BAS Science Summaries

2018-2019 Antarctic field season

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

POLAR SCIENCE FOR PLANET EARTH

BAS Science Summaries

2018-2019 Antarctic field season

Introduction

This booklet contains the project summaries of field, station and ship-based science that the British Antarctic Survey (BAS) is supporting during the forthcoming 2018/19 Antarctic field season. I think it demonstrates once again the breadth and scale of the science that BAS undertakes and supports. For more detailed information about individual projects please contact the Principal Investigators.

There is no doubt that 2018/19 is another challenging field season, and it's one in which the key focus is on the West Antarctic Ice Sheet (WAIS) and how this has changed in the past, and may change in the future. Three projects, all logistically big in their scale, are BEAMISH, Thwaites and WACSWAIN. They will advance our understanding of the fragility and complexity of the WAIS and how the ice sheets are responding to environmental change, and contributing to global sea-level rise.

Please note that only the PIs and field personnel have been listed in this document. PIs appear in capitals and in brackets if they are not present on site, and Field Guides are indicated with an asterisk. Non-BAS personnel are shown in blue. A full list of non-BAS personnel and their affiliated organisations is shown in the Appendix.

My thanks to the authors for their contributions, to MAGIC for the field sites map, and to Elaine Fitzcharles and Ali Massey for collating all the material together. Thanks also to members of the Communications Team for the editing and production of this handy summary.

My best wishes to all of the teams. I hope you all have a successful and safe 2018/19 field season.

David Vaughan
Director of Science, BAS

November 2018

Contents

Detailed contents

Field-based projects

continued ▷

Field-based projects continued

Rothera Research Station

Detailed contents *continued*

Halley VI Research Station

Project title	Personnel PI in capitals and brackets if not present, Non-BAS personnel in blue, *Field Guide	Page
Clean Air Sector Laboratory	(NEIL BROUGH, ANNA JONES), Thomas Barningham, Sabino Del Vento, Josh Eveson, David Goodger	**38**
Future pinning of the Brunt Ice Shelf from seabed bathymetry and recent grounding history	(DOMINIC HODGSON, JAMES SMITH)	**39**
Glaciological monitoring of the Brunt Ice Shelf	(OLIVER MARSH, DAVID VAUGHAN), Dominic Hodgson, Jaskiran Nagi, James Smith, Ralph Stevenson-Jones	**40**
Halley Automation Project	(THOMAS BARNINGHAM, JOE MEDDLE, MIKE ROSE), [Halley Automation Project Team]	**41**
Meteorology and ozone monitoring	(STEVE COLWELL), Thomas Barningham, Sabino Del Vento, Josh Eveson, Ross Sanders	**42**
Optical – All-sky camera	(TRACEY MOFFAT-GRIFFIN), David Goodger	**43**
Space weather programme – electromagnetic quiet area	(MARK CLILVERD, RICHARD HORNE, MERVYN FREEMAN), Jaskiran Nagi, Ross Sanders, Ralph Stevenson-Jones	**44**
The lost meteorites of Antarctica	(GEOFFREY EVATT, KATHERINE JOY), David Abrahams, Mike Rose	**46**

Bird Island Research Station

Project title	Personnel PI in capitals and brackets if not present, Non-BAS personnel in blue, *Field Guide	Page
Bird Island marine predators Long Term Science (LTS)	RICHARD PHILLIPS, ANDY WOOD, Derren Fox, Claire Fraser, Rosie Hall, Elizabeth Morgan, Camille Toscani, Mark Whiffin	**47**
Fitness consequences of niche choice and conformance in a colonially breeding marine mammal: roles of the social environment, genetic quality and offspring behaviour	JAUME FORCADA, JOSEPH HOFFMAN, Claire Fraser, Rebecca Nagel, Camille Toscani	**48**
Investigating behavioural cues in fur seals and macaroni penguins using acoustic recording tags	MARK JOHNSON, Claire Fraser, Rebecca Nagel, Camille Toscani, Pauline Goulet	**49**
Macaroni foraging limits on the north coast of South Georgia	(SOPHIE FIELDING, PHIL TRATHAN), Jessica Phillips, Victoria Warwick-Evans, [Bird Island penguin ZFA*]	**50**

continued ▷

Bird Island Research Station continued

King Edward Point Research Station

Signy Research Station

continued ▷

Signy Research Station continued

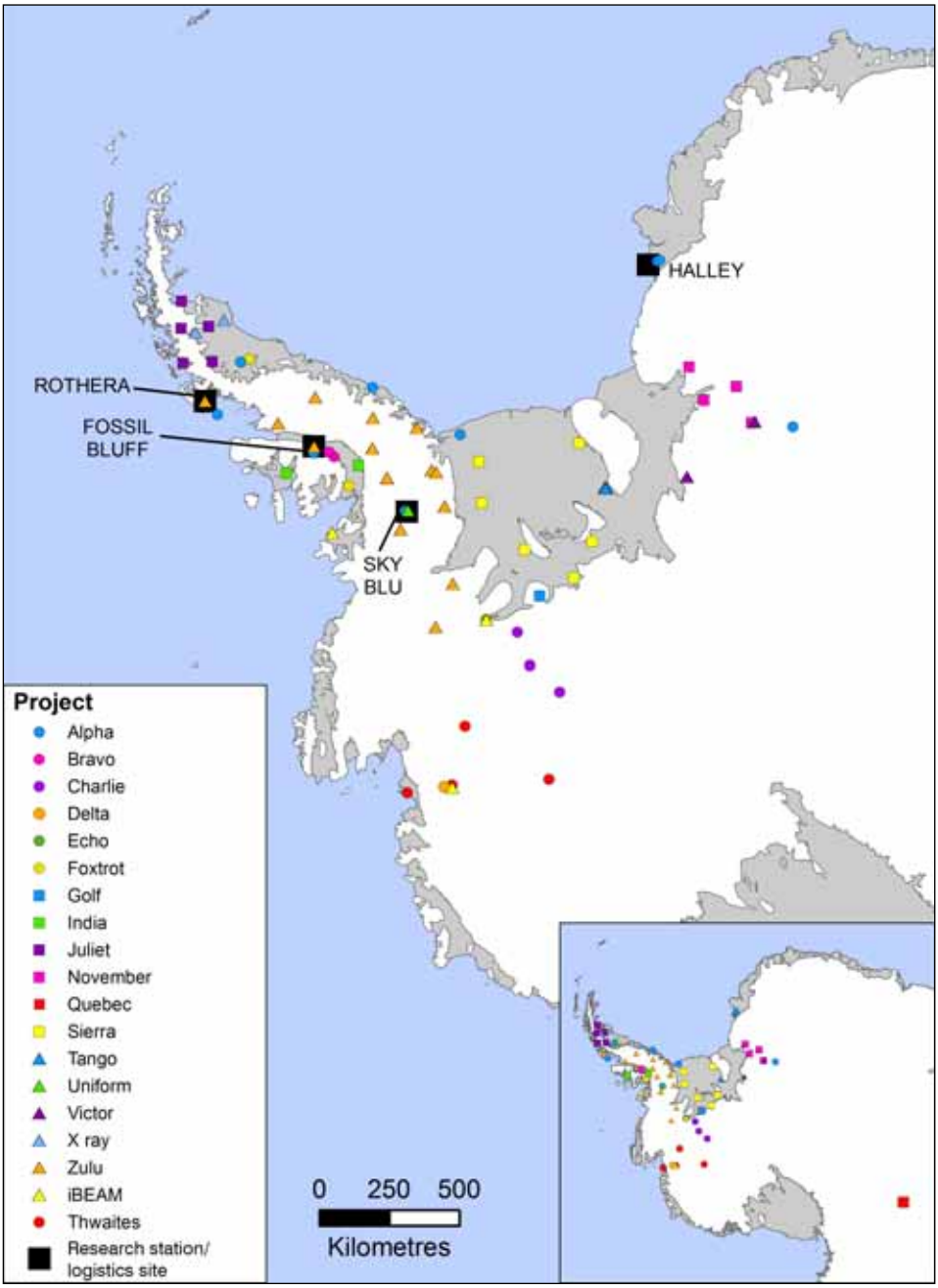
RRS James Clark Ross

RRS Discovery

HMS Protector

Map of field-based project locations

2018-2019 Antarctic field season



Sledge Alpha

Automatic Weather Station (AWS) network servicing

(STEVEN COLWELL), Thomas Barningham, Sabino Del Vento, Josh Eveson, John Law, Mairi Simms, Hannah Walker

Location: Various sites along the Antarctic Peninsula

Timing: Opportunistic throughout the season

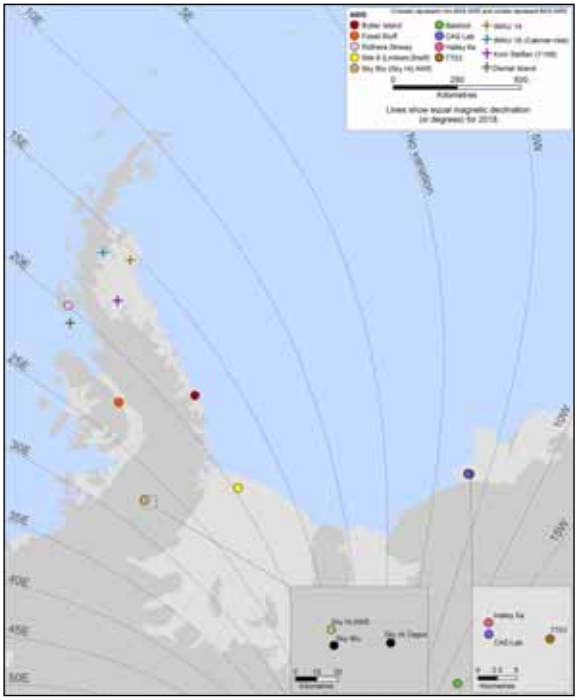
More information: *https://www.bas.ac.uk/project/meteorology-and-ozone-monitoring/#about*

BAS runs a network of eight Automatic Weather Stations (AWS) on the Antarctic Peninsula and in the Halley region. They are Fossil Bluff, Butler Island, Sky-Blu, Site 8, Baldrick, Halley VIa, CASLab and TT03 (circles on map below). The BAS AWS are part of an international network of over 100 stations covering Antarctica. The BAS Met Team collaborates with scientists from all over the world to ensure the best possible coverage of Antarctica in order to meet the needs of the scientific and forecasting communities. In addition BAS services stations for the Universities of Utrecht, Colorado and Wisconsin (crosses on map below).

Data is sent via satellite link to meteorological offices around the world so that it can be used immediately for weather forecasting. As well as being vital for forecasting, the data from these stations is the very data that has provided scientists with the incredible climate statistics of the last five decades. It is therefore essential that we visit the stations as regularly as possible to ensure that this invaluable data continues to be recorded.

Every year the Rothera Met Team visits the Peninsula sites, while the Halley Met Team visit the Halley sites and Baldrick. A site visit involves collecting high resolution data from the last year, raising the instruments and power systems above the previous year's snow accumulation and carrying out necessary repairs and updates. A station service usually takes about six hours.

This project will be supported out of Rothera and Halley.



▲ *Locations of Automatic Weather Stations serviced and supported by BAS*

Sledge Bravo

Long-term micro-environmental monitoring for terrestrial biology

(PETE CONVEY, KEVIN NEWSHAM, LLOYD PECK), Ali Massey, [Field Guide*]

Location: Rothera (Anchorage Island) and Alexander Island (Mars Oasis and Coal Nunatak)

Timing: Opportunistic throughout the season

More information: *https://www.bas.ac.uk/team/science-teams/biodiversity*

BAS runs a network of four Automatic Weather Stations (AWS) for long-term micro-environmental monitoring for terrestrial biology (at Signy, Anchorage Island, Coal Nunatak and Mars Oasis) which require annual checks and maintenance. The AWS locations span almost the entire extent of the biological region known as the maritime Antarctic, which has been one of the fastest-warming regions of the planet over recent decades.

This long-term data-gathering activity provides robust descriptions of the micro-environment experienced in different but typical Antarctic terrestrial habitats.

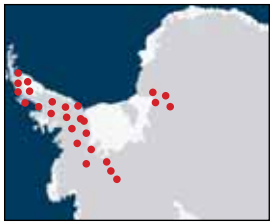
Each site consists of a data logger, recording data from a range of probes measuring various temperatures (e.g. air, soil/rock surface, sub-surface), humidity and irradiance. They operate year-round, giving a detailed picture of patterns of environmental variability over annual, seasonal, daily, and shorter timescales, and have made a central contribution to interpreting detailed biological studies of, for instance, microbiological, plant and invertebrate communities at the different locations.

An important part of the activity this season will be complete replacement of the Coal Nunatak station – to overcome the wear and tear inevitable in the decade since its last replacement.

▲ *Mars Oasis site*

▲ *The Automatic Weather Station on Anchorage Island*

Sledges Charlie, Juliet, November and Zulu



Quantifying West Antarctic mantle viscosity via precise GPS measurement of Earth's response to surface mass balance anomalies (GPS servicing)

(MIKE BENTLEY, PETER CLARKE, MATT KING, PIPPA WHITEHOUSE), [BAS Engineers], [Field Guide*]

Location: Throughout western Antarctica

Timing: Opportunistic throughout the season

Satellite measurements of ice-sheet change are necessary to understand and predict sea-level rise, but are contaminated by a phenomenon known as Glacial Isostatic Adjustment (GIA). GIA is a form of ongoing solid Earth deformation in response to previous ice-sheet mass changes. It can be measured wherever we have access to bedrock, but this is not the case for much of Antarctica and therefore we require physically-based mathematical models of GIA. These models must be calibrated and validated, which can be done with the aid of precise measurements of Earth deformation made using continuous GPS receivers sited on bedrock.

A fundamental property that must be quantified is the rheology of the solid Earth (its deformational response to forces acting on it). The Earth's mantle shows viscous behaviour over longer timescales but behaves elastically in the short term. Recent studies have demonstrated that there are large spatial variations in mantle viscosity across Antarctica, but at present the magnitude of such variations is not known. We are pioneering a new approach to determining spatially-variable mantle viscosity that involves analysing the viscoelastic response of the solid Earth to episodic surface mass balance (SMB) anomalies across Antarctica.

▲ *GPS instrument near Leppard Glacier – the GPS antenna must be bolted to solid rock, while the black box containing batteries and electronics needs a larger area of flat ground and the solar panel needs a good view to the north*

▲ *Servicing a GPS instrument near Marmelon Point – a few bird footprints and a dusting of snow, but the site is in good shape after the polar winter*

Sledge Delta

Thwaites Glacier National Capability aerogeophysical survey

Tom Jordan, Carl Robinson, Tom King*

Location: Rothera and Lower Thwaites Glacier field camp

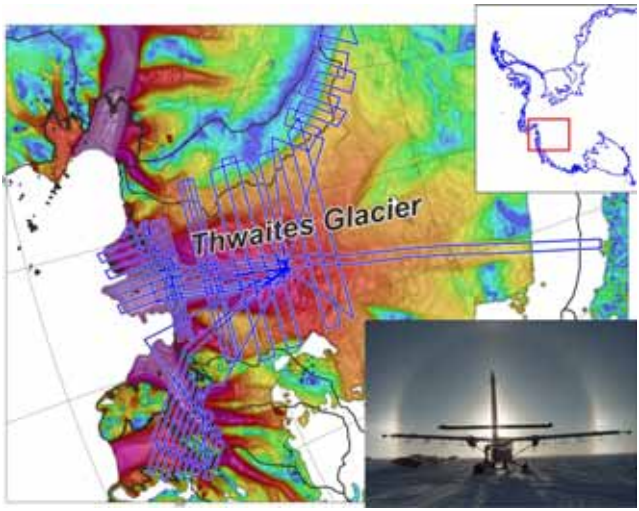
Timing: Mid-January to mid-February 2019

More information: *https://www.bas.ac.uk/project/international-thwaites-glacier-collaboration*

The International Thwaites Glacier Collaboration is joint UK-US research programme to predict the future impact of sea-level rise from the largest glacier in West Antarctica, Thwaites Glacier.

