1/C2 | Conductivity Cells |
| Dissolved Oxygen | Oxygen in the Water |
| Bottles Bottom End Cap | Water collection (24) |
| Bottles Top End Cap | Water collection (24) |
| Transmissometer | Measure of light transmitted through water |
| SBE35 Top | Accurate Temperature sensor |
| SBE35 Bottom | Accurate Temperature sensor |
| Par | Radiation Sensor |

## 8.3 Additional work completed on cruise

### 8.3.1 Fuel Monitoring

The system for monitoring the ships fuel consumption had been having issues since refit, I was asked to assist due to knowledge of monitoring system and labview. After swapping around the fuel sensors so that the calibrations matched and then updating the calibrations the Chief Eng. was happy with the system.

### 8.3.2 Deep Tow Cable

In preparation for the next cruise some work needed to be carried out on "Deep Tow" or "Conducting" Cable. This mainly involved testing the continuity and sealing the end for a deep sea test. The cable seems electrically good although I have some worries about the attachment of the CTD to the end. Once the mechanical termination has been applied and load tested I will be happier with the situation.

### 8.3.3 Dave Barnes Camera

A sea ice camera was maintained on an island near Rothera. The field party changed the SD card but on photo recovery it was found that the screen wiper was not functioning as intentioned. After talking to David Barnes and Will Clarke (in Cambridge) a plan was made for short term repair. Using a spare from Cambridge to plan the repair. A long-term plan of; replacement, maintenance and running the site in a more "AME field site" style has been planned and submitted to Mike Rose.

### 8.3.4 Rothera Marine Lab

Assistance was provided to the marine lab who have a small seabird CTD. This appears to be under maintained especially when it comes to the details. Assistance was provided servicing

O-rings, greasing connectors, looking at cables and generally providing TLC. If possible, it would be nice for AME to do this in the future when the skills to do so are in Rothera.

### 8.3.5 Rothera Cover

Due to a slow start to the field season, both the incoming and outgoing radar (AME) engineer where in the field simultaneously. To enable this I covered the science alarms for the day while the JCR was in Rothera.

## 8.4 AME Department notes

### 8.4.1 Pre-cruise tasks

| Task | Status |
|---|---|
| Download AME_Eng/Platform_Specific/JCR | Y |
| Check cruise planning meeting notes | Y |
| Number of hours hand over with previous ships AME Engineer | 40 |

### 8.4.2 Daily & weekly tasks

| Task | Frequency | Status |
|---|---|---|
| Sanity check the Oceanlogger data | Daily | Y/N |
| Check the Following Fans:<br>Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween) | Daily | Y/N |
| Mega test CTD cable | Weekly | Y/N |
| Clean Underway System | Weekly | Y/N |

### 8.4.3 End of cruise checks

| Task | Status |
|---|---|
| XBT left in cage, in a suitable state | N |
| The salinity bottles have been cleaned, if used | Y |
| CTD left in suitable state - Ducts cleaned with Triton and deionised water, blanking plugs installed and system washed with water | Y |
| CTD Slip Ring have been cleaned | Y |
| Office is tidy, with manuals and files returned and items stowed for sea | Y/N |
| Clean the following fans:<br>Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween) | Y |
| Scintillation Counter test Precedure | Y |

### 8.4.4 Items to be purchased

| Item | Supplier | Quantity | Use |
|---|---|---|---|
| Additional CTD sea cable Pigtails. Down to last one | Seabird | 4 | |

| | | | |
|---|---|---|---|
| Marine Radio | | 1 | 1 lost overboard by AME Staff |
| | | | |

# 9. AME Mechanical technical report

**Bjørg Helen Apeland**
**Gareth Flint**

## 9.1 Multicorer

### Marian Cove

Multicorer deployed 27 times, 12 unsuccessful.

Most of these deployments were unsuccessful as the multicorer did not fire, or the cores were too few and too shallow. However, after calling the manufacturers they suggested completely removing the damper piston.

On inspection, some light scoring and dirt contamination was found on the piston sleeve, but the root cause of the failures has not been identified. Dialogue with the manufacturer is open and hopefully this can be resolved prior to the next multicore cruise.

After the piston was removed, nearly all deployments were successful. It is still however, very important to properly clean the Multicorer, especially the spring mechanism, and the top lid latch. It is also necessary to keep the firing spring in the correct position to keep it from catching on the bottom lid. Another item to keep an eye on is the firing latch (connected to the bungee cords) itself. It was discovered that these may move and completely overshoot the top lids, and hence not activating the firing mechanism.

### Börgen Bay

Deployed 15 times, 1 unsuccessful.

After the unsuccessful deployment wooden “skis” were fitted to the legs to prevent excessive sinking into the sea bed and allow the mechanism to fire. The skis stayed on for the remainder of deployments in Börgen Bay.

### Sheldon Cove

Deployed 17 times, 4 unsuccessful

Some sandy sediment in certain locations appeared to be preventing firing of the corer. The skis were removed. Additional weights and a faster descent could have helped but we were able to obtain the required number of cores without. It’s also worth noting that a faster descent onto a firm seabed might have caused damage due to the absence of the damper piston.