Underpinning many of the component science programmes will be new data on the sub-ice topography, geology and basal conditions of the glacier, together with new information about the bathymetry hidden beneath the adjacent ice shelf. Much of this new data will be collected by BAS scientists using the aerogeophysically-equipped BAS Twin Otter aircraft VP-FBL. This system simultaneously collects data from a suite of instruments including lidar, shallow snow radar, deep depth-sounding radar, gravity and magnetic sensors. Together this data will provide the highest resolution view of the glacier extending from the ice surface, through the internal ice-sheet structures, to the bed conditions and the geology beneath.

Our work will include about 10 days at Rothera to equip VP-FBL for survey and test, and calibrate all systems. We will then transit via Sky-Blu to the Lower Thwaites Glacier field camp where we will fly 8-10 survey flights, before returning to Rothera about a month later, depending on the weather.



▲ *Survey flight lines over the Thwaites Glacier region*

Sledge Echo

BEAMISH: Basal conditions on Rutford Ice Stream: bed access, monitoring and ice-sheet history

ANDY SMITH, Paul Anker, Alex Brisbourne, Dominic Hodgson, Keith Makinson, Keith Nicholls, Samuel Rios Costas, James Smith, Sridhar Anandakrishnan, Tavi Murray, Rebecca Schlegel, Catrin Thomas*

Location: Rutford Ice Stream

Timing: October 2018 to February 2019

More information: *https://www.bas.ac.uk/project/bed-access-monitoring-and-ice-sheet-history-beamish*

Currently, the biggest uncertainty in predicting future sea-level rise comes from the ice sheets. The BEAMISH project aims to reduce this uncertainty by understanding two aspects of it, the past behaviour of the West Antarctic Ice Sheet, and the flow of the glaciers that drain it.

The field location is Rutford Ice Stream and the plan is ambitious, with a lot of work to be achieved in the short summer season. The main work will be hot-water drilling through the ice, more than 2km thick, to reach the bed, which we plan to do four times. We will collect samples of the bed and from within the ice itself, and we will install instruments into the bed and the ice column. Each hole will be deeper than BAS has ever drilled before.

As well as the drilling, we will carry out extensive seismic, radar and GPS experiments to study the ice motion and the bed underneath it. The full BEAMISH field team will be 10 people, some of whom will swap with replacements mid-season. We will also be a refuelling site supporting the ice-core drilling on Skytrain Ice Rise; BEAMISH will be a very busy place this season.

▲ *BEAMISH site location on Rutford Ice Stream, with the Ellsworth Mountains in the background*

▲ *Deep drilling on Rutford Ice Stream during a storm*

Sledge Foxtrot

SIBLEX: Sub-ice-shelf boundary-layer experiment

(KEITH NICHOLLS), [BAS Engineers], [Field Guide*]

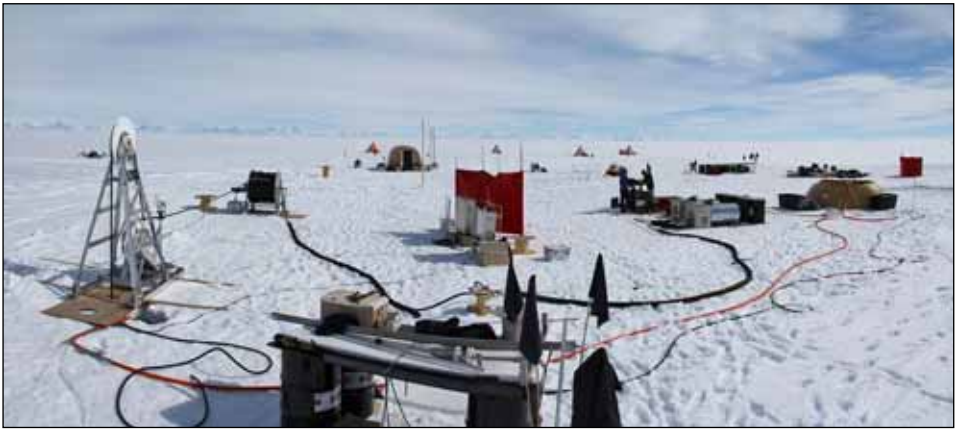
Location: Larsen C and George VI Ice Shelves

Timing: Opportunistic throughout the season

More information: *https://www.bas.ac.uk/team/science-teams/oceans*

The interaction between the Antarctic Ice Sheet and the ocean is largely played out at the base of floating ice shelves. Variations in the rate at which the ocean melts the ice either causes an increase or decrease in the ice-shelf thickness. This ultimately has consequences for global sea level. Being able to calculate how fast heat can be transferred from ocean to ice, though the upper ocean boundary layer, is central to being able to predict the future contribution of the Antarctic Ice Sheet to sea-level rise.

To address this boundary layer problem, hot-water drilled access holes were made through Larsen C and George VI Ice Shelves in 2011/12, and instruments were deployed beneath the ice. The aim was to provide data from the ice-ocean boundary layer in an attempt to characterise the dynamics of the layer beneath two different ice shelves. Data were successfully collected for the year of the experiment, but as part of the Polar Oceans programme long-term monitoring, the instruments continue to monitor the oceanographic conditions beneath the ice shelves.



▲ *The BAS ice shelf hot-water drill, as used during the deployment of instruments on Larsen C and George VI Ice Shelves. A similar, though larger, drill was used in 2014/15 when instruments were deployed beneath Site 5 on Berkner Island*

Sledge Golf

Warm climate stability of the West Antarctic Ice Sheet in the last interglacial (WACSWAIN)

ROB MULVANEY, ERIC WOLFF, Scott Polfrey, Julius Rix, Rebecca Tuckwell, Christoph Nehrbass-Alles, Emily Doyle, Mackenzie Grieman, Casper McKeever*

Location: Skytrain Ice Rise

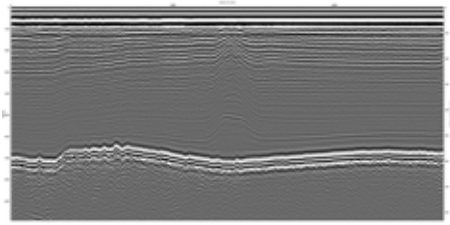
Timing: November 2018 to February 2019

More information: *https://www.esc.cam.ac.uk/news/warm-climate-stability-of-west-anarctic-ice-sheet*

Recent papers predict the loss of most of the West Antarctic Ice Sheet (WAIS) by 2500 if CO_2 emissions and rising global temperatures are not controlled. To test these projections, we will obtain new data from the last interglacial (LIG), 130,000-115,000 years ago when Antarctica was warmer than today, to assess the response of the WAIS in contributing to the 6-9m higher sea level that has been deduced for the LIG. WACSWAIN is funded by the European Research Council.

In the 2018/19 season, we will drill an ice core through to the bedrock at 620m depth on Skytrain Ice Rise. We expect to recover a record of the climate of the last full glacial cycle from 130,000 years ago to the present. Analysis of the ice core will be carried out in the BAS ice-core laboratory in Cambridge. The chemistry of the ice will tell us when and if the Ronne Ice Shelf retreated and when it re-grew. The loss of WAIS ice would have strongly impacted conditions at Skytrain Ice Rise and we will use measurements of water isotopes, air content and other parameters to diagnose the LIG history of WAIS.

▲ *Ice core drilling camp similar to the one planned for Skytrain Ice Rise*



▲ *The radar image across the dome of Skytrain Ice Rise shows the presence of layering to the bottom of the ice sheet*

Sledge India

Antarctic firn aquifers, Alexander Island

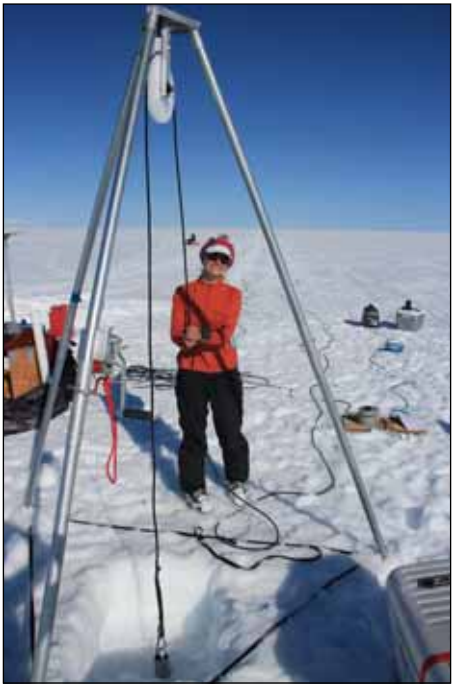
TED SCAMBOS, Clement Miege, Julie Miller, Lynn Montgomery, Bruce Wallin, Tom Lawfield*

Location: Wilkins Ice Shelf and George VI Sound, Alexander Island

Timing: November to December 2018

We propose to investigate areas in the southern Antarctic Peninsula where water from summer melting of snow drains down into the deeper snow (firn) and remains as a water-flooded snow layer throughout the Antarctic winter. These zones are called 'firn aquifers'. Our project aims to confirm indications from satellite data that these areas exist on the Wilkins Ice Shelf and the George VI Ice Shelf coast.

They are important because persistent water in the upper layers of an ice shelf can destabilise the ice shelf and cause it to fracture and disintegrate – or, on a non-floating ice sheet, can cause it to flow faster by draining to the bottom of the ice and reduce the friction between bedrock and glacier. Under warmer conditions in the future, the extent of these firn aquifer areas could spread to regions in front of major outlet glaciers.



▲ *The hot-ring drill system, see here at a Greenland firn aquifer site, will extract a 4cm firn core to 60m depth*

▲ *Water-saturated firn at depth, acquired in the spring season, is indicative of a perennial firn aquifer*

Sledge Quebec

Beyond EPICA (European project for ice coring in Antarctica) – Oldest Ice project at Dome F

(ROB MULVANEY), KENNY MATSUOKA, Jean-Charles Gallet, Brice Van Liefferinge

Location: Dome F

Timing: November 2018 to January 2019

More information: *https://www.bas.ac.uk/project/beyond-epica*

This EU-funded project is seeking a site in Antarctica where we might drill an ice core that will access the oldest continuously dated ice on Earth. The new deep ice core should enable us to build a picture of the changes in global climate and greenhouse gases over more than a million years – we hope for 1.5 million years.

Glaciologists can model where they think old ice might be found (see figure), and two of the most likely places are near Dome C, and near Dome F. BAS has been active at the Dome C site for the last two seasons, with its EU collaborators and with EU funding, and we have built up a good geophysical picture of the potential for old ice near to Concordia Station. In the 2018/19 season, a BAS Twin Otter will support the input of a Norwegian radar team to Dome F, which is the second focus of interest for the European Oldest Ice project. They will gather the information we need to make a final decision on whether European researchers will focus the deep ice core drilling project near to Dome C or to Dome F.

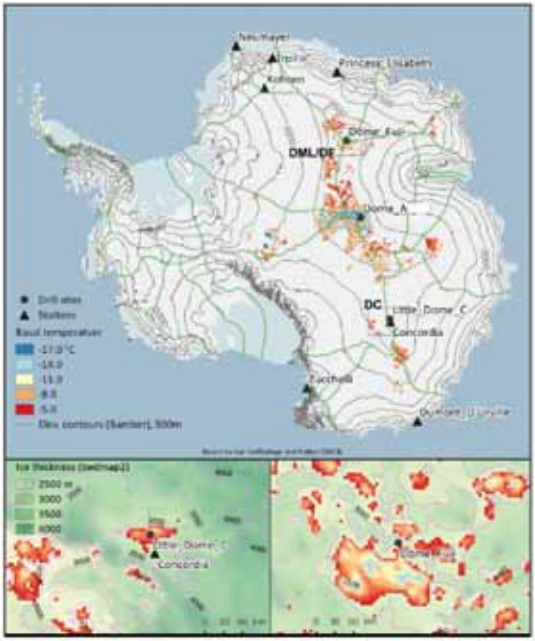


Figure: *Top: Map of Antarctica indicating our two regions of interest near* ***Dome C (DC)*** *and in Dronning Maud Land near* ***Dome Fuji (DML/DF)****. Major European stations are shown. Coloured blobs indicate areas of potentially old ice at the base. Ice divides in green, elevation contours in meters. Bottom: Insets show close-up of regions around DC (lower left) and DML/DF (lower right). Background colour and isolines indicate ice thickness in meters. Chinese and US permanent stations are located at Dome A and South Pole, respectively.*

Sledge Sierra

Melt rates on Ronne Ice Shelf (FISS: Filchner Ice Shelf System)

(KEITH NICHOLLS), [BAS Engineers], [Field Guide*]

Location: Ronne Ice Shelf

Timing: December 2018

More information: *https://www.bas.ac.uk/project/fiss*

The difficulty in accessing the cavity beneath an ice shelf means that models of the sub-ice shelf circulation lack an observational basis for validation. To optimise the performance of oceanographic models, time series of ice-shelf basal melt rates have many advantages over time-averaged basal melt rates, and huge logistical advantages over drilling an access hole to make direct oceanographic measurements.

As part of a NERC research grant, 16 novel radars were used over a two-year period to retrieve the basal melt rate of the Filcher-Ronne Ice Shelf. The results showed clearly that year-to-year variations meant that a longer time series would be needed to view the response of the system to external oceanographic forcing (warm ocean waters).

In the 2017/18 field season, five instruments were left in place to provide a longer record. The aim in 2018/19 is to revisit those sites, and also to test deploy an Iridium-based Store and Forward (SAF) unit that will allow a near-lossless transmission of data back to the UK. If successful, future site revisits will be required only when the accumulation of snow means that the instruments need to be raised to the surface.

▲ *An ApRES (phase sensitive) radar system after being raised during a site-servicing visit on Ronne Ice Shelf*

Sledge Tango

Monitoring the Filchner-Ronne Ice Shelf open cavity at Site 5 (FISS: Filchner Ice Shelf System)

(KEITH NICHOLLS), [Field Guide*]

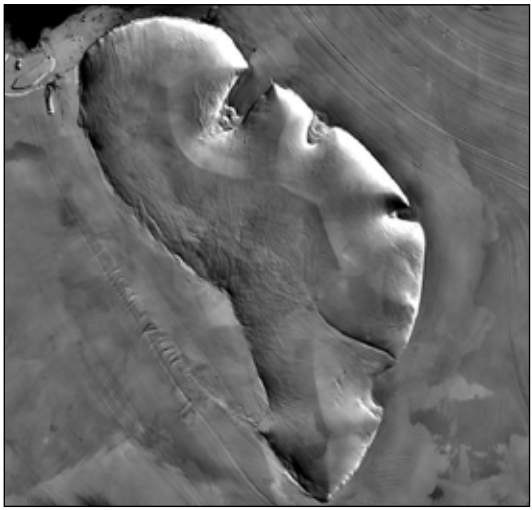
Location: Site 5, Berkner Island

Timing: Opportunistic throughout the season

More information: *https://www.bas.ac.uk/project/fiss*

In the 1998/99 field season BAS made an access hole at Site 5 (off the south-west Berkner Island coast). Oceanic data were collected for four years and showed a water column highly sensitive to the ocean forcing from the ice front some 400km distant. The site was revisited in the 2014/15 season, three access holes were made, forming a triangle some 5km along each side, and the water column instrumented at each location. The aim was for the instruments to last for up to ten years. The site needs to be revisited every two years to raise the loggers, batteries and solar panels, the next visit being needed in 2018/19.

The results so far have shown a distinct annual cycle, with an inter-annual signal superimposed. The inter-annual signal is very significant, it shows how the entire southern Weddell Sea continental shelf is responding to changes in the regional climate. If the flow of water past Site 5 increases overall, the chance of warmer waters getting beneath the ice shelf reduces. If the flow reduces, the chance of warmer water gaining access to the ice shelf increases. The flow at Site 5 is significantly lower than during the early years of the century, but is now showing hints of a possible recovery.



▲ *Satellite image of Berkner Island*

Sledges Uniform and Victor

The lost meteorites of Antarctica

GEOFF EVATT, Katherine Joy, Julie Baum*

Location: Halley, Sky-Blu and Whichaway Nunatak

Timing: January to February 2019

More information: *https://ukantarcticmeteorites.wordpress.com*

To continue advancements in our understanding of the Solar System, large numbers of all classes of meteorite must be recovered and analysed. Antarctica's ice dynamics produce highly-concentrated and localised meteorite stranding zones. Yet the inherent complexities of visiting these zones means collection missions are few. Crucially, all of the past missions have followed similar collection protocols, which seems to have led to the significant under-representation of iron-based meteorites.

Recent laboratory and mathematical modelling work has shown that missing iron meteorites are likely to lie hidden a few centimetres below the surface of the meteorite stranding zones, just out of sight of surface searches.

Funding by the Leverhulme Trust has been granted to the team to test this hypothesis. This season, the team will conduct two preliminary missions. The first is an equipment field trial at Sky-Blu. The second will visit a selection of blue ice areas in the Whichaway/Argentina/Recovery Basin regions, to see which of them also operate as meteorite stranding zones. This mission will hopefully bring back the UK's first ever dedicated haul of Antarctic meteorites. Informed by these two preliminary missions, a mission to explicitly search for a hidden layer of meteorites will commence in 2019/20.

▲ *A field trial in Svalbard (Arctic)*

Sledge X-ray

University of Utrecht IMAU Automatic Weather Station in the Antarctic

(WIM BOOT, CARLEEN REIJMER, MICHIEL VAN DEN BROEKE), Mairi Simms, John Law

Location: Larsen B and Larsen C Ice Shelves

Timing: Opportunistic throughout the season

More information: *https://www.projects.science.uu.nl/iceclimate/aws*

In close collaboration with BAS, UU/IMAU operates Automatic Weather Stations at two sites in the Antarctic Peninsula which are serviced each year by BAS personnel from Rothera. These are part of a project started in 2009 with the overall aim to investigate the changing climate over the Larsen C Ice Shelf. The stations are equipped with sensors to measure temperature, humidity, wind speed and direction, air pressure, snow accumulation, short-wave incoming and reflected radiation, long-wave incoming and outgoing radiation, and snow temperature. With these observations it is possible to calculate the amount of melt and study the changing snow conditions on the ice shelf.

AWS14 is situated on Larsen C Ice Shelf, close to the former BAS 'Larsen C' AWS site. The station has been operational since January 2009 and was updated in 2017 to the latest unit. AWS18 is also situated on Larsen C, in Cabinet Inlet. The station was installed in December 2014, and although originally planned for a single year of operation (MIDAS project), the station is still operational. In the 2018/19 season, data will be collected and the units will be swapped, which is standard maintenance procedure.

▲ *Maintenance of the IMAU iWS on Cabinet Inlet, Larsen C (AWS18) in January 2017*

▲ *Close up of the sensor yard with on the left the radiation sensors, in the middle the wind speed and direction sensor, and on the right the iWS unit which includes all other sensors except snow temperature*

iBEAM

iBEAM traverse

Tim Gee, Steve Pollitt, Nick Gillett*, Rob Grant*, Fran Pothecary*, Mark Scales* [and others]

Location: Ronne Ice Shelf

Timing: Mid-December 2017 to late-February 2018

The iBEAM traverse will be working in a logistics set-up this season, and will be assisting with the set-up of the BEAMISH drilling camp and input of the WACSWAIN team. Once this tasking is complete, the iBEAM team will depart for Sky-Blu where, on arrival, maintenance work will be undertaken on the equipment, fuel will be collected and snow management work will be completed on the Sky-Blu runway and around camp for a period of around one week.

The team will then depart Sky-Blu in early December heading for the English Coast/Ronne Inlet and start preparations for the arrival of RRS *Ernest Shackleton* and HMS *Protector*. Between these two vessels around 400m^3 of fuel, along with 100 tonnes of breakbulk cargo and vehicles from the UK and USA programmes will be unloaded. This cargo and fuel is the first input and start of the International Thwaites Glacier Collaboration, between NERC and NSF around the Thwaites Glacier region. Cargo and fuel will unloaded from the ship for around two weeks. Once the ship departs we will move all equipment to a staging point referred to as SB9, where the majority of the fuel and cargo will get stored for use in the 2019/20 season. This will involve four 480km round trips between SB9 and the Ronne Inlet, moving the equipment away from a high snow-accumulation area. To achieve this the traverse team will be working 24-hour operations during January.

Once all the equipment is at SB9 we will begin the first run of cargo into the lower Thwaites Glacier region, taking in cargo for three of the larger projects within the Thwaites campaign. This will make a depot with around 50m^3 of fuel and 25 tonnes of cargo, which will become a key staging point during the project in 2019/20 season of the Thwaites campaign. Once this is complete, the vehicles and team will drive back up towards SB9 to winterise the equipment and await pickup around the end of March.

▲ *Piston bulleys and a caboose during a recent Antarctic traverse*

ORCHESTRA

ORCHESTRA airborne science (MASIN)

TOM LACHLAN-COPE, Russ Ladkin, Alex Wiess

Location: Southern Ocean (flying from Falkland Islands)

Timing: 2018/19 season

More information: *https://www.bas.ac.uk/project/orchestra*

The Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) project will span five years and use a combination of data collection, analyses, and computer simulations to radically improve our ability to measure, understand and predict the circulation of the Southern Ocean and its role in global climate. It will make unique and important new measurements in the Southern Ocean using a range of techniques, including use of RRS *James Clark Ross* and RRS *Sir David Attenborough*, as well as deployments of autonomous surface and underwater vehicles, the BAS meteorological aircraft, and other innovative techniques for collecting data. It will also involve the development and use of advanced ocean and climate simulations, to improve our ability to predict climatic change in coming decades.

During the 2018/19 season, a BAS Twin Otter fitted with atmospheric instruments will fly from the Falkland Islands over the Southern Ocean. The flying will be coordinated with two ORCHESTRA cruises. We will be measuring the exchange of energy and CO_2 between the ocean and atmosphere in order to better understand the processes that drive the climate over the Southern Ocean and to improve the parameterisation of these processes in climate models.

▲ *During the ORCHESTRA fieldwork, combined observations of turbulent fluxes with the Twin Otter science equipment and the JCR turbulent mast are planned*

Thwaites

International Thwaites Glacier Collaboration

JO JOHNSON, ROB LARTER, KEITH NICHOLLS, ANDY SMITH, Tim Gee [and others]

Location: Thwaites Glacier region

Timing: Antarctic summer seasons 2018 to 2023

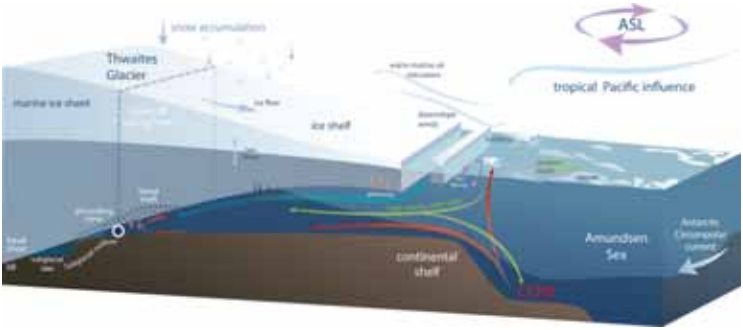
More information: *https://www.bas.ac.uk/project/international-thwaites-glacier-collaboration*

NERC and the NSF are co-funding a research programme which aims to substantially improve both decadal and longer-term (century-to multi-century) projections of ice loss and sea-level rise originating from Thwaites Glacier in West Antarctica.

Considerable uncertainty remains in projections of future ice loss from West Antarctica. Since the 1990s, satellites have shown accelerating ice loss driven by ocean change in five neighbouring glacier catchments, including Thwaites Glacier, that drain more than one third of the West Antarctic Ice Sheet (WAIS). The rate of ice loss there doubled in six years and now accounts for about 10% of global sea-level rise. The most rapid ice loss is currently from Pine Island Glacier, which has been the focus of the NERC Ice Sheet Stability Programme and National Science Foundation (NSF) funded science. Recent studies indicate the greatest risk for future rapid sea-level rise now arises from Thwaites Glacier.

Warm ocean water from the Amundsen Sea circulates under the ice, causing it to melt. Melting loosens the ice from the bedrock below, causing it to flow faster and eventually to retreat into the deeper and thicker ice areas where it is likely to speed up still more.

Starting in 2018, and over the next five years, teams of scientists will explore the ocean and marine sediments, measure currents flowing toward the deep ice, and examine the stretching, bending, and grinding of the glacier over the landscape below. The project will involve more than 60 scientists and students. During this 2018/19 season, equipment and supplies for the following four years of fieldwork will be input to Thwaites via a combination of ship (RRS *Ernest Shackleton* and HMS *Protector*), air and tractor traverse (see iBEAM traverse). Additionally an aerogeophysical survey of Thwaites Glacier will map the area to enable future fieldwork (see Sledge Deltas).



▲ *Multiple factors affect the glacier, such as snow, winds, calving fronts, Circumpolar Deep Water (CDW), and the Amundsen Sea Low (ASL)*

INTERNATIONAL THWAITES GLACIER COLLABORATION

Rothera Research Station

Adaptations marine project

MELODY CLARK, LLOYD PECK

Timing: January to February 2019

More information: *https://www.bas.ac.uk/team/science-teams/biodiversity*

We all know that in humans, lifestyle influences how fit you are, how you cope with different situations and your response to illness etc. The same is true of animals in the sea, such as marine snails, limpets, clams and starfish. Our project is going to evaluate how two different lifestyle factors critically affect an animal's ability to respond to climate change. We will look at how the type of reproduction affects dispersal of animals and gene flow between different populations and how longevity impacts responses to change, via changes in an animal's DNA. The reproductive study is a European collaboration, funded by the German Government (DFG).

These projects relate to the Grand Challenge of 'Polar Change: understanding animals' responses to climate change and the identification of thresholds that might have irreversible impacts *(https://www.bas.ac.uk/science/our-research/our-strategy/our-grand-challenges/grand-challenge-1-polar-change)*.

This also relates to one of our team priorities: 'Species resilience to environmental change: Discovering how organisms react and respond to changing environmental conditions, and how their polar adaptations could be an advantage or disadvantage in a warming world'.

▲ The salt-water clam *Laternula*

▲ *Liothyrella uva is an Antarctic brachiopod*

Rothera Research Station

Aliens in the polar regions: impacts of invasive species and invasion engineers on Arctic and Antarctic terrestrial ecosystems

(REIN AERTS), Stef Bokhorst, Hans Cornelissen

Timing: January to February 2019

A lot of effort and money is being spent on limiting alien invasions and eradication and mitigation programs in the Arctic and Antarctic regions. Given the ever-increasing anthropogenic activities and ongoing rapid climate warming in parts of the Polar Regions, it is unavoidable that alien species will reach these ecosystems, as some already have. However, we currently do not know what the impacts of these species will be for polar terrestrial ecosystems, despite the vital roles and services these ecosystems play in regional and global processes.

This project aims to quantify and measure the impact of alien species on Arctic and Antarctic terrestrial ecosystems. This knowledge will add focus and impetus for efforts to restrict alien species from reaching the polar regions, and in particular those biological groups with the largest ecosystem impacts. Furthermore, we recognise that there are both native and alien species whose ecosystem contribution can facilitate the invasion success of other new arrivals, for instance by providing shelter (e.g. tall shrubs) or nutrients (e.g. penguins). Identifying such 'invasion engineers' and their roles will greatly help in pin-pointing and identifying particularly vulnerable areas where alien species are likely to be successful, and provide key data on the functioning of polar ecosystems.

▲ *Artificial plant on Anchorage Island*

Rothera Research Station

Benthic species interaction in Antarctica – shedding light on food web dynamics in a pristine marine ecosystem

(DAVID BARNES, SIMON MORLEY), LLOYD PECK, Nadescha Zwerschke

Timing: December 2018 to March 2020

More information: *https://www.bas.ac.uk/team/science-teams/biodiversity*

Shallow subtidal communities on the West Antarctic Peninsula are adapted to living in a hostile and extreme environment. The biodiversity and species distribution in these habitats is broadly known, however it is unclear which species interact and how. Interactions could exacerbate or reduce the effects of environmental stresses such as iceberg scour and low light availability. This project aims to gain a better understanding of how species interactions alter existing food web dynamics (who eats who, when and where).

Researchers aim to identify some species interactions and measure their impact on the overall community. This involves diving to collect samples and taking photos and transects. The team will measure abundance, density, biomass, reproduction potential as well as using stable isotope analysis to look at places of specific species in the food web in different habitats.

▲ *Benthic Antarctic community sessile species competing for space and offering 3D structure to mobile consumers and additional substratum to smaller sessile species*

Rothera Research Station

Ecology and biodiversity of seaweeds in inshore Antarctic benthic communities

(SIMON MORLEY), Aurelia Reichardt

Timing: December 2017 to March 2019

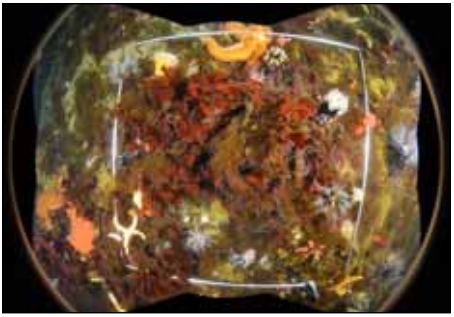
More information: *https://www.bas.ac.uk/team/science-teams/biodiversity*

This project will provide unprecedented, new insight about the ecology and biodiversity of seaweed-dominated benthic communities at Rothera (Adelaide Island, Antarctica). In shallow ecosystems, seaweed can form the base of the food web as well as provide a habitat and nursery for many marine species. Having a baseline understanding of the importance of seaweeds now, and how they survive through the extreme change in light from summer to winter, will help us to predict how climate change will affect them, and the communities that rely on them, into the future.

Year-round diving surveys will be used to assess biodiversity patterns of key species and communities, and record how they change with depth. They will also show what invertebrate species are associated with each seaweed species, how these vary throughout the year and provide an understanding of the grazing rates in summer and winter.