On one deployment the rope became caught under one of the legs and the corer came out almost sideways. It was landed on the deck but one corer tube and one of the firing latches (attached to bungee) is bent. We have spares. Three firing latches seem to have moved and now foul the trigger when installing core holders. Needs checking & re-rigging and a thorough once-over to ensure everything else is ok.

On a few occasions the corer fired but the mechanisms weren't closing with enough force to create a good seal and samples were being lost. The sliding surfaces and spring cylinders were greased, this significantly improved the action of the corer and the retention of samples in core tubes. It also made the cores easier to remove. If the corer remains unmodified we need to take spray grease (Rocol Biogen) on its next cruise.

The firing mechanism can be easily tested on deck by craning the weight head onto a barrel (arm) and lifting it clear again (fire).

We lost three core holders in total. We were removing them each time to clean initially but it's not necessary and clearly introduces the risk of incorrect reinstallation .
The average number of cores throughout the cruise was less than 5, although with the piston removed and 'agreeable' sediment that increased to around 6 (of 9 by this point). It would be helpful to have an identification system so repeat failing ones could be identified and remedial action taken.

A rattle gun should be taken as part of the multicore kit to allow quicker adjustment of the feet, if required.

**Cambridge Maintenance:**

- One of the legs is bent.
- Build suitable platform
- Develop removable "skis"
- Full inspection & torque of all fasteners.
- There's a lot of friction in the sliding mechanism, maybe it can be modified.
- Manufacturer recommends replacement of springs after 2 years.

### 9.2 Mini AGT

#### Burdwood Bank

4 successful deployments.

#### Sheldon Cove

6 successful deployments.

The tears in the rubber are advancing. The worst was stitched with whipping twine to prevent further tearing and this seems to have worked. Suggest packing twine, needle & awl in AGT spares box.

Some holes in both nets.

**Cambridge Maintenance:**

- Fix holes in nets
- Give once over
- Several tears to rubber – assess & repair/replace

### 9.3 Hamon Grab

#### Marian Cove

Deployed 35 times, 10 unsuccessfully.

There was a discrepancy between the ea600 and the em122 leading to some failed deployments. Or the slack on the wire was not enough.

#### Börgen Bay

Deployed 42 times, 2 unsuccessfully.

The wire was found to have a lot of twists in it which couldn't be removed & was replaced. A second rope got caught on the grab and a strand was broken, also replaced. There is one remaining spare.

The pulleys are not running smoothly.

#### Sheldon Cove

Deployed 33 times, 2 unsuccessfully.

Wire rope replaced again. No spares remain and unable to make more as the JCR's swager isn't working.

**Cambridge Maintenance:**

- Should receive an onceover upon return to Cambridge.
- More spare ropes, it might be worth assessing the use of Dyneema ropes over SWR.
- Check pulleys

## 9.4 N70 Plankton Net

### Marian Cove

Deployed 5 times successfully.
Lost resting cradle for weight.

### Börgen Bay

Deployed 5 times successfully.

### Sheldon Cove

Deployed 9 times successfully.
The brass shackles were working loose, make sure to mouse them when assembling at the next cruise.

**Cambridge Maintenance:**

- Replace resting cradle

## 9.5 Gravity Corer

From BGS, and came without correct deployment gear. Was deployed of the side gantry using the coring warp as main lifting point, and the 2T auxiliary winch as secondary lifting point. By lifting with both winches simultaneously we were able to lift the gravity corer horizontally, come forward on the gantry, lift the corer outboards, lower the 2T winch to slack, remove the 2T winch attachment point, and the lower the gravity corer vertically by the coring warp. The gravity corer was then deployed successfully.

The Deck Engineer has a method statement, to be added to AME OneDrive for future reference.

The hydraulic core tube extractor was functional but wasn't necessary.

### Marian Cove

Deployed 8 times, 1 unsuccessful.
Failed due to rock blocking coring tube.

### Börgen Bay

Deployed 8 times, 5 unsuccessful.

### Sheldon Cove

Deployed 8 times, 1 poor core.

# 10. IT

**David Hunter** British Antarctic Survey

- Data is logged under the concept of a "*leg*" which is defined as a port-to-port voyage of the JCR.
- JR16004 data will be available on the BAS Storage Area Network (SAN) as **leg 20170120**.
- *legs* start or end at ports with customs, for example; Punta, Stanley and UK ports.
- A leg number is the date at which the leg was started in the format YYYYMMDD.

## Data Collection Process

- Most instruments are connected via serial links to the central collection point; the SCS server (JCR-SCSS1).
- The data is recorded in raw format (.RAW) and also sub-sampled to give a time delimited data file (.ACO). An indication of the variables and their units can be found in the (.TPL) files. This data is found under the /scs directory.
- Data from instruments which do not log directly to the SCS are also gathered in the legdata area such as CTD, ADCP, XBT, etc.
- A copy of all data collected under legdata is transferred to Cambridge and will be available forever. Please make requests via the Polar Data Centre or helpdesk@bas.ac.uk.