Aquarium-based experiments and laboratory analysis will be used to study how Antarctic seaweeds are adapted to their environment, particularly how they manage to spend more than six months a year in darkness.

This work is complimentary to the BAS Rothera Marine LTMS.



▲ *Typical seabed assemblage of seaweed and marine animals at Rothera*

▲ *Diver collecting seaweeds*

Rothera Research Station

Metabolic characteristics of polar diatoms

MELODY CLARK, Sam Coffin

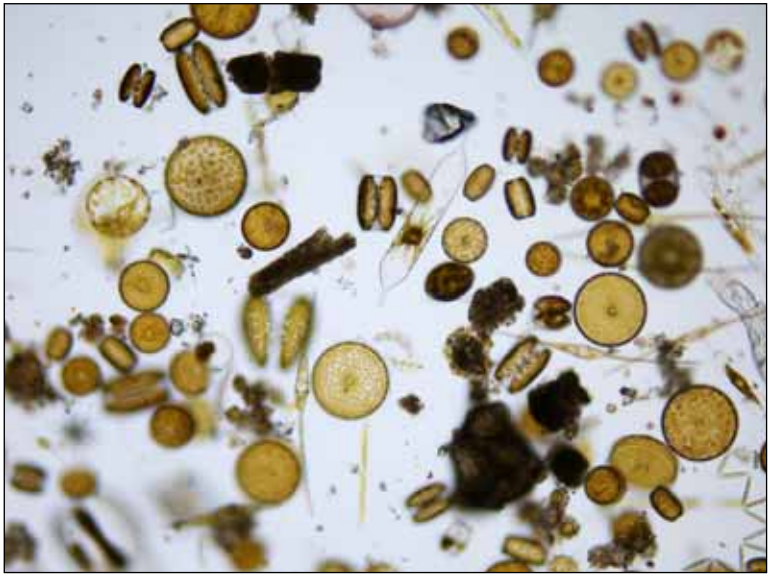
Timing: January to March 2019

More information: *https://www.bas.ac.uk/team/science-teams/biodiversity*

Diatoms are single-celled, photosynthetic microalgae which are unique in having a silica cell wall. They are responsible for a large proportion of global primary productivity and support food webs in the Polar Regions.

Using existing strains and fresh strains of polar diatoms, this project will provide insight into the local adaptations of polar diatoms focusing on their metabolism, whilst also isolating new strains or species of polar diatoms. Studying the metabolic adaptations of polar diatoms to their extreme environment will improve our knowledge of how diatoms may be impacted by a changing environment. Understanding these adaptations will also provide an insight into what potential polar diatoms have in biotechnological applications.

This season, new strains of polar diatoms will be isolated to establish cultures which will then be analysed in Cambridge.



▲ *A natural diatom assemblage (Image courtesy of Jack Dickenson, The Marine Biological Association of the United Kingdom)*

Rothera Research Station

Monitoring of south polar skuas at Rothera

(KEVIN HUGHES, RICHARD PHILLIPS), Ali Massey

Timing: December 2018 to March 2019

More information: *https://www.bas.ac.uk/project/skua-monitoring-at-rothera*

Rothera Point has been the site of a BAS research station since 1975. Since the construction of the first hut, the station has grown in size and now is the largest British research facility in Antarctica with accommodation for up to 140 people.

Under the UK Antarctic Act, and the Environmental Protocol to the Antarctic Treaty, BAS are obliged to undertake environmental monitoring of its impacts on the natural environment. Antarctic Specially Protected Area (ASPA) 'No. 129 Rothera Point' was specifically designated to act as a pristine control site on Rothera Point so that comparisons with impacted sites could be made.

Up to 25 pairs of skuas nest on Rothera Point including within the ASPA, where the skuas have been studied to some extent since the late 1990s.

The breeding parameters that are recorded include laying dates, clutch size, egg dimensions, hatching success, fledging success, chick condition and adult attendance (which provides an index of foraging effort). In addition, since the 2007/08 season, monitoring has included re-sighting of colour-ringed adults, which can be used to estimate adult survival, breeding frequency and divorce rates, and to determine the breeding histories of individuals and the effects of mate change.

▲ *A ringed brown skua (Catharacta antarctica) at Rothera Research Station*

Rothera Research Station

Monitoring the introduction of biofouling organisms to Antarctica on vessel hulls

(KEVIN HUGHES, Arlie McCarthy), [Rothera Marine Team]

Timing: Opportunistic throughout 2019/20 summer season

More information: *https://www.bas.ac.uk/team/operational-teams/operational-support/environment-office*

Few reports exist that describe marine non-native species in the Southern Ocean and near-shore waters around the Antarctic continent. Antarctica's isolated marine communities are specifically adapted to their environment and may be vulnerable to invasion by human-introduced species via vessel hull biofouling. Hull surveys of RRS *James Clark Ross* have been undertaken since 2007 at Rothera Research Station to investigate levels of vessel biofouling.

Increasing ship traffic volumes and declining duration of sea ice to the north and west of the Antarctic Peninsula mean the region may be at increased risk of non-native species introduction. This project aims to provide data on vessel biofouling to quantify the risks and inform management action. Hull surveys undertaken by divers at Rothera Research Station will provide data on which parts of the hull are colonised and by which biofouling species.

▲ *Goose barnacles removed from intake ports on the hull of RRS James Clark Ross*

▲ *RRS James Clark Ross alongside the Biscoe Wharf at Rothera Research Station*

Rothera Research Station

Polar marine viral diversity and dynamics

(CORINA BRUSSAARD), Nisma Abdelmalik, Gonçalo Piedade, Ella Wesdorp

Timing: November 2018 to March 2019

More information: *https://www.nioz.nl/en/research/projects/4333-2*

Nowhere are the effects of climate change more evident than at the poles of our planet. Polar marine microorganisms (bacteria and phytoplankton) play vital roles in the global cycling of important elements and form the base of the food web. Our preliminary results indicate viruses kill Antarctic microorganisms at rates comparable to grazing (traditionally dominant loss factor), but their identity is largely unknown. To know the identity of the viruses infecting the ecologically relevant microbial groups is critical to ultimately develop predictive models and prepare for living on a changing planet.

Climate change-induced shifts in microbial species composition and their specific viruses can be expected to affect nutrient and energy flux, and therefore ecosystem functioning. The overall aim of this project is to elucidate the thus far hardly studied polar marine viral diversity, and relate viral diversity to the activity and host range of viruses. New technological developments allow us to obtain new insights into the diversity and temporal dynamics of viruses in Antarctic and Arctic waters, and relate our findings to viral lysis rates and host community dynamics. Together, our project will reveal much-needed knowledge about the viruses that drive biodiversity and microbial turnover in both the polar seas.

▲ *Ryder Bar, Rothera Research Station*

Rothera Research Station

RaCETraX (Radium in Changing Environments)

AMBER ANNETT

Timing: December 2018 to February 2109

More information: *https://www.southampton.ac.uk/oes/research/projects/radium-in-changing-environments.page#project_overview*

Along the western Antarctic Peninsula, 87% percent of glaciers have retreated in the past ~60 years. The increasing flux of glacial meltwater delivers both dissolved and particulate material, which have different impacts on the surrounding ecosystem. Meltwater supplies dissolved nutrients and trace metals, but flux of fine particulate material can negatively affect benthic organisms. However, little is known about the delivery, distribution and fate of this dissolved and particulate matter.

The proposed study will use naturally-occurring radium (Ra) to assess the seasonal pattern of glacial fluxes of dissolved and particulate material to the nearshore environment. Radium isotopes are produced from decay of thorium in lithogenic material, and are effective tracers of coastal inputs as each isotope decays at a different rate. I have previously used Ra isotopes to assess water-mass ages and mixing rates in central Ryder Bay, and this new work will characterise meltwater and sediment end-members, to quantify the relative importance of each of these sources. Trace metal and nutrient fluxes from underlying sediment will assess the effects of particulate delivery to benthic organisms. This complements a UK-Chile initiative evaluating the impact of deglaciation on Antarctic benthic ecosystems by providing temporal context to a multi-year spatial study.

▲ *Collecting seawater for radium analysis in Ryder Bay*

▲ *Processing cores for sediment fluxes via the RaTh disequilibrium method*

Rothera Research Station

Rothera oceanographic and biological Time Series (RaTS)

(DAVE BARNES, MIKE MEREDITH, HUGH VENABLES), Marlon Clark, Zöe Waring

Timing: 1997 to present (ongoing)

More information: *https://www.bas.ac.uk/project/rats*

The Rothera Time Series (RaTS) is a unique, long-term study measuring year-round ocean properties including temperature, salinity, nutrients and chlorophyll in Ryder Bay, by Rothera Research Station. For more than 20 years, measurements have been taken several times per week using small boats or – if the bay is frozen – sampling through holes in the ice.

A full depth cast (500m) is undertaken using a hand winch and then water samples are taken from 15m for analysis in the Bonner Laboratory and to be distributed to scientists in the UK and the Netherlands.

Ryder Bay is very sensitive to winter sea-ice variability and is the main site on the Antarctic Peninsula from which systematic winter-time measurements are obtained. We have been able to see how winter changes feed through to changes in the summer in both the scale of the phytoplankton bloom (amount of plant growth) and the uptake and release of heat and carbon by the ocean.

The programme is funded by NERC as National Capability Science. Data supports a wide range of research by UK and international collaborators, including many PhD students.

▲ *Preparing to deploy the CTD*

▲ *Scuba diving for sample collection*

Halley VI Research Station

Clean Air Sector Laboratory

(NEIL BROUGH, ANNA JONES), Thomas Barningham, Sabino Del Vento, Josh Eveson, David Goodger

Timing: 2018/19 season

More information: *https://www.bas.ac.uk/polar-operations/sites-and-facilities/facility/halley/clean-air-sector-laboratory-caslab*

This season sees the resumption of a range of experiments at the Clean Air Sector Laboratory (CASLab) and the continuation of key scientific monitoring data sets throughout the Antarctic winter. Following its successful relocation last season the power and network link will be restored, returning the lab to functionality.

Tropospheric ozone

Last year, we established a low power field unit to measure tropospheric ozone. These measurements help us to understand the mechanisms of reactive chemistry in the seasonal sea-ice zone. This year, we will supplement these measurements with a higher-power, laboratory-based TEi 49i ozone monitor that will provide a higher temporal frequency and more precise data set.

BAS data feeds into the World Meteorological Organisation Global Atmospheric Watch Programme.

Sea-ice emissions chemistry

We will be trialling our MAX-DOAS instrument to run over the winter period unattended. This is a spectrophotometer that primarily measures reactive halogen oxides (IO and BrO) emitted from the seasonal sea-ice zone, and hence contributes to our understanding of the chemical mechanisms of ozone depletion events.

Aerosol loading

Throughout the summer period we will collect a number of high and low volume filter samples as part of a wider programme to understand the chemical composition and quantity of aerosols and their impact on the atmosphere's albedo – a key measurement in our calculation of the radiation balance of the planet.

Greenhouse gas observations of CH_4 and CO_2

As part of the Halley Automation Project, we have developed an autonomous system centred on the Picarro instrument, to measure atmospheric methane (CH_4) and carbon dioxide (CO_2) mole fraction. This is an international collaboration with the Alfred Wegner Institute's (AWI) Neumayer Station III that contributes to two NERC-funded projects; the SONATA-RoSES programme, that assesses the current state of the Southern Ocean carbon cycle; and also the MOYA project, aimed at improving quantification the global budget of atmospheric methane.

▲ *The relocation of the CASLab at the Halley VIa site*

Halley VI Research Station

Future pinning of the Brunt Ice Shelf from seabed bathymetry and recent grounding history

(DOMINIC HODGSON, JAMES SMITH)

Timing: January 2019

More information: *https://www.bas.ac.uk/project/brunt-ice-shelf-movement*

A significant calving event is imminent at the Brunt Ice Shelf as Chasm 1 approaches the McDonald Ice Rumples. The future of the ice shelf depends on the trajectory of Chasm 1. If it progresses upstream of the McDonald Ice Rumples (MIR), the ice shelf could become structurally detached from the bed. The alternative is that Chasm 1 progresses downstream of the pinning point at the ice rumples, the ice shelf remains in contact with the bed, and retains its structural integrity. We have two aims:

- To make direct measurements of the thickness of the ice shelf and depth to the bed in a transect away from the MIR to calibrate existing radar and bathymetry data
- To take a series of sediment cores along the transect to examine the history of ice-shelf grounding at the ice rumples. Here we use the onset of biogenic sedimentation in the cores and examine the sedimentary facies that are diagnostic of the presence/absence of past ice-shelf grounding. These will provide scientific evidence for an assessment of the future stability of the ice shelf and its infrastructure

▲ *Chasm 1 in the Brunt Ice Shelf, Antarctica*

Halley VI Research Station

Glaciological monitoring of the Brunt Ice Shelf

(OLIVER MARSH, DAVID VAUGHAN), Dominic Hodgson, Jaskiran Nagi, James Smith, Ralph Stevenson-Jones

Timing: 2018/19 season

More information: *https://www.bas.ac.uk/project/brunt-ice-shelf-movement*

The Brunt Ice Shelf is the most closely and thoroughly observed ice shelf on Earth. A network of 17 GPS instruments measure the deformation of the ice shelf every day. European Space Agency satellite imagery (Sentinel 2), NASA Worldview satellite images, US Landsat 8 images, ground-penetrating radar, and on-site drone footage provide key information on any growth of the cracks.

A significant early warning system used by BAS to inform BAS Operations is the innovative ApRES (Autonomous phase-sensitive Radio Echo Sounder) system developed by BAS in collaboration with University College London to monitor ice shelf changes. This radar measures precisely the width of Chasm 1 every two hours and is used to inform daily operations on the Brunt Ice Shelf. In 2012, satellite monitoring revealed the first signs of growth in a chasm (Chasm 1) that had lain dormant for at least 35 years. In October 2016, a new crack was detected some 17 km the north of the new location of Halley Station, known as 'Halloween Crack'. It has continued to widen, but has not yet released the expected iceberg.

▲ *Checking the data recording during a GPR survey on the Brunt Ice Shelf*

Halley VI Research Station

Halley Automation Project

(THOMAS BARNINGHAM, JOE MEDDLE, MIKE ROSE), [Halley Automation Project Team]

Timing: 2017 to 2020

More information: https://www.bas.ac.uk/project/halley-automation

This innovative, multi-year project aims to provide a micro-turbine power supply and datalink to a suite of autonomous scientific instrumentation around Halley VI Research Station and on the Brunt Ice Shelf. This system will enable data collection throughout the Antarctic winter when the station may be unoccupied.

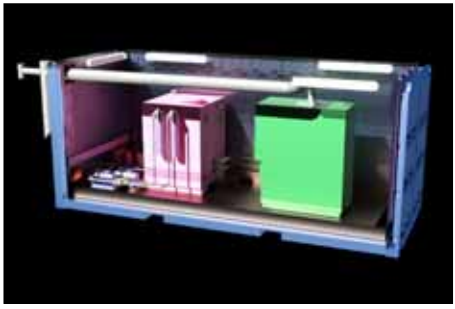
Low power systems

The automation of experiments requiring low power (12V) is straight-forward and represents tried and tested field-based systems that are in use across Antarctica. Several experiments are automated already as part of normal station operations and will be maintained as part of this project.