## Significant Incident Log

**Logistics & Prep**

**20181127**

- dahun joined at 09:00L in Stanley, FI
- Worked from Stanley office

**20181128**

- Worked Stanley office

- Inbound MoD flight canx - tomorrow's departure changed from 20:00L to 16:00L

**20181129**

- Issues raised surrounding use of Office on arrival
    - Purser and others can open existing Excel files, but highlighting a cell and trying to up font size, for example, crashes the program.
    - Profile rebuild resolved.
- Deck Engineer laptop given to add drives for
    - Attempted but need credentials from Tom for his JCR domain account.
- Radio Officer was given an XP laptop to add to network but hasn't done so yet
    - Directed user to O365 for now.

**Transit 16:00L from FIPASS to HMNB East Cove**

**20181130**

**Arrive HMNB East Cove 0800L**

- Working through issues
    - Lab Manager couldn't print. Re-added printers from server and attempting to remove previous lab manager's email account.
    - Tried to change the Master's personal account password (tspa) but couldn't.
- Powerdown confirmed for 0830L tomorrow. Will shut down at 0800L
- Started newleg process up to powering equipment back up.

**20181201**

- 0600L prep for powerdown
- 0800L initiate powerdown of VM hosts and servers
- Assist AME with XBT
- 1000L power restored
- 1030L servers powering up
- 1130L newleg process complete - will start collection process after lunch
- Delayed collection process until tomorrow when all available to test
- ChEng PC issue with Office different to Purser
    - Clicking to open a document flashes the document then reverts to just Excel with no document opened. Minimising that window and reopening the document opens it in that window. Having an xlsx open then opening another closes the open document and just opens blank Excel.
    - Suspected update. Shows updates for Office 2007 (*why is this even installed still?*) at time of failure. Will try System Restore.
    - 1830L ChEng PC finished System Restore and Office now working again as intended.
- 1900L started setting-up scientist laptops in Conference room.
    - Many with Macbooks do not have adapters - now have a handful to loan
- 2200L finished most scientist laptops

**Week 1**

**20181202**

- 0820L depart HMNB East Cove for Rothera.
- 0920L **Lifeboat Drill**
- 1005L begin startups for collection of underway data.
- 1100L startups of EA600, EM122, ADCP.
- 1300L found the adapters and distributed.

- Users unable to write to *legwork* again.
    - Fixed with ***chown -R nobody:nobody **** on *jrlb/data/cruise/jcr/current/work*
- EA600 seems to be logging but not feeding to SCS monitor.

**20181203**

- 0300L deep CTD test (3000m) OK
- Handful more laptops brought to set-up this morning.

**20181204**

- Connected Purser's PC to JRsafety AMS account
- Issue reported around not being able to connect one of their PC's to workdrives in the UIC using the pstar account
    - Had to change many Symlinks and edit some of the scripts.

**20181205**

- Called to bridge as all Eventlogs had failed
    - Upon inspection all Apache had failed on jrlb
    - ***service apache restart*** resolved.

**20181206**

**20181207**

- Set-up EK80 as requested ahead of Marian Cove survey
    - Scientists have a previous paper they need to compare results to, which used an EK80

**2100L arrive MARIAN COVE, KING GEORGE ISLAND**

**20181208**

- Positive feedback on EK80 results
- Working with David Goodger on EA600 not repeating to NavMet.
    - EA600 can be seen logging to the correct folders as required. SCS and NavMet however refuse to acknowledge their existence.

**Week 2**

**20181209**

- EK80 saying U: is full even though there is >1TB free. For reliability the scientists would like to use an external HDD, which I have provided temporarily.

**20181210**

- ADCP crashed. Powered-down and started again OK from scratch.

**20181211**

- Restarted EA600 again but still no NavMet/SCS output
- EA600-SCS fixed
    - COM4 output on EA600 was set to 9600 but COM9 receiving on SCS is expecting 4800 BAUD
- Sophos started blocking Firefox and Adobe Reader. Suspect changes in Cambridge as this is on PC's that seem to have had the licensing fixed.
    - Cambridge known issue and fix being pushed-out

**~1900L depart MARIAN COVE**

**20181212**

**~1200L arrive BÖRGEN BAY, ANVERS ISLAND**

- Sophos still blocking - called in by Master as stopping critical business now
    - Have changed Sophos settings myself now. Firefox Quantum browser is in an app control list

- All the DPREP (Public UIC) PC's and the Lab Manager's laptop are sapping all useable bandwidth downloading updates from Windows Update, not WSUS
    - Forcing WSUS in local group policy seemingly doesn't have any effect
    - Lab Manager's PC isn't on the domain
- EK80 still very unstable

**20181213**
**20181214**
**20181215**
**Week 3**
**20181216**
**20181217**
**~1630L arrive ROTHERA**
**20181218**

- ***Rothera Layover***
    - Went to assist Martin Steel but due to arriving earlier he was working Deep Field.

**20181219**

- ***Rothera Layover***
    - Assist vessel cargo and assist Martin Steel for a little while in stores

**20181220**
**~0830L depart ROTHERA**
**20181221**

- ~0600 no DHCP
    - Upon inspection all SAN storage had failed again. VMware host reboots fixed. SCS collection restarted.

**20181222**

- ~2030 Profiler PC lost mountings during the storage failure. Scripts won't read data files properly - truncating at time of failure despite further rows in the same file
    - Remounted path. xinetd restart didn't help truncation issue. Will ask Andy/Jeremy.

**Week 4**
**20181223**

- ~1300 fire in an Upper Deck cabin
    - Suppressed - no further details

**20181224**

- ***Rothera Dropoff***

**20181225**

- Science completed so shut down SCS logging and transducers

**20181226**
**~0800L arrive PALMER, ANVERS ISLAND**

- Engaged with USAP Comms and AME counterparts

**~1600L depart PALMER, ANVERS ISLAND**

- Science NOT over! Restarted logging and equipment back on!

**20181227**

- Combined Office printers remapped for Doctor
- Combined Office PC screen misbehaving - cable was loose.

**20181228**

- Bridge Microplot not loading new license or charts for Punta/TdF

- Fixed license - old license was being read because files weren't in root of USB
    - Chief Mate in contact with Admiralty/UKHO over charts not loading, as I checked disks and chart isn't there
    - Admiralty confirm charts were withdrawn so ascertaining next steps for navigation
- Deleted duff logs from Eventlog

**20181229**

- Assist George with EK80 PC to get some screenshots off

**Week 5**

**20181230**

**20181231**

- **Shore transfer 1200L**

**~2200L arrive PUNTA ARENAS**

# 11. Appendix

***A1.1 EM122 System Setup and Calibration***

Installation and runtime parameters can be found in the document 'EM122 Settings 2 Dec.rtf' within the 'scientific work areas / EM122' folder and are available on request from the UK Polar Data Centre (polardatacentre@bas.ac.uk).

Initial set-up of EM122 followed the process outlined in the document 'Using EM122 Multibeam on an Opportunistic Basis v3.3' provided on the JCR. A Basic Installation Self-Test (BIST) was conducted in SIS on system start up and no errors were identified. The system appeared in good health with the exception of the stave display which showed staves 60 and 97 as having reduced signal level (Figure A1.1 ). This had no apparent effect on data acquisition.

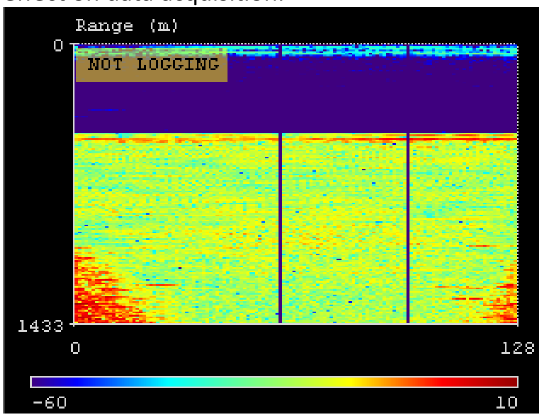


*Figure A1.1 SIS Stave display showing 2 receive staves with reduced signal level (vertical blue lines)*

It was not possible to conduct a static validation or patch test during the period owing to tight time constraints and lack of a suitable seabed target. The initial multibeam work at Burdwood Bank produced a number of lines of various orientation which were used to confirm no obvious pitch, roll or latency issues.

A value for the MRU to waterline offset was calculated from vessel's midships draft marks and input in SIS installation parameters (see *Figure A1.2 and Table A1.1)*. All other values for offsets were checked against the vessel's latest reference frame survey[5]. Calibration certificates for all systems can be found in the JR18003 'Legwork' folder and are also available on board. JCR's last Dimension control survey in Harwich, UK, 15-17

[5] Oceanfix International RRS James Clark Ross, Gyro & MRU Calibration, DGNSS Verification and Offset Survey Report, 15-17 September 2018

September 2018, included gyro and MRU calibration, DGNSS verification, vessel reference frame survey and static validation.

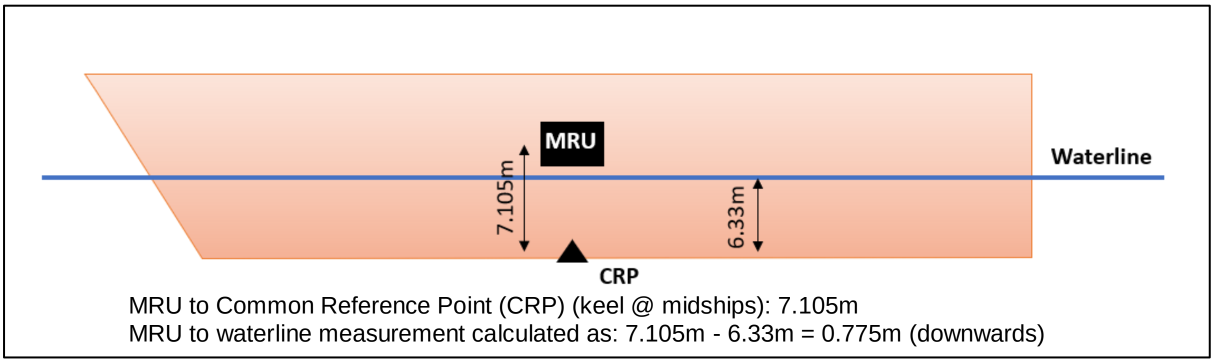


*Figure A1.2 MRU to waterline calculation on departure from ECMP.*

*Table A1.1 MRU to waterline corrections*

| Date (UTC) | Occurrence | Draft Fwd / Midships / Aft (m) | Correction Applied |
|---|---|---|---|
| **14/12/2018 12:21** | Sailing from ECMP | 5.88 / 6.33 / 7.08 | 0.775m (downwards) |
| **20/12/18 08:00** | Sailing from Rothera after cargo offload | 5.28 / 5.90 / 6.56 | 1.205m (downwards) |