High power system

Automation of experiments requiring high power (230V) needs a power generation system that can be fuelled autonomously and run without servicing for a minimum of nine months. The aim is to deploy a containerised generator unit (Capstone C30 micro-turbine) with an autonomous fuelling system. Remote sensing and IT infrastructure will provide technology teams with information about how the micro-turbine is operating: A data link to the system between Halley and Cambridge will allow some remote control, whilst passive monitoring measures will enable Cambridge-based engineers to track the performance of the micro-turbine and the associated fuelling system throughout the winter.

▲ *Automatic Weather Stations already operate with a low power solution*



▲ *A plan of the micro-turbine container*

Halley VI Research Station

Meteorology and ozone monitoring

(STEVE COLWELL), Thomas Barningham, Sabino Del Vento, Josh Eveson, Ross Sanders

Timing: 2018/19 season

More information: *https://www.bas.ac.uk/project/meteorology-and-ozone-monitoring*

We have three Automatic Weather Stations on the Brunt Ice Shelf, two of which are on the station which maintain the Halley long-term climate record (see Sledge Alpha for more information). Long-term meteorological and ozone observations and data help determine the causes of climate change in the Polar Regions.

Stratospheric ozone measurements

This year a second Dobson spectrophotometer will be set up to make automated ozone observations. It will run independently of station power.

Stratospheric ozone shields the Earth's surface from more than 90% of harmful solar ultraviolet radiation. The Antarctic Ozone Hole was discovered in 1985 by BAS scientists using Halley's unique data set of Dobson spectrophotometer observations which now spans 60 years. Maintaining these observations, at Halley and elsewhere, is crucial to monitoring the slow recovery of stratospheric ozone following the banning of CFCs.

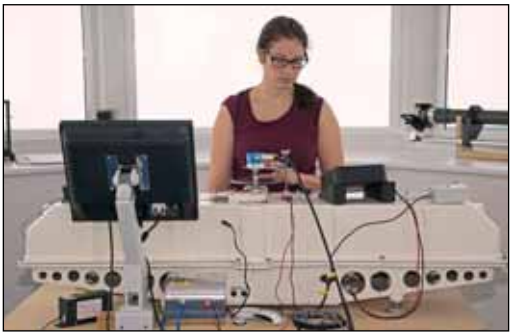
Radiosonde launches

This year, as part of the International Year of Polar Prediction *(http://www.polarprediction.net)*, we will also be launching two radiosonde balloons per day. These radiosondes measure temperature, humidity, wind speed and wind direction from the Earth's surface, through the troposphere (10km) and high up into the stratosphere (~25km). Each set of measurements provide a snapshot of the state of the atmosphere above Halley at the time of the launch. This information is then fed into global weather forecasting models.

Sampling campaigns

We also carry out several sampling campaigns throughout the season that include:

- Air sampling using glass flasks that are then analysed by the US National Oceanic and Atmospheric Administration (NOAA) for a range of greenhouse gases and atmospheric pollutants (running since 1986)
- Snow sampling that is then melted down for water samples. These are sent to the IAEA-WMO Global Network for Isotopes in Precipitation (GNIP) which has been in operation since the 1960s and is comprised of hundreds of observation stations located around the world



▲ *The Dobson spectrophotometer at Halley VI Research Station*

Halley VI Research Station

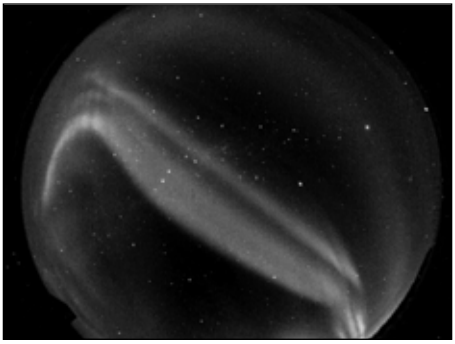
Optical – All-sky camera

(TRACEY MOFFAT-GRIFFIN), David Goodger

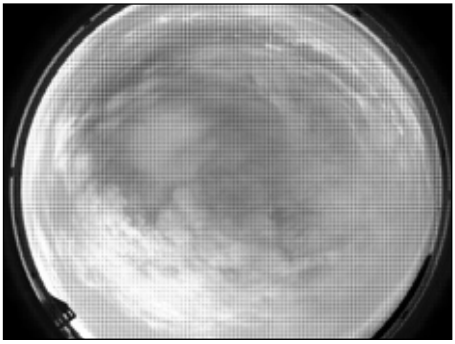
Timing: 2006 to present (ongoing)

More information: *https://www.bas.ac.uk/polar-operations/sites-and-facilities/facility/all-sky-camera-black-and-white*

This instrument takes regular, visible light images of the sky using a fisheye lens. This data is used to determine the cloud cover levels at a given site. It is normally used to aid the analysis of mesopause (upper middle atmosphere, 87km altitude) airglow spectra measurements (cloud = poor airglow spectra) which are used to calculate mesopause temperatures. It also can be used to observe aurora. This instrument is being deployed to Halley this coming season and has been adapted by the BAS engineering team so that it can run through the winter.



▲ *The aurora australis*



▲ *A cloudy sky means poor airglow spectra*

Halley VI Research Station

Space weather programme – electromagnetic quiet area

(MARK CLILVERD, RICHARD HORNE, MERVYN FREEMAN), Jaskiran Nagi, Ross Sanders, Ralph Stevenson-Jones

Timing: 2018/19 season

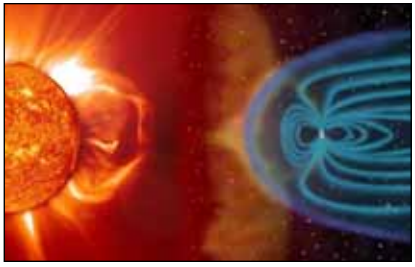
More information: *https://www.bas.ac.uk/project/national-capability-space-weather*

The space weather observatory programme is designed to understand how solar variations affect the Earth's space radiation environment, upper atmosphere and climate in the Polar Regions.

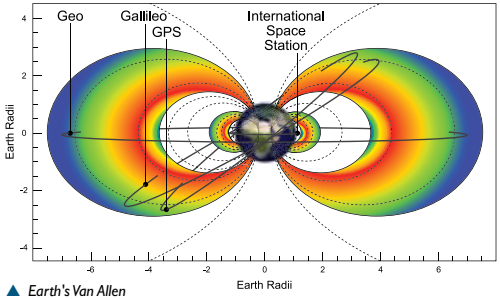
Sensitive instruments within the Electro Magnetic Quiet Area (EMQA) at Halley detect very slight disturbances in the Earth's magnetic field and variations in one of the uppermost layers of our atmosphere – the ionosphere. This year, as part of the Halley Automation Project we aim to run the following experiments:

Search coil magnetometer

The Halley and Rothera search coil magnetometers are part of an international network of magnetometers called MICA-S (Magnetic Induction Coil Array – South). These instruments are designed to measure ultra-low frequency waves generated in space by natural processes during geomagnetic storms and other active periods driven by solar disturbances. We want to find out more about the impact of these waves on the Earth's radiation belts. By making measurements over a network of instruments at different locations we can get a better information on where the waves originate, where they propagate to, and thus gain a better understanding on the region in space where they deplete the Earth's radiation belts.



▲ *The solar wind pushing on Earth's magnetic field (Image: NASA)*



▲ *Earth's Van Allen radiation belts*

Fluxgate magnetometer

This instrument measures perturbations in the Earth's magnetic field caused by electrical currents in the ionosphere and beyond. Periods of particularly large and variable magnetic perturbations are known as magnetic storms during which electrical power distribution networks across the globe, such as the National Grid, can be disrupted or damaged.

Halley VI Research Station

Space weather programme – electromagnetic quiet area (continued)

As part of the Halley Automation Project we also run three low power, Very Low Frequency (VLF) wave receivers. These instruments provide back up to two of our higher power experiments, known as AARDDVARK and VELOX.

The Halley VLF receiver listens to very low frequency radio waves as part of several networks of receivers located all over the Polar Regions. The data gathered by these networks are used by more than 35 institutions around the world to record and map, in real-time, lightning strikes around the world. This technique uses the upper atmosphere as a gigantic energetic particle detector to find out about:

- Interactions between our atmosphere and solar flares, solar eclipses, explosions on other stars, and particles effects from the solar wind – the aurora (AARDDVARK instrument – University of Otago, New Zealand)
- Record electromagnetic waves from space – these waves are responsible for the harsh conditions for satellites as they orbit through the Van Allen Belts (VELOX instrument – BAS, Space Weather Observatory)
- Record and analyse whistling tones originating from lightning in America – this inputs into space weather models used to protect satellites from the harsh radiation environment of space (AWDA instrument – University of Eotvos, Budapest, Hungary)

▲ *The Halley VLF receiver*

MOSAIC

The Mesospheric Ozone Spectral Analysis Instrument Chain (MOSAIC) is a chain of spectrometers running from pole to pole at about the longitude of Europe/Africa. The chain is a joint collaboration between the Massachusetts Institute of Technology, Lancaster University, the South African National Space Agency, and the British Antarctic Survey. This experiment will map the concentration of high altitude ozone from pole to pole and identify the changes caused by space weather.

The instrument is a passive, low cost spectrometer for detecting ozone at altitudes of ~100km (about the same height as the aurora). The instrument uses a satellite TV dish and a low noise block converter (LNB) to monitor the line radiation generated by ozone in the mesosphere. By fitting the shape of the ozone line radiation very accurately we can determine the concentration of ozone with altitude, especially from 50-100km altitude. At these high altitudes the concentration of ozone is affected by chemical reactions induced by energetic particle impacts on the atmosphere, such as those that cause the aurora.

Halley VI Research Station

The lost meteorites of Antarctica (see Sledges Uniform and Victor)

(GEOFFREY EVATT, KATHERINE JOY), David Abrahams, Mike Rose

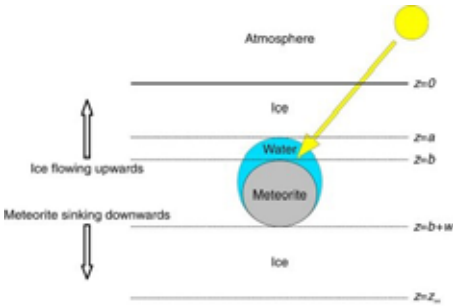
Timing: 2018/19 season

Location: Sky-Blu, Argentina North, Outer Recovery, Whichaways

More information: *https://ukantarcticmeteorites.wordpress.com*

Antarctica has contributed over 66% of the world's classified meteorite samples. This collaborative research project aims to collect evidence of how the Solar System formed and evolved through time. Fieldwork spans two seasons. During 2018/19, two separate activities will take place; Katherine Joy will visit target Meteorite Stranding Zones (MSZs) to confirm they do contain meteorites. Geoff Evatt and Mike Rose will visit Sky-Blu to test metal detection electronics, and the practicalities of towing a 5m-wide detector 100km+ by skidoo. This work will inform the following 2019/20 field season, when a full systematic search of several blue-ice areas between the Shackleton and Argentina range of mountains takes place. This is when the science team hopes to find the elusive buried iron rich meteorites as well as a greater number of 'normal' surface meteorites.

The remoteness of MSZs means collection missions are few (around one or two a year, with no UK missions to date). Modelling work has shown that missing iron meteorites are likely to lie hidden a few centimetres below the surface of the MSZs, just out of sight of surface searches. Definitive proof of the existence of this layer will help close this meteoritic mystery.



▲ *Iron meteorites are thought to lie a few cms below the snow surface*

▲ *Meteorite Stranding Zones (MSZs) are usually remote*

Bird Island Research Station

Bird Island marine predators Long Term Science (LTS)

RICHARD PHILLIPS, ANDY WOOD, Derren Fox, Claire Fraser, Rosie Hall, Elizabeth Morgan, Camille Toscani, Mark Whiffin

Timing: 2018/19 season

More information: *https://www.bas.ac.uk/project/higher-predators-long-term-science*

British Antarctic Survey carries out a Long Term Science (LTS) project that measures changes in Antarctic ecosystems and seeks to understand the underlying drivers and processes. Marine predators are sensitive to changes in the ecosystem, some of which are natural (e.g. climate variability), whereas others are caused by humans (e.g. fishing). Monitoring breeding populations of seabirds and seals is an important part of the LTS programme, providing scientists and conservationists with indicators of change in the Scotia Sea and elsewhere in the south-west Atlantic. These indicators include estimates of population size and trends, breeding frequency, reproductive success, and the composition of predator diets.

Scientists have carried out targeted research projects on most of Bird Island's breeding species over recent decades. Survival and breeding histories are recorded for wandering, black-browed and grey-headed albatrosses, northern and southern giant petrels, macaroni penguins, and Antarctic fur and leopard seals. BAS also monitors population size and breeding success of light-mantled albatrosses and gentoo penguins, and a range of other parameters that reflect annual changes in food availability in the wider environment.

These data help inform the regional conservation management authority for Southern Ocean fisheries, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

▲ *A grey-headed albatross on its nest*

▲ *Antarctic fur seals at Bird Island*

Bird Island Research Station

Fitness consequences of niche choice and conformance in a colonially breeding marine mammal: roles of the social environment, genetic quality and offspring behaviour

JAUME FORCADA, JOSEPH HOFFMAN, Claire Fraser, Rebecca Nagel, Camille Toscani

Timing: 2018/19 and 2019/20 summer seasons

For an organism or population, the niche describes how they respond to the environment, for example with changes in food supply and competitors. Under certain environmental conditions, it is expected that individuals select niches to which they are a good fit (niche choice), based on their physiology and behaviour; or they alter their behaviour or physiology to fit their niche (niche conformance). These alternative options however are poorly understood, despite having major implications for survival and reproduction (fitness) and adaptation to environmental change.

This project will study two neighbouring Antarctic fur seal colonies of high and low density of individuals respectively at Bird Island, South Georgia. Different densities can present opportunities and challenges to seal mothers and their pups. High density offers breeding females greater freedom to choose their mates, but also carries increased stress and offspring mortality. The consequences of maternal niche choice, offspring niche conformance and genetic quality will be evaluated by collecting biometric, behavioural, endocrine (hormones), immune, and genetic data from mother-offspring pairs followed from birth to weaning (approximately four months) equipped with radio-transmitters. This project will provide a novel evolutionary genetic perspective on the individualised niche, fitness variation and adaptation potential of a wild species.

▲ *High seal concentration colony at Bird Island*

Bird Island Research Station

Investigating behavioural cues in fur seals and macaroni penguins using acoustic recording tags

MARK JOHNSON, Claire Fraser, Rebecca Nagel, Camille Toscani, Pauline Goulet

Timing: November 2018 to April 2019

Efficient foraging is critical for central-place foragers that provision offspring on land via prey caught at sea. This is particularly true during the austral summer on Bird Island when breeding seals and penguins are competing for the same limited resource – Antarctic krill. Despite recent developments of biologging technologies, there is little information on how these animals find prey patches in the Southern Ocean. We developed new animal-borne tags which incorporate a passive acoustic sensor (hydrophone) synchronised with high-resolution movement and location sensors into a single, compact unit. They will be attached on breeding macaroni penguins and Antarctic fur seals when they go at sea to find food until they come back and provision their young.

The tags will be used to sample the marine soundscape around South Georgia waters and investigate how foraging Antarctic fur seals and macaroni penguins respond to acoustic cues. These data will be used to assess where animals find food and whether they use acoustic cues to find prey patches while avoiding predation and competition.