### *A1.2 Position Data*

Seapath 320 GNSS NMEA data were logged to the JCRs computer system (SCS) and input to SIS during data collection. The position output is the standard GNSS service with no differential corrections outside of the standard Northern Hemisphere EGNOS[6] and WAAS[7] service areas. Standard GNSS position was logged during all MBES operations but it is intended the position be refined using Real Time Kinematic (RTK) post processing in Marian Cove, Börgen Bay and Sheldon Glacier to improve horizontal and vertical accuracy in these shallow water locations. To facilitate this, and following advice from Kongsberg Maritime (KM), the Seapath raw position data was logged as Telegram Output messages for post-processing against RINEX data from nearby IGS stations (*Table A5.1.2)*. Instructions on how to log raw Seapath data has been saved in the JCR AME Wiki webpage.
Seapath Raw data were exported as *.l15, *.l14 and *.l16 Telegram outputs (R24,R25, R26 Seapath Proprietary formats, RTCM v3 messages and IMU Raw data). RTCM data were then converted using the Kongsberg 'rinexconverter 2.00.00' tool and post processed using the RTKLib 'RTKPost' tool (Kinematic setting). IGS observation data (*.18o file for each IGS station) and navigation files (brbc *.18n) were obtained from the NASA Space Based Geodesy website: CDDIS[8]. RTK processed data will be converted to binary or SBET format for use in Qimera processing software to refine the vessel's horizontal accuracy and build a GPS Tide model.
Although it is possible to download SBAS real time corrections via the internet from the European Space Agency, this method was least preferred owing to spatial decorrelation from the WAAS and EGNOS correction service areas.

*Table A1.2. GNSS observation files used for post processing*

| Area | IGS Reference Station | Period of observation | Seapath Raw files | Converted Obs files | Daily GNSS Navigation files | IGS Reference Station files (rapid ephemeris) |
|---|---|---|---|---|---|---|
| **Marian Cove** | OHI3 (O'Higgins) | JD344-JD345 | 27 | 27 | 2 | 2 |
| **Börgen Bay** | PALM (Palmer) | JD346-JD350 | 90 | 90 | 5 | 5 |
| **Sheldon Glacier** | ROTH (Rothera) | JD351-JD358 | 166 | 166 | 8 | 8 |

[6] https://www.gsa.europa.eu/egnos/services
[7] https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/waas/
[8] https://cddis.nasa.gov/Data_and_Derived_Products/GNSS/broadcast_ephemeris_data.html

### *A1.3 Tides*

The small tidal range in all areas enabled rapid initial MBES processing without application of tidal corrections to support cruise scientific activity.

Post-processing will make use of RTK GNSS data to generate GPS tide corrections using separation values provided by the UKHO as shown in table A1.3.

*Table A1.3 UKHO Provided separation values for GPS tide.*

| Location | Position | ITRF to CD separation (m) | ITRF to MSL separation (m) | ITRF to EGM08 separation (m) | Uncertainty (m) |
|---|---|---|---|---|---|
| Börgen Bay (Anvers Island) | 64° 44′·687 S 63° 28′·472 W | +13.8695 | +14.9466 | +18.0710 | ±0.2618 |
| Marian Cove (S. Shetland Islands) | 62° 13′·000 S 58° 48′·000 W | +19.8628 | +21.2087 | +21.7870 | ±0.2621 |
| Sheldon Glacier (Adelaide Island) | 67° 33′·212 S 68° 18′·796 W | +6.0618 | +7.0625 | +8.5030 | ±0.2623 |

Seapath raw data was logged alongside Rothera to obtain values for a GPS tide validation against the Rothera Tide Gauge. Periods suitable for use were confined to those outside of stores transfer and fuelling activity to avoid draught changes and are shown in table A1.4.

*Table A1.4. Periods alongside Rothera identified as suitable for GPS Tide Validation.*

| Start Time (UTC) | End Time (UTC) | Draught | Comments |
|---|---|---|---|
| 17/12/18 1942 | 18/12/18 1130 | 6.00m | Taken from boat readings |
| 18/12/18 2240 | 19/12/18 1100 | Not Known | Draught readings not available |
| 19/12/18 2100 | 20/12/18 1130 | 5.90m | Alongside measurements |

Tide gauge data were downloaded[9] from the stations summarised in *Table A1.5* and will be used if the GNSS tide validation is not successful.

*Table A1.5 Tidal stations (if GPS Tide not achieved):*

| Station | IOC ID | Type | Logging Interval |
|---|---|---|---|
| Roth (Sheldon Glacier) | ID: 342 | Radar | 1 min |
| Vern (Börgen Bay) | ID: 188 | Pressure | 1 min |
| Prat3 (Marian Cove) | ID: 189 | Pressure / Radar | 1 min |

Photos of the tide gauge at Rothera show it to be in good condition and protected from the elements and ice. It appears to be in similar condition to when Kate last visited with HMS Protector in Spring 2017. The gauges at Vernadsky and Prat were not accessed during this cruise.

Email contact with South Korean Base (King Sejong) in Marian Cove confirmed the presence of a tidal station and Differential GNSS station at the base. A request was made via email for the data covering the survey period and is currently ongoing.

### *A1.4 Sound Velocity*

CTD casts performed routinely as part of the scientific cruise plan were used to obtain SVPs and were preferred to XBT generated SVPs for cost and environmental reasons. It is intended to post process sound velocity spatially during processing in Qimera using CTD data as little temporal variation was noticed. During passage synthetic SVPs were applied due to time and budget constraints. These SVPs were generated using HydrOffice Sound Speed Manager software following the procedure outlined in JR17004’s cruise report.

The ‘sound speed at the transducer’ value in SIS runtime parameters was set to ‘sensor’ and updated at 5 second intervals with sound velocity values taken from the vessel’s uncontaminated seawater. This was achieved by running the python script from the documents folder on the SIS terminal in Windows Powershell using the

[9] http://www.ioc-sealevelmonitoring.org/

command: “python .\JCR_c_keel.py” following the procedure outlined in JR17004’s cruise report. The sound velocity was monitored during data collection for differences greater than 3 $ms^{-1}$ between the SV profile and SV in use. A list of sound velocity (*.asvp) files is shown in table A1.6.

*Table A1.6 Sound Velocity Profiles used during JR18003*

| Filename | Date and Time (UTC) | Project |
|---|---|---|
| 20181202_1501_WOA09.asvp | 2/12/18 1501 | jr18003_a |
| 20181202_2301_WOA09.asvp | 2/12/18 2301 | jr18003_a |
| JR18003_001.asvp | 3/12/18 1027 | jr18003_a |
| JR18003_002.asvp | 4/12/18 1103 | jr18003_a |
| 20181204_1139_WOA09.asvp | 4/12/18 1139 | jr18003_a |
| 20181205_0100_WOA09.asvp | 5/12/18 0100 | jr18003_a |
| WOA09_20181206081341.asvp | 6/12/18 0813 | jr18003_b |
| 20181206_0910_WOA09.asvp | 6/12/18 0910 | jr18003_b |
| 20181206_1927_WOA09.asvp | 6/12/18 1927 | jr18003_b |
| 20181207-044941-WOA09.asvp | 7/12/18 0449 | jr18003_b |
| 20181207_1700_WOA09.asvp | 7/12/18 1700 | jr18003_b |
| 20181207_2359_WOA09.asvp | 7/12/18 2359 | jr18003_b |
| JR18003_003.asvp | 8/12/18 0359 | jr18003_c |
| JR18003_004.asvp | 8/12/18 0625 | jr18003_c |
| JR18003_005.asvp | 8/12/18 0757 | jr18003_c |
| JR18003_006.asvp | 8/12/18 0956 | jr18003_c |
| JR18003_007.asvp | 8/12/18 1130 | jr18003_c |
| JR18003_008.asvp | 8/12/18 1243 | jr18003_c |
| JR18003_009.asvp | 8/12/18 2227 | jr18003_c |
| JR18003_010.asvp | 8/12/18 2344 | jr18003_c |
| JR18003_011.asvp | 9/12/18 0215 | jr18003_c |
| JR18003_012.asvp | 9/12/18 0341 | jr18003_c |
| JR18003_013.asvp | 9/12/18 0708 | jr18003_c |
| JR18003_014.asvp | 9/12/18 0835 | jr18003_c |
| JR18003_015.asvp | 10/12/18 1111 | jr18003_c |
| JR18003_016.asvp | 10/12/18 1636 | jr18003_c |
| JR18003_017.asvp | 10/12/18 1711 | jr18003_c |
| 20181212-0718_WOA09.asvp | 12/12/18 0718 | jr18003_d |
| JR18003_018.asvp | 12/12/18 1817 | jr18003_e |
| JR18003_019.asvp | 13/12/18 1609 | jr18003_e |
| JR18003_020.asvp | 13/12/18 1809 | jr18003_e |
| JR18003_021.asvp | 13/12/18 1925 | jr18003_e |
| JR18003_022.asvp | 13/12/18 2057 | jr18003_e |
| JR18003_023.asvp | 13/12/18 2237 | jr18003_e |
| JR18003_024.asvp | 13/12/18 2359 | jr18003_e |
| JR18003_025.asvp | 14/12/18 0037 | jr18003_e |
| JR18003_026.asvp | 14/12/18 0112 | jr18003_e |
| 20181217-0813_WOA09.asvp | 17/12/18 0813 | jr18003_f |
| JR18003_027.asvp | 20/12/18 1323 | jr18003_g |
| JR18003_028.asvp | 20/12/18 1750 | jr18003_g |
| JR18003_029.asvp | 20/12/18 1926 | jr18003_g |
| JR18003_030.asvp | 20/12/18 2043 | jr18003_g |
| JR18003_031.asvp | 20/12/18 2203 | jr18003_g |
| JR18003_032.asvp | 20/12/18 2306 | jr18003_g |
| JR18003_033.asvp | 21/12/18 0030 | jr18003_g |
| JR18003_035.asvp | 21/12/18 1353 | jr18003_g |
| JR18003_036.asvp | 21/12/18 1453 | jr18003_g |
| JR18003_037.asvp | 21/12/18 1620 | jr18003_g |
| JR18003_038.asvp | 21/12/18 1743 | jr18003_g |
| JR18003_039.asvp | 24/12/18 0236 | jr18003_g |
| 20181227-2142_WOA09.asvp | 27/12/18 2142 | jr18003_h |