Such information will enhance our knowledge of predator ecology in the Scotia Sea and may ultimately help understand help understand why some populations are increasing while others are declining.

▲ *Antarctic fur seal with the tag attached*

Bird Island Research Station

Macaroni foraging limits on the north coast of South Georgia

(SOPHIE FIELDING, PHIL TRATHAN), Jessica Phillips, Victoria Warwick-Evans, [Bird Island penguin ZFA*]

Timing: January and February 2019

The project will track macaroni penguins from the northern coast of South Georgia, during the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) sponsored synoptic krill survey planned for 2018/19.

Tracking will be undertaken during the macaroni brood period in January. Tracking from Bird Island will coincide with the bio-acoustic surveys for krill which are collected during the standard Western Core Box (WCB) cruise which in 2018/19 will be undertaken by RRS *Discovery*. The acoustic data from the WCB will comprise the UK contribution to the synoptic krill survey. During the macaroni tracking work, individual animals will be fitted with a range of instruments, including GPS units, time-depth-recorder units, and video cameras. The data from the tracking instruments will provide details about the prey field used by macaroni penguins for comparison with the wider prey field in the vicinity of the colony. Analyses will be published in the peer-reviewed literature, but also submitted to the Government of South Georgia and to CCAMLR for use in management of the krill fishery.

▲ *A pair of macaroni penguins on Bird Island*

Bird Island Research Station

Reducing South Georgia albatross mortality in high seas tuna fisheries

ANDY WOOD, Derren Fox, Rosie Hall

Timing: November 2018 to April 2020

Albatrosses are one of the most threatened groups of birds in the world, and South Georgia's albatrosses are experiencing some of the steepest declines. In 2017, South Georgia's Albatross Conservation Action Plans identified the largest risk to these populations as being bycatch in fisheries outside South Georgia's waters. A project run by the RSPB and BAS identified Japanese and Taiwanese tuna fleets as posing the greatest threat.

This project is a partnership between British Antarctic Survey, RSPB and BirdLife International. It aims to increase compliance using independent data from Global Fishing Watch alongside educational 'stories' about the albatrosses of South Georgia.

At the start of the 2018/19 breeding season, BAS will set up a system through which the breeding progress of birds can be monitored, including remote cameras. Content will be sent to RSPB, where it will be turned into stories. These stories will then be translated by BirdLife and modified for a Japanese audience. Albatross cartoon characters will be created in-country, and associated materials developed for outreach. Social media will also be used to increase the audience, and will target not only tuna purchasers, and fishers but also the general public.

▲ *Wandering albatross (Diomedea exulans) engaged in courtship dance on Bird Island, South Georgia*

Bird Island Research Station

Winter diving behaviour in seals

IAIN STANILAND, Camille Toscani

Timing: April to December 2019

Whilst we have a wealth of data from South Georgia on predator foraging during the summer months we lack information from the winter time especially in terms of diving behaviour. Importantly this is when the krill and finfish fisheries operate in this region and thus the time when the greatest competition and interaction occurs. In addition, because of logistical difficulties, we also know very little about the distribution (vertical and horizontal) and behaviour of Antarctic krill in the winter months.

Preliminary data from fishing vessel sonar suggests krill may inhabit progressively deeper depths towards mid-winter which will affect their availability to air breathing predators such as seals and penguins. To address these knowledge gaps we will deploy biologging tags on female fur seals, on Bird Island, at end of the breeding season in order to measure their diving behaviour and foraging locations using light-based geolocation and time-depth recorders throughout the following winter. These data will allow us to measure the overlap with fishing activities in the region and identify changes in prey distribution especially in terms of depth in the water column. Such data will be used to measure foraging effort at a time of low food availability and inform fisheries management through CCAMLR.

▲ *An Antarctic fur seal (Arctocephalus gazella) underwater*

King Edward Point Research Station

Global Seismographic Station II.HOPE

JONATHAN BERGER, PETER DAVIS

Timing: 1996 to present (ongoing)

More information: *https://ida.ucsd.edu*

Project IDA is a global network of broadband seismometers operated by the University of California, San Diego. The team work with BAS to operate a permanent seismographic station at King Edward Point with funding from the US National Science Foundation and the IRIS Consortium. The station is part of a worldwide network of over 150 similar stations whose data are used for scientific investigations of the Earth's interior structure and the nature of earthquakes, as well as for hazard warning purposes related to earthquakes and tsunamis.

II.HOPE station is crucial for understanding patterns of seismic activity in the southern hemisphere, where seismic station density is much lower than in the north. Detailed investigation of pockets of earthquakes that often occur in the South Sandwich Islands would not be possible without data from the equipment at KEP. Similarly, high latitude stations such as II.HOPE enable scientists to address the question of whether the Earth's solid inner core is rotating faster than the rest of the planet. Data streamed from the station's sensitive instruments permit analysts to assess rapidly and accurately the potential for an earthquake to generate a deadly tsunami in time to warn affected communities in Chile and other regions.

▲ *King Edward Point Research Station on South Georgia*

King Edward Point Research Station

King Edward Point Geodetic Observatory (KEP-GO)

NORMAN TEFERLE

Timing: 2013 to present (ongoing)

The primary objective of the King Edward Point Geodetic Observatory (KEP-GO) is to measure crustal and local land movements to improve our understanding of past and presently-active processes (sea level, tectonic and glacial isostatic adjustment) in the region. KEP-GO consists of two continuous Global Navigation Satellite System (GNSS) stations, one on Brown Mountain and one at KEP, a tide gauge at KEP, and the benchmark network to tie the tide gauge to the GNSS stations and consequently to a global reference system, which is fundamental to monitoring our planet.

The processing of GNSS measurements provides information on the movements of the stations at the millimetre-per-year level in the same reference system. In particular, the vertical land movements are required to de-couple the sea-level measurements obtained by the KEP tide gauge from these movements, which enables the data to be used in combination with other tide gauges from around the world and helps satellite altimeter calibration over the Southern Atlantic Ocean. Furthermore, the GNSS observations allow the monitoring of tropospheric water vapour, the dominant natural greenhouse gas, and of ionospheric activity, which is an indicator of space weather effects on modern communication systems, in this under-sampled region.

▲ *Global Navigation Satellite System (GNSS) antenna at KEP*

▲ *GNSS antenna on 1.5m mast, concrete pillar and equipment case with view southwest towards Brown Mountain*

King Edward Point Research Station

Long-term monitoring of higher predator populations at Maiviken, South Georgia

PHIL HOLLYMAN, Alice Clement, John Dickens

Timing: Ongoing

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) ecosystem approach to fisheries management ensures that the effects of commercial fishing on not only the harvested (target) species but also the animals that depend on the target species for food are closely monitored. Higher predators act as 'indicator species' by showing measurable responses to changes in the availability of the commercially caught fish/krill, for example changes in population size, breeding success, body mass and foraging behaviour.

The long-term study programme at Maiviken, South Georgia, monitors Antarctic fur seals, gentoo penguins, and both northern and southern giant petrels. Last season additional observation and monitoring of breeding elephant seals was introduced at King Edward Point. This information, in conjunction with comparable results collected at Bird Island, provides valuable data that are fed into stock assessments, which are then used to set quotas that guarantee the responsible and sustainable management of the commercial fisheries in the region. This season, extra observations of brown skua populations will be undertaken around King Edward Point to monitor breeding success.

▲ *Gentoo penguin and chicks*

▲ *Antarctic fur seals*

King Edward Point Research Station

Monitoring sea-level movement at KEP

PETER FODEN, ANGELA HIBBERT, JEFF PUGH

Timing: 2018/19 season

The South Atlantic Tide Gauge Network was set up in 1985 under the auspices of the ACCLAIM (Antarctic Circumpolar Current Levels from Altimetry and Island Measurements) Program. The network, in its present form, was completed in 2008, with the addition of a tide gauge at King Edward Point, South Georgia.

The main purposes of the network was to provide a means of monitoring the Antarctic Circumpolar Current, while providing a long-term sea-level measurements from this traditionally under-sampled region, but it has since proven invaluable for purposes that are as diverse as the validation of satellite altimetry and the development of unique technology adaptations for remote and hostile environments.

The tide gauge at KEP consists of two underwater pressure sensors mounted at the end of the quay, whilst supporting equipment (such as the datalogger and microcontroller) is located in the nearby boatshed. Sea levels are sampled and recorded every minute and a copy of these data is transmitted at intervals of five minutes to the National Oceanography Centre (NOC) in Liverpool via the BAS/GSGSSI VSAT system. This provides sea-level scientists with a near real-time sea-level monitoring system in the region.

▲ *King Edward Point Research Station, South Georgia*

King Edward Point Research Station

SKiMET meteor radar

TRACY MOFFAT-GRIFFIN, NICK MITCHELL

Timing: 2015 to 2020

The radar at King Edward Point detects meteor ion trails (shooting stars) as they enter the Earth's atmosphere and burn up. The radar then monitors the diffusion of the meteor trail over time. This data allows the speed and direction of the winds to be calculated in this part of the atmosphere.

We will use the data collected at King Edward Point combined with data from a meteor radar located at Rothera to measure the winds, waves and tides of the middle atmosphere. We will then determine the degree to which fluctuations in the waves we measure in the lower atmosphere drive the variability of the middle atmosphere and, in particular, the role of waves in driving anomalous events recently observed in the polar middle atmosphere. These are important to understand as they can have an effect on global circulation and are not always well represented in atmospheric models. We will also use meteor radars on South Georgia and at Rothera to investigate recent suggestions that atmospheric waves generated by mountains can propagate to heights of 90km or more – effectively the edge of space.

▲ *Meteor radar antennas at King Edward Point*

King Edward Point Research Station

South Georgia and Shag Rocks groundfish survey

PHIL HOLLYMAN, Alice Clement, John Dickens

Timing: Ongoing

BAS fisheries scientists will undertake research and monitoring of the fish assemblages of South Georgia on behalf of the Government of South Georgia and the South Sandwich Islands (GSGSSI), contributing to its sustainable management of the island's fisheries.

This includes participating in the South Georgia groundfish surveys, which occur on an approximately biennial basis. The surveys provide an estimate of the standing stock and length/age structure of the mackerel icefish population, which is used for stock assessment. They also provide information on the abundance of juvenile toothfish, the abundance of species not commercially caught (non-target species), and provide samples for projects studying the diet, ecology and genetics of fish. Information from the samples will be used to assess potential fishery impacts on non-target species and provides data on long-term variability in the South Georgia ecosystem.

In addition, monthly sampling of fish larvae in Cumberland Bay and Rosita harbour on the northern coast of South Georgia will be undertaken to assess changes in their composition, distribution and abundance.

Throughout the year scientists are also deployed as scientific observers on commercial fishing vessels used for harvesting krill, icefish and toothfish. This is important for collecting additional information on fishery/ecosystem interactions.

▲ *Icefish trawler in Cumberland Bay*

▲ *Mackerel icefish*

King Edward Point Research Station

South Georgia geomagnetic observatory

SIMON FLOWER, Vicki Foster, Kieran Love, Anthony Swan, Tim Taylor, Chris Turbitt

Timing: 2010 to present (ongoing)

More information: *http://geomag.bgs.ac.uk/operations/kingedwardpoint.html*

The project involves the creation (2010/11) and operation (2011-present) of a geomagnetic observatory at King Edward Point, South Georgia. Data from the observatory is fed to international data centres and contributes to our understanding of how the Earth's magnetic field functions. This location is particularly interesting because of its proximity to the 'South Atlantic Anomaly', an area of weaker magnetic field in the South Atlantic that could be a precursor to a reversal of the Earth's magnetic field.

▲ *The buildings of the observatory between KEP and Mount Duse*

▲ *An absolute measurement being made a little way from the observatory (on a good weather day!)*

King Edward Point Research Station

South Georgia right whale field survey

JENNIFER JACKSON, Connor Bamford, Emma Carroll, Amy Kennedy, Darryl MacDonald, Stephanie Martin

Timing: January and February 2019

More information: *https://www.bas.ac.uk/project/south-georgia-right-whale-project*

The South Georgia right whale project is a dedicated population survey of southern right whales, in their summer feeding grounds off South Georgia, since whaling ceased in the 1970s.

Southern right whales are now the most commonly seen whale in the coastal and offshore waters of South Georgia during the summer. These whales are likely to be part of the southwest Atlantic population, which feed in the waters around South Georgia during the austral summer and migrate to waters off Southern Brazil and Argentina to calve in the austral winter.

This project is conducting dedicated surveys in this summer feeding ground to understand whale habitat use, diversity, health status and connectivity to calving grounds. Two months of surveys local to KEP waters will be carried out in January/February 2019, and an offshore voyage will be conducted in January/February 2020. The research crew will collect information on whale distribution (with sightings and acoustics), foraging patterns (using satellite tracks), connections with calving grounds (using photo-identifications and genetic samples), diet (using skin isotope chemistry) and health status (using photo based assessments of whale health and stress assays).

▲ *Two months of surveys will be carried out this season*

▲ *A southern right whale off South Georgia*

King Edward Point Research Station

The ecological fate of microplastics in Antarctic marine environments – a source to sink approach

(CLAIRE WALUDA), CATH WALLER, Jack Buckingham

Timing: 2018/19 season

This CASS proposal will use BAS logistic support to enable input into KEP/Bird Island in order to collect samples of shallow marine/intertidal invertebrates for lab-based behavioural and ecotoxicological experiments.The project aims to investigate the interactions between microplastics, temperature and the nearshore marine food web.

▲ *Jack Buckingham will be working in the field*

Signy Research Station

NERC radiocarbon facility soil collections

(KEVIN NEWSHAM, MARK GARNETT), Matt Jobson, Ali Massey

Timing: 2018/19 season

A recent study showed that carbon respired from soils (as CO_2) from Leonie Island by saprotrophic fungi is up to 1,200 years in age. This collaborative project will further study to the effects of freeze-thaw cycles and warming on the age of carbon respired from soil from Leonie Island and Signy.

▲ *North side of Leonie Island*

Signy Research Station

Polar atmosphere-ice-ocean interactions: impact on climate and ecology at Signy

MANUEL DALL'OSTO, [Signy personnel]

Timing: 2018/19 season

The topic of this proposal is the natural marine aerosol, which is of paramount importance at the global scale and influences the Earth's radiative budget and the biogeochemical cycles. Currently there is a serious lack of aerosol data over the Polar Regions in general. In particular, over the polar sea-ice zones, which is one of the largest ecosystems on Earth, composed of a variety of habitats and organisms tolerating extreme conditions. As climatic changes are rapidly amplifying in the Polar Regions, understanding biogeochemical processes involved in the air-sea-ice interface is crucial to pinpoint climate feedbacks.

PI-ICE (Polar atmosphere-ice-ocean Interactions: Impact on Climate and Ecology) aims to directly identify atmospheric aerosols emitted in the polar regions, their biological origin and their impact on the indirect radiative effect, with particular emphasis on the ice-water-atmosphere biogenic nitrogen cycle.

▲ *Signy Research Station, Signy Island, South Orkney Islands*

Signy Research Station

Signy Island marine predators long-term monitoring and survey programme

MIKE DUNN, (RICHARD PHILLIPS), Tim Morley

Timing: Ongoing

More information: *https://www.bas.ac.uk/project/higher-predators-long-term-science/higher-predators-signy-island-penguin-monitoring*

Marine predators are sensitive to changes in ecosystem properties including changes brought about by natural ecosystem processes (such as climate variability), and those brought about by humans (such as fishing). Long-term monitoring of animals such as seabirds and seals is therefore important for understanding the drivers and processes leading to changes in Antarctic ecosystems.