***A1.5 MBES Processing***

Raw Kongsberg (.all) files were imported into QPS Qimera and Fledermaus software and an initial rough edit performed to remove gross error. Combined Uncertainty Bathymetric Estimate (CUBE) and manual editing methods were used to remove systematic noise and random errors. Tide and GNSS solutions were not applied during the cruise owing to IGS data delays and time constraints and will be processed later with a more thorough edit.

An initial appraisal of each area was conducted to identify medium scale changes from the 2017 ICEBERGS cruise. Some minor potential changes were noted but cannot be confirmed until more robust processing has been achieved.

The Geocoder tool within QPS FMGT software was used to perform Angular Range Analysis on MBES backscatter data. The products show variability broadly in line with that expected but further analysis incorporating seabed sample particle-size analysis will enable calibration of the vessel's beam pattern correction and a more accurate assessment of sediment characterisation of the seabed.

Outputs for each survey area are shown in table A1.7. QPS iView4D Free Software can be used to view QPS files.

*Table A1.7 Survey Data Outputs for JR18003 – Processed Projects*

| Survey | Area | Projection | QPS Project | Products | Comments |
|---|---|---|---|---|---|
| JR18003_a | Burdwood Bank | WGS84 World Mercator | Burdwood Bank | 78 x .all files (Raw)<br>6 x ASVP files<br>QPS Dynamic Surfaces:<br>- Burdwood_Bank 25m<br>- Burdwood_Bank 50m<br>- Burdwood_CUBE_50m<br>BAG files:<br>- JR18003_a_100m<br>- JR18003_a_50m<br>- JR18003_a_50m_CUBE<br>ASCII files:<br>- JR18003_a_AcceptedSoundings_WGS84.xyz<br>- JR18003_a_RejectedSoundings_WGS84<br>- JR18003_a_CUBE_50m.xyz<br>QPS Scene files:<br>- ARA.scene<br>Images:<br>Burdwood Bank.tif<br>Burdwood Bank Coverage.tif<br>JR18003_a_Area Stats.jpg<br>JR18003_a_overview.jpg<br>JR18003_a_overview3D.jpg<br>Video files:<br>Burdwood_Bank_001.wmv<br>Burdwood_Bank_002.wmv | Full product list: scientific_work_area folder/EM122/Burdwood Bank EM122 Products list.docx<br><br>No Tide / SV / or GNSS post processing conducted. |
| JR18003_c | Marian Cove | WGS 84 UTM Zone 21S | Marian Cove 2018 | 18 x .all files (Raw)<br>15 x ASVP files<br>QPS Dynamic Surfaces:<br>- Marian Cove_5m<br>BAG files:<br>- JR18003_c_5m.bag<br>ASCII files:<br>- JR18003_c_AcceptedSoundings_WGS84.xyz<br>- JR18003_c_RejectedSoundings_WGS84<br>- Marian Cove_5m.xyz<br>QPS Scene files:<br>- Marian Cove.scene | Cube 2m and 5m grids produced. Edited iaw MCA SOP using manual removal of soundings and update of CUBE surface.<br><br>No Tide / SV / or GNSS post processing conducted during cruise. |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Images:<br>Marian Cove_5m.tif<br>Marian Cove Mosaic.tif<br>Marian Cove Mosaic 2.tif | |
| JR18003_e | Börgen Bay | WGS 84 UTM Zone 20S | Börgen Bay 2018 | 77 x .all files (Raw)<br>9 x ASVP files<br>QPS Dynamic Surfaces:<br>- Börgen Bay CUBE 5m<br>BAG files:<br>- JR18003_e_5m_CUBE.bag<br>ASCII files:<br>- JR18003_e_AcceptedSoundings_WGS84.xyz<br>- JR18003_e_RejectedSoundings_WGS84<br>- Börgen_Bay_5m_CUBE.xyz<br>QPS Scene files:<br>- Börgen_Bay.scene<br>Images:<br>Börgen Bay Overview.tif | CUBE 5m grid produced. Edited with Very Weak Spline filter and manually checked to ensure features preserved.<br>No Tide / SV / or GNSS post processing conducted during cruise. |
| JR18003_g | Sheldon Glacier | WGS 84 UTM Zone 19S | Sheldon 2018 | 68 x .all files (Raw)<br>12 x ASVP files<br>QPS Dynamic Surfaces:<br>- Sheldon_10m_working<br>- Sheldon_5m_working<br>BAG files:<br>- JR18003_g_10m.bag<br>ASCII files:<br>- JR18003_g_AcceptedSoundings_WGS84.xyz<br>- JR18003_g_RejectedSoundings_WGS84<br>- Sheldon_10m_CUBE.xyz<br>QPS Scene files:<br>- Sheldon.scene<br>Images:<br>Sheldon_Overview.tif<br><br>74 x supporting photos | CUBE 5m grid produced. Edited with Weak Spline filter and manually checked to ensure features preserved.<br>No Tide / SV / or GNSS post processing conducted during cruise. |