Scientists at Signy study breeding populations of Adélie, chinstrap and gentoo penguins, southern giant petrels, blue-eyed shags and transient Antarctic fur seals and southern elephant seals. They monitor population size, reproductive success and the quality and abundance of food eaten by predators. This data is crucial for modelling and understanding the potential relationships between the populations and breeding performances of seabirds and seals and environmental variability and change in the Scotia Sea.

Work will deliver priority, primary data to CCAMLR and Ocean Ecosystems on annual seabird and seal population sizes, breeding success, diet, condition and at-sea foraging behaviour during chick rearing. This data collected annually at Signy Island follows approved, internationally-recognised standard CCAMLR methods and parameters for surveying and measuring animals.

▲ *Adélie penguin colony on Signy Island*

Signy Research Station

Summer-monthly collections of the intertidal bivalve Lissarca miliaris at Shallow Bay, Signy Island

(KATRIN LINSE), Tim Morley

Timing: November 2018 to March 2019

Lissarca miliaris is a small, up to 5mm long, reddish-brown bivalve that lives on red and brown seaweed in the intertidal region of Signy Island. Specimens previously collected between 1972 and 2011 were analysed for growth and reproduction and showed changes in growth performance correlating with a 40-year warming event of air temperatures, suggesting local adaptation to increasing temperatures. They also showed changes in reproductive efforts with more but smaller juveniles being brooded and released. We started annual bivalve collections in 2011 and since 2014 collected temperature data in the intertidal, subtidal and on land in order to compare further changes in growth and reproduction to in situ water and air temperatures (in the past, only air temperatures has been measured).

For the bivalve collections a handful of seaweeds is picked at monthly intervals during the summer season from the stepping stones in Shallow Bay and checked for the presence of the small bivalves. The bivalves (~50 individuals) will be removed either in the field or in the lab from the seaweed and fixed in ~70% ethanol.

▲ *A sample of seaweed collected at Shallow Bay, Signy Island*

Signy Research Station

Using biologging to identify Pygoscelis penguin foraging activity from Signy island colonies in order to validate habitat models

(PHIL TRATHAN, VICTORIA WARWICK-EVANS), FABRIZIO MANCO

Timing: 2018/19 season

This project will track *Pygoscelis* penguins from Signy Island, South Orkney Islands, during the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) sponsored synoptic krill survey planned for 2018/19. Tracking will be undertaken during the chinstrap incubation, brood and crèche periods, that is, during December to January. Two sites are under consideration: Gourlay Peninsula and North Point.

Tracking from Signy Island will coincide with the bio-acoustic surveys for krill during 2018/19. During the chinstrap tracking work, individual animals will be fitted with a range of instruments, including GPS units, time-depth-recorder units, accelerometers and video cameras. The data from the tracking instruments will provide details about the prey field used by penguins for comparison with the wider prey field in the vicinity of the colony. Analyses will be published in the peer-reviewed literature, but also submitted to CCAMLR for use in management of the krill fishery.

▲ *Tracking penguins from Signy Island will coincide with bio-acoustic surveys for krill*

RRS *James Clark Ross*

JR18001 – The Atlantic Meridional Transect (AMT)

(ANDY REES), Cecilia Liszka [and others]

Location: Atlantic Ocean

Timing: 23rd September to 30th October 2018

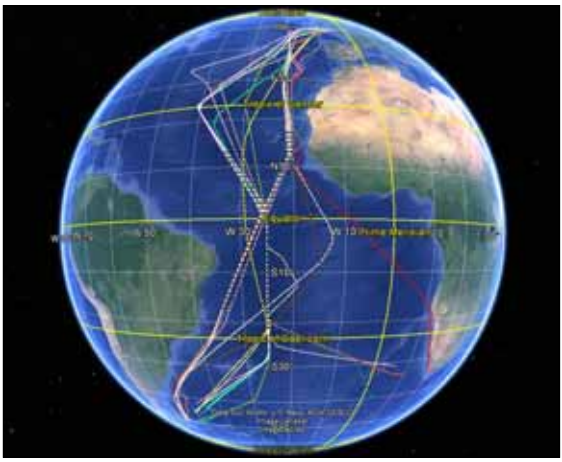
More information: *http://www.amt-uk.org*

Now in its 23rd year, AMT is a multidisciplinary programme which undertakes biological, chemical and physical oceanographic research during the transit of the RRS *James Clark Ross* between the UK and the Falkland Islands.

AMT delivers a unique time series of observations on the structures and biogeochemical properties of planktonic ecosystems in the Atlantic Ocean. These long-term observations help to understand the variability in planktonic ecosystems and how it affects nutrient cycling, carbon storage in deep ocean and the air-sea exchange of climate active gases. This information can be used to validate global carbon cycle models.

During AMT28 the team from the UK, USA, France, Portugal and South Africa will be making measurements of microbial diversity and respiration, productivity and cycling of nutrients. Carbon chemistry will be measured to maintain observations of Atlantic Ocean acidification, and we will be deploying 13 ARGO floats and maintaining a long time-series sediment trap mooring in the South Atlantic Gyre. In addition, this AMT cruise includes the continuation of ocean measurement validation of the European Space Agency Sentinel-3 satellite observations.

▲ *Onboard RRS James Clark Ross*



▲ *Atlantic Meridional Transect (AMT) tracks*

RRS *James Clark Ross*

JR18002 – Drake Passage repeat hydrography

AMBER ANNETT, YVONNE FIRING, MARIE-JOSE MESSIAS [and others]

Location: Drake Passage

Timing: 3rd November to 23rd November 2018

More information: *http://www.amt-uk.org*

Ocean storage of anthropogenic heat and carbon plays a critical role in ameliorating climate change but we need better understanding of the processes involved to improve future projections. On JR18002 we will measure parameters such as temperature, salinity, carbon, oxygen and nutrients throughout the water column, from the South American to the Antarctic Peninsula continental shelf. In addition, we will measure substances with known sources such as CFCs and isotopes of oxygen, carbon and radium, to trace the pathways by which water circulates and mixes. These parameters will be measured using ship-mounted instrumentation as well as instruments lowered from the ship on a frame (rosette), and water samples will be collected from Niskin bottles fixed to the rosette.

These measurements are repeated along this transect every 10 years, with a subset repeated each year, as part of an international programme to monitor ocean change. The data gathered will not only allow us to calculate current heat and carbon stored by the ocean, but also to better understand what determines them, and therefore better project the ocean's future role. Opportunistic studies of phytoplankton, microplastic pollution, and species distribution are also planned.

▲ *Lowering a CTD over the side of RRS James Clark Ross*

RRS *James Clark Ross*

JR18002 – Microplastics in Drake Passage

MIGUEL ANGEL MORALES, Alethea Mountford

Location: Drake Passage

Timing: 3rd November to 23rd November 2018

Surveys of plastics in the open ocean have focused so far on plastic abundance in the surface mixed layer. These studies have established that floating plastic debris tends to accumulate in the oceanic subtropical gyres. There is also evidence of plastic build-up in the Atlantic sector of the Arctic Ocean. Very few studies on plastic abundance in the Southern Ocean have been conducted, mostly concentrated on macroplastics and benthic microplastics.

We propose to carry out the first observational section of microplastic distribution in the Southern Ocean, specifically in Drake Passage. The whole water column will be sampled to map the distribution of floating plastic, plastics that are drawn down by turbulence or downwelling and non-buoyant plastic.

▲ *This will be the first observational section of microplastic distribution in the Southern Ocean*

RRS *James Clark Ross*

JR18003 – Understanding the impact of ice loss and deglaciation on Antarctic coastal benthic ecosystems (ICEBERGS)

JAMES SCOURSE, David Barnes, Chester Sands, Nadescha Swerschke [and others]

Location: Marian Bay (King George Island), Borgen Bay (Anvers Island), Sheldon Glacier (Adelaide Island)

Timing: December 2018

More information: *http://www.amt-uk.org*

The West Antarctic is rapidly warming, resulting in retreating glaciers, collapsing ice shelves and lengthening of the sea-ice melting season. The resulting increase in iceberg scouring and sediment discharge have an impact on the marine animals living in these coastal areas. Fewer sea-ice days leads to longer phytoplankton blooms resulting in growth increases of seafloor dwelling animals and an increase of carbon captured from the atmosphere and stored on the seabed – the largest negative feedback on climate change. It is urgent that we evaluate the real changes in the environment and see how the animals react to regional warming over time and across different locations.

Our project, funded by NERC and CONICYT, includes researchers from University of Western Florida to look at plastic pollution across our study sites; University of Norway in Svalbard, to examine changes in phytoplankton composition over time; South Hampton and Cardiff Universities, which bring in a geochemical aspect of variation across sites; and the South Atlantic Environment Research Institute who, together with BAS, will be collecting information to assist with marine spatial planning on the Patagonian Shelf.

▲ *RRS James Clark Ross in polar waters*

RRS *James Clark Ross*

JR18003 – Ocean impacts of cryospheric transformation by Antarctic underwater turbulence (OCTONAUT)

KATY SHEEN, Mike Boniface, Ben Lincoln

Location: Western Antarctic Peninsula

Timing: December 2018

The glaciers and ice shelves of the Western Antarctic Peninsula (WAP) are undergoing major changes. Strong glacier retreat-rates are observed in many regions, primarily driven by enhanced delivery of warm ocean water at depth. This project will investigate the processes that modulate both the outflow of melt water and the inflow of deep warm along the WAP coastline. Hydrographic and current velocity measurements, multi-beam bathymetry data and microstructure data will be utilised to both characterise the oceanographic environment and to estimate turbulent mixing rates. Three regions of varying glacial retreat rates along the WAP will be studied. Findings will enable enhanced understanding of the processes responsible for glacial retreat at the WAP, and the impact of the glacial melt released on the physical ocean environment and the marine ecosystem.

▲ *Lowering a CTD from RRS James Clark Ross*

RRS *James Clark Ross*

JR18004 – ORCHESTRA – Orkney Passage moorings, A23 section

(EMILY SHUCKBURGH), Povl Abrahamsen, David Bett, Alex Brearley, Leo Middleton, Ryan Scott [and others]

Location: Weddell and Scotia Seas, Discovery Bank (east of South Orkney Islands)

Timing: 4th January to 13th February 2019

More information: *https://www.bas.ac.uk/project/orchestra*

As part of the Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) Programme, we are repeating long-term measurements in the Weddell and Scotia Seas, and performing a process study on Discovery Bank, east of the South Orkney Islands.

Since 2007, BAS and LDEO have maintained an array of oceanographic moorings across Orkney Passage, a key pathway for cold, dense Weddell Sea Deep Water (WSDW) into the Scotia Sea and the South Atlantic Ocean. We will recover instruments on six moorings that were deployed from RRS *James Clark Ross* two years ago; we will then download the data, service and re-battery the instruments, and redeploy them for another two years.

To measure the varying properties and volumes of water masses in the Weddell and Scotia Seas, we are performing the 13th repeat of the A23 CTD section from the northern Weddell Sea, across the eastern Scotia Sea, and north to South Georgia. This will include 31 CTD/LADCP (lowered acoustic Doppler current profiler) casts and sample collection for oxygen isotope analysis. In addition, we will be deploying a Vertical Microstructure Profiler (VMP) to measure turbulence in the water column at some of these stations.

The process study involves deploying underwater gliders and undertaking CTD and VMP work around Discovery Bank to the east of Orkney Passage. This will target a region of underwater mountains which we believe is an important area for the exchange and transformation of waters between the Weddell and Scotia Seas. These gliders will profile for two months and be recovered on JR18005.

▲ *Underwater gliders will be deployed for two months*

RRS *James Clark Ross*

JR18005 – Alcohols in the polar oceans

MING-XI YANG, Charel Wohl

Location: Southern Ocean

Timing: 14th February to 15th April 2019

More information: *https://www.polar.lu/single-post/2018/01/11/Charel-Wohl-searching-for-trace-gases-in-the-polar-regions*

Oxygenated Volatile Organic Compounds (OVOCs) are a group of organic compounds like acetone, methanol or acetaldehyde. They are present in the atmosphere at tiny concentrations. However, OVOCs are very important as they play a significant role in the oxidative capacity of the atmosphere. That is the ability of the atmosphere to cleanse itself from organic pollutants like methane. A major uncertainty is if the oceans absorb or emit those compounds.

The aim of this expedition is to increase the available data set and measure the air-sea gas exchange of these trace gases in the Polar Regions. As part of my PhD, I have developed a new method to extract these gases from the surface ocean and quantify them using Proton-Transfer-Reaction Mass Spectrometry. To the best of our knowledge these will be the first measurements of acetone, acetaldehyde and methanol in the Antarctic Ocean. We are looking forward to measuring these gases in the water from different depths, in the underway surface water and in the air.

▲ *The project may obtain the first measurements of acetone, acetaldehyde and methanol in the Antarctic Ocean*

RRS *James Clark Ross*

JR18005 – Antarctic deep rates of export II (ANDREX II)

ANDREW MEIJERS, Carol Arrowsmith, Ian Brown, Marie-Jose Messias, Natalie Freeman, Charel Wohl, Malcolm Woodward, Ming-Xi Yang

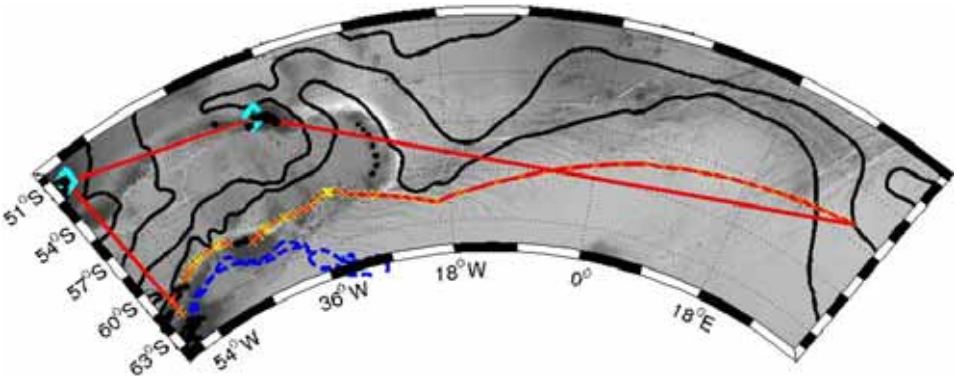
Location: Weddell Sea

Timing: 17th February to 10th April 2019

ANDREX II will be a physics and biogeochemistry cruise along the northern rim of the Weddell Gyre between the Antarctic Peninsula and 30°E, to survey the Gyre's northern rim with complete measurements of water mass properties, biogeochemical and carbonate parameters, CFCs and current velocity. This is a repeat of the original ANDREX voyage in 2010, which produced the first estimates of Weddell Sea overturning and property budgets.

Our cruise will be complemented with a US-funded cruise, which will conduct measurements of the same variables along the eastern edge of the Weddell Gyre in the 2018/19 austral summer season. Together, the two cruises will form a closed 'box' of the Gyre that is ideal to measure the exchanges with the surrounding oceans, and to investigate physical and biogeochemical budgets.

The ANDREX II cruise will commence at the tip of the Antarctic Peninsula and proceed eastward along the crest of the South Scotia Ridge, completing a set of 55 stations. This segment of the cruise will include a survey of the Orkney Passage, the deepest gap in the ridge. The cruise will then track east, mimicking the trajectory of the Weddell Gyre's northern boundary and hopefully taking some SWATH obserations in search of a potential sill into the South Sandwich Trench. Our sampling strategy thereafter will consist of tracking the climatological position of the Gyre's northern boundary, and repeating most of the stations conducted during the original ANDREX voyage. This sampling regime will maximise our chances of sampling the import/export routes of deep water masses to/from the Gyre.



▲ *The ANDREX II cruise track*

RRS *Discovery*

DY098 – Western core box

(SOPHIE FIELDING), Bjorg Apeland, Dan Ashurst, Alejandro Ariza, Alysa Hulbert, Kirstie Jones-Williams, Clara Manno, Gabi Stowasser [and others]

Location: South Georgia and South Sandwich Islands

Timing: January to February 2019

More information: *https://www.bas.ac.uk/project/poets-wcb*

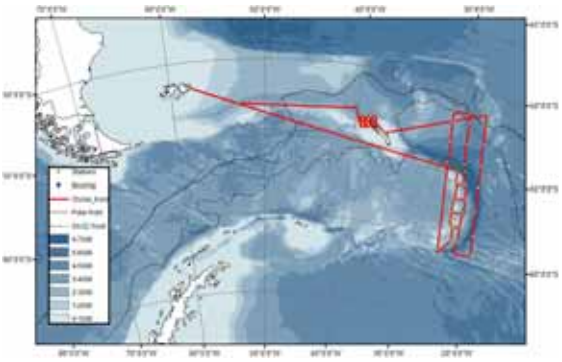
Cruise DY098 is the 23rd occupation of the Polar Ocean Ecosystem Time Series Western Core Box (POETS-WCB), which provides consistent measurements of the distribution and abundance of Antarctic krill and an understanding of their physical environment within the region of South Georgia (1996 to present). This is important for understanding the long-term variability in krill biomass at South Georgia and the influences from climatic variability, fishing pressure and predation.

The cruise will also continue open-ocean observations as part of the SCotia sea Open-Ocean Biological laboratoriES (SCOOBIES) programme. This project considers the flux of carbon to deep ocean layers and monitors ocean chemistry parameters, particular in relation to ocean acidification.

In addition we will contribute to the 2019 large-scale survey of krill density and distribution in the South Atlantic, surveying the South Sandwich Islands. Led by Norway with contributions from UK, USA, Korea, China and Ukraine it will be used to inform CCAMLR of the current Antarctic krill status, pertinent to managing the Antarctic marine ecosystem.

The team will use a CTD to make measurements of the water column physical properties, an EK60 echosounder to make acoustic observations of water column biology and use a number of nets (Bongo, Plastic-Neuston, RMT1, RMT8) to collect organisms ranging from 100 microns to several centimetres. These include plastic items, copepods and Antarctic krill.

▲ *RRS Discovery*



▲ *The cruise track for DY098*

RRS *Discovery*

DY100 – South Atlantic islands: underpinning complex fisheries with multidisciplinary science

MARTIN COLLINS, Bjorg Apeland, Dave Barnes, Gareth Flint, Simon Morley, Chester Sands, Gabi Stowasser, [Polar Data Centre], [AME techs] [and others]

Location: South Atlantic islands

Timing: 12th March to 14th April 2018

The food security and economies of the British Overseas Territories in the South Atlantic, Tristan da Cunha and St Helena, are heavily reliant on marine harvestable resources and tourism. Understanding how vulnerable these resources are to the impact of climate change will be key to the future cultural and economic security of these nations.

During this project our multi-disciplinary team will construct a food web for the exploited marine populations that will allow us to identify critical links in the food chain and identify their vulnerability to environmental variability. Annual cruises will allow us to understand the variability between years that will then allow us to pick out any longer-term trends, including climate change signals.

The assembled team will investigate the communities underpinning the harvestable resources from shelf depths (1,000m) to the surface, both benthic and pelagic. They will describe the ecological and physiological interactions, food web connections (stable isotopes and fatty acids) and connectivity and phylogeny related to the current patterns over the island shelves. Repeated annual measurements will allow the variability to be described and pinch points in the food web to be constrained.

This is a collaboration with multiple partners including Cefas, Saeri and the RSPB.

▲ *The team will construct a food web for the exploited marine populations*

HMS *Protector*

Geological mapping in Eastern Palmer Land

ALEX BURTON-JOHNSON, [Field Guide*]

Location: Palmer Land, Antarctic Peninsula

Timing: 2018/19 season

As part of the current geological mapping update of British Antarctic Territory, BAS geologists are executing a series of field seasons in Palmer Land on the Antarctic Peninsula. We are visiting regions of limited or no geological data, and answering key questions about the region's tectonic history. This season we will visit the east coast of Palmer Land, targeting gaps in our geological data and exploring the geological source of significant features in the aerogeophysical data.

Our geological maps and samples will inform current projects to map the geology of the entire continent; integral to our continuing research on the influence of the bedrock geology on the overlying ice sheet. We are also targeting our sampling on units that will inform about key periods in the Peninsula's tectonic history, including the driving forces of its extensive granite and volcanic magmatism, deep sedimentary basins, and the origin of its distinctive 'S' shape, and linking these events to global processes.

▲ *Typical terrain in Eastern Palmer Land, from our previous geological fieldwork in the region*

HMS *Protector*

Geological mapping on the Davis Coast, Graham Land

ALEX BURTON-JOHNSON, Rowan Whittle

Location: Graham Land, Antarctica

Timing: 2018/19 season

The Davis Coast of north-west Graham Land is one of the last large areas of largely unknown geology on the Antarctic Peninsula. Outcrops that have been visited in the region are composed of massive sequences of layered sedimentary rocks comprising the Trinity Peninsula Group – a thick sequence of sediments deposited on the margin of the Gondwana supercontinent in the Carboniferous to Triassic periods.

This project aims to complete mapping of the coastal outcrops in this unexplored region and build a better understanding of the history and evolution of this important sedimentary sequence – one of the largest geological units on the Antarctic Peninsula. We will incorporate the mapping and sampling into ongoing BAS geological research on the history of Antarctica and explore its influence on modern processes.

▲ *Geological field mapping on the Antarctic Peninsula*

Appendix

List of non-BAS personnel and their associated institutes

Field-based

Name	Institute
Sridhar Anandakrishnan	*Penn State University, USA*
Mike Bentley	*Durham University*
Wim Boot	*Utrecht University*
Peter Clarke	*Newcastle University*
Emily Doyle	*Cambridge University*
Geoff Evatt	*University of Manchester*
Jean-Charles Gallet	*Norwegian Polar Institute*
Mackenzie Griemen	*Cambridge University*
Katherine Joy	*University of Manchester*
Matt King	*University of Tasmania*
Kenny Matsuoka	*Norwegian Polar Institute*
Clement Miege	*University of Utah*
Julie Miller	*University of Colorado*
Lynn Montgomery (TBC)	*University of Colorado*
Tavi Murray	*University of Swansea*
Christoph Nehrbass-Alles	*Cambridge University*
Carleen Reijmer	*Utrecht University*
Ted Scambos	*University of Colorado*
Rebecca Schliegel	*Alfred Wegener Institute*
Michiel Van Den Broeke	*Utrecht University*
Brice Van Liefferinge	*Norwegian Polar Institute*
Bruce Wallin	*University of Colorado*
Pippa Whitehouse	*Durham University*
Eric Wolff	*Cambridge University*

Rothera Research Station

Name	Institute
Nisma Abdelmalik	*Royal Netherlands Institute for Sea Research (NIOZ)*
Rein Aerts	*VU University, Amsterdam*
Amber Annett	*University of Southampton*
Stef Bokhorst	*VU University, Amsterdam*

continued ▷

Appendix *continued*

List of non-BAS personnel and their associated institutes

Rothera Research Station continued

Name	Institute
Corina Brusaard	*Royal Netherlands Institute for Sea Research (NIOZ)*
Hans Cornelissen	*VU Amsterdam*
Gonçalo Piedade	*Royal Netherlands Institute for Sea Research (NIOZ)*
Ella Wesdorp	*Royal Netherlands Institute for Sea Research (NIOZ)*

Halley Research Station

Name	Institute
David Abrahams	*University of Cambridge*
Geoffrey Evatt	*University of Manchester*
Katherine Joy	*University of Manchester*

Bird Island Research Station

Name	Institute
Pauline Goulet	*University of St Andrews*
Mark Johnson	*University of St Andrews*

King Edward Point Research Station

Name	Institute
Jonathan Berger	*University of California, San Diego*
Jack Buckingham	*University of Hull*
Emma Carroll	*University of St Andrews*
Peter Davis	*University of California, San Diego*
Simon Flower	*BGS*
Peter Fodden	*NOC*
Angela Hibbert	*NOC*
Amy Kennedy	*NOAA*
Darryl MacDonald	*Clear Blue Photo*
Stephanie Martin	*independent*
Nick Mitchell	*University of Bath*
Jeff Pugh	*NOC*

continued ▷

Appendix *continued*

List of non-BAS personnel and their associated institutes

King Edward Point Research Station continued

Name	Institute
Anthony Swan	*BGS*
Tim Taylor	*BGS*
Norman Teferle	*University of Luxembourg*
Chris Turbitt	*BGS*
Cath Waller	*University of Hull*

Signy Research Station

Name	Institute
Manuel Dall'Osto	*ISAC-CNR*
Mark Garnett	*NERC Radiocarbon Facility*
Fabrizio Manco	*Anglia Ruskin University*

RRS James Clark Ross

Name	Institute
Amber Annett	*University of Southampton*
Carol Arrowsmith	*BGS*
Mike Boniface	*University of Exeter*
Ian Brown	*PML*
Yvonne Firing	*NOC*
Natalie Freeman	*UCSD*
Ben Lincoln	*Bangor University*
Marie-Jose Messias	*University of Exeter*
Miguel Angel Morales	*Newcastle University*
Alethea Mountford	*Newcastle University*
Andy Rees	*Plymouth Marine Laboratory*
James Scourse	*University of Exeter*
Katy Sheen	*University of Exeter*
Charel Wohl	*PML*
Malcolm Woodward	*PML*
Ming-Xi Yang	*PML*

Feedback and further information

We welcome your feedback and comments on this document. These should be addressed to:

Ali Massey

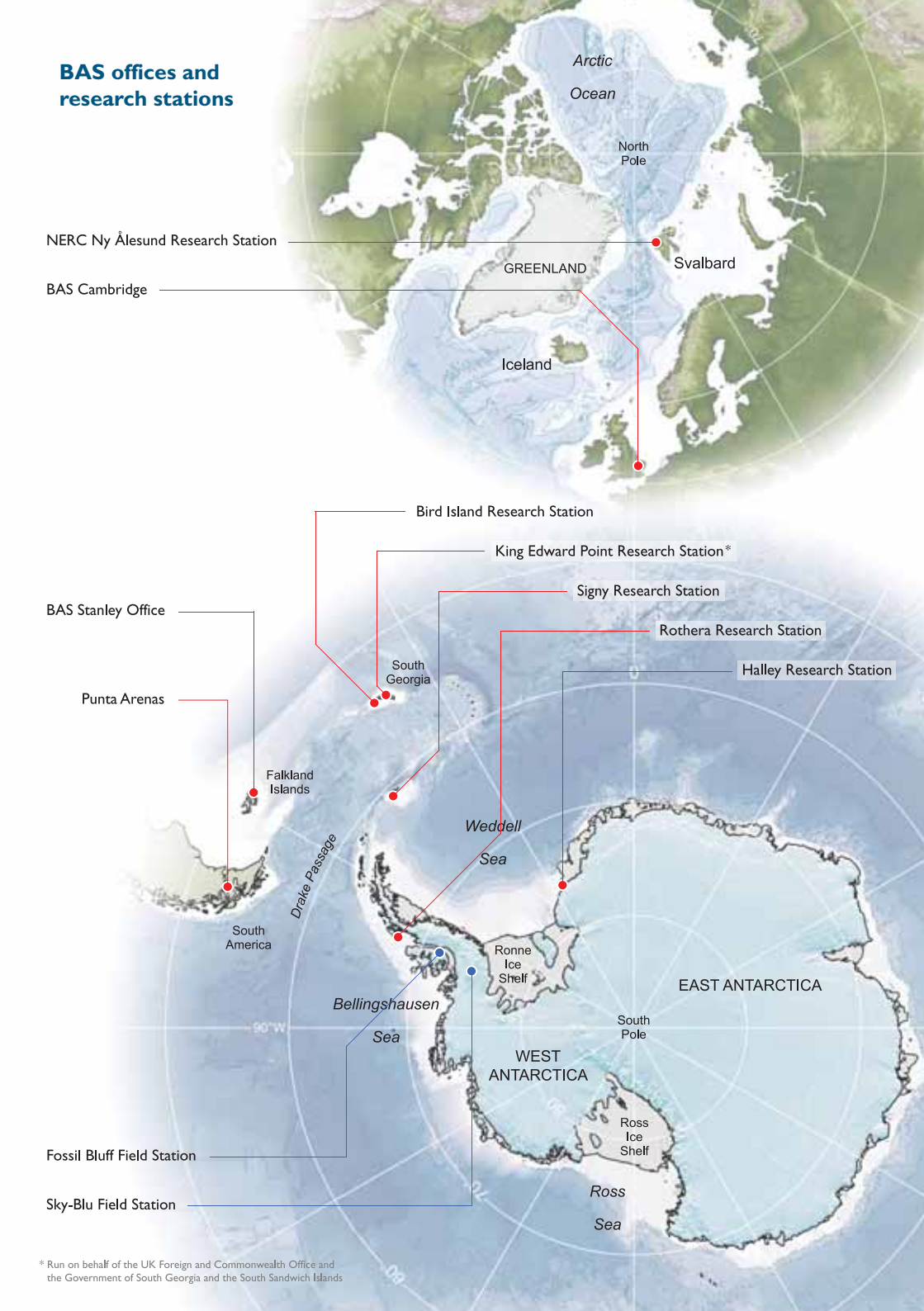
British Antarctic Survey
High Cross, Madingley Road
Cambridge, CB3 0ET, UK

Tel: +44 (0)1223 221400
Email: ajmas@bas.ac.uk

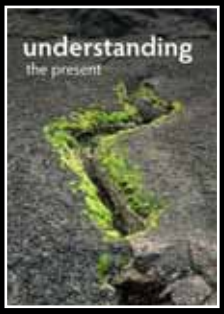
For further information about BAS, please visit:
www.bas.ac.uk

Published by British Antarctic Survey

BAS offices and research stations



* Run on behalf of the UK Foreign and Commonwealth Office and the Government of South Georgia and the South Sandwich Islands



British Antarctic Survey (BAS), an institute of the Natural Environment Research Council (NERC), delivers and enables world-leading interdisciplinary research in the Polar Regions. Its skilled science and support staff based in Cambridge, Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth as a sustainable planet. Through its extensive logistic capability and know-how BAS facilitates access for the British and international science community to the UK polar research operation. Numerous national and international collaborations, combined with an excellent infrastructure help sustain a world-leading position for the UK in Antarctic affairs.

NERC is part of UK Research and Innovation www.ukri.org

www.bas.ac.uk

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

UK Research and Innovation