Opportunistic sounding conducted between survey sites was not processed onboard. This will be rendered in raw data format to BAS as outlined in table A1.8.

*Table A1.8 Unprocessed MBES Transit data from JR18003*

| Survey Name | Start (UTC) | End (UTC) | Projection | Description | Number of RAW files (.all) |
|---|---|---|---|---|---|
| **jr18003_b** | 5/12/18 1846 | 10/12/18 1123 | WGS84 World Mercator | Transit from Burdwood Bank to Marian Cove | 55 |
| **jr18003_d** | 11/12/18 2047 | 12/12/18 1508 | WGS84 World Mercator | Transit from Marian Cove to Börgen Bay | 21 |
| **jr18003_f** | 16/12/18 0722 | 17/12/18 1903 | WGS84 World Mercator | Transit from Börgen Bay to Rothera | 31 |
| **Jr18003_h** | 24/12/18 1851 | 28/12/18 0139 | WGS84 World Mercator | Transit from Rothera to edge of Argentinian EEZ<br>Including Interim Seamount | 36 |

***A1.6 Supporting photographs***

74 photographs were taken at Sheldon Glacier to provide supporting evidence for the apparent floating ice front. Details are shown in table A1.9 below.

*Table A1.9 Sheldon Glacier Supporting Photos*

| Ship Position Latitude | Longitude | Date / Time | Bearing | File Number | Comments |
|---|---|---|---|---|---|
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 310° - 333° True | NEF 8254 - 8269 | Floating Ice Edge panorama (bearing 310-333) |
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 310° - 333° True | NEF 8270 - 8286 | Floating Ice Edge 2nd panorama |
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 310° - 333° True | NEF 8287 - 8292 | Floating Ice Edge Overview |
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 345° - 003° True | NEF 8293 - 8304 | Other Ice Feature panorama |
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 003° – 025° True | NEF 8305 - 8324 | Panorama continued right |
| 67°32'.34S | 068° 15'.83W | 24/12/18 1125 UTC (0825 Local) | 345° - 003° True | NEF 8325 - 8327 | Panorama Overview of other Ice Feature |

### *A1.7 Equipment Issues*

Very few issues were encountered with the ship's survey systems. A list of problems is shown in table A1.10.

*Table A1.10 Problems encountered with EM122 acquisition software*

| Date (UTC) | Issue | Resolution | Observer |
|---|---|---|---|
| **12/12/2018** | SIS not able to grid data (Make xyz: Problem transferring data to Grid Engine. Input Queue Full (224)) | Too much data stored. Created new survey prior to Börgen Bay and ensured project cell size was not set too small. | Kate/Floyd |
| **14/12/2018 12:21** | Seapath HMI Crash | System Restarted | Kate |
| **20/12/2018 08:00** | SIS EM122 not pinging | System Restarted | Kate/Floyd |

Standard GNSS position data was not deemed accurate enough for the shallow water work in Börgen Bay and Marian Cove. Kongsberg Maritime were engaged and provided assistance instructing as to the use of Seapath to log raw GNSS data that could be post processed using IGS data. Standard GNSS solutions were used for deep water survey of Burdwood Bank and Passage Sounding.

### *A1.8 Conflicts with Other Systems*

JCR's Kongsberg KSYNC system was used to avoid interference with other underwater acoustic systems by deconflicting transmissions. Despite this, interference was stilled noted between EM122 and the EA600 and TOPAS sensors. EA600 was switched to passive mode whenever sounding with MBES to avoid this. TOPAS lines were run as separate lines to the MBES survey as to ensure sufficient data density. No interference was observed with the EK80 or ADCP which were used extensively throughout the cruise.

### *A1.9 Software and versions*

**Seapath 320-5+** Product version 1.10.00 Processing SW version 4.15.02
GNSS Antenna 1 Type Novatel OEMV Firmware L1G DES10319106V1GV-1.03-TT 3.907 3.010 2015/May/27 16:29:46
GNSS Antenna 2 Type Novatel OEMV GNSS 2 Firmware L1G DES10160010V1GV-1.02-TT 3.907 3.010 2015/May/27 16:29:46

**Kongsberg Seafloor Information System (SIS)** Version 4.1.3 Build 14
**Qimera** Version 1.6.0 64 bit edition
**Fledermaus** Version 7.8.0 64 bit edition
**FMGeocoder Toolbox** Version 7.8.0 64 bit edition
**Kongsberg RINEXCONVERTER** Version 2.00.00