BAS Science Summaries

2017-2018 Antarctic field season

British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

POLAR SCIENCE FOR PLANET EARTH

Contents

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

BAS Science Summaries

2017-2018

Introduction

This booklet contains project summaries of field and station-based science taking place during the 2017-2018 Antarctic summer season from BAS research stations and ships. It is intended as a brief overview of the science, for detailed information about individual projects please contact the Principal Investigators (PIs) listed.

Please note that only the PIs and field personnel have been listed and full lists of project collaborators are not included in this summary. **PIs appear in capital letters, and in brackets if not present on site, and Field Guides are indicated with an asterisk.** A list of non-BAS personnel and their affiliated organisations is shown in the Appendix.

Thanks to all the authors for their contributions and to Laura Gerrish and Elena Field for the field sites map.

This booklet was compiled by:

Elaine Fitzcharles
Senior Laboratory Manager

Rosey Grant
Rothera Physical Sciences Coordinator

Ali Massey
Bonner Laboratory Manager

September 2017

Detailed contents

Field-based projects

Detailed contents *continued*

Rothera Research Station

Bird Island Research Station

King Edward Point Research Station

Signy Research Station

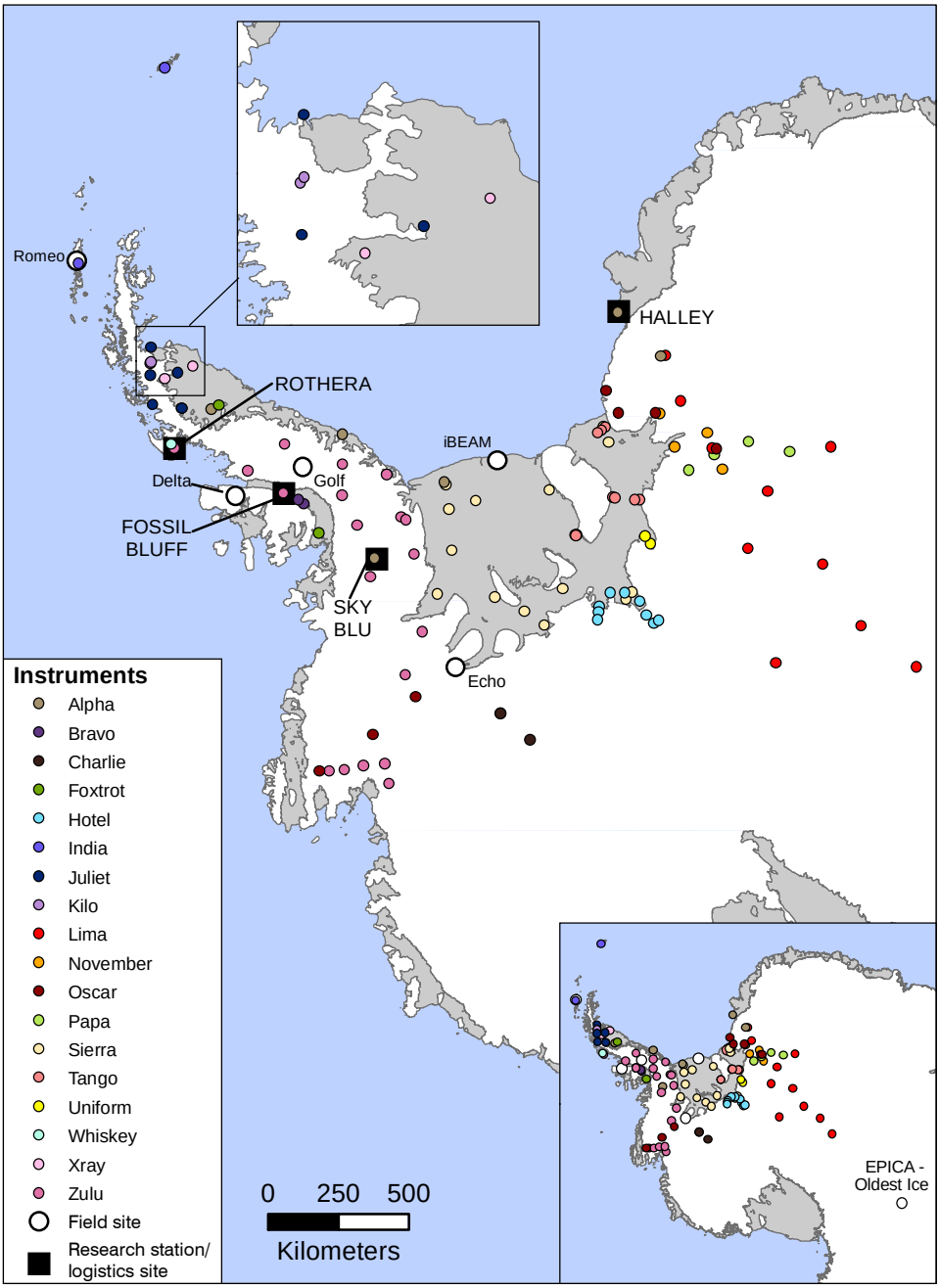
Multiple stations

RRS James Clark Ross

RRS Ernest Shackleton

Map of field-based project locations

2017-2018



Sledge Alpha

Automatic weather station network servicing

(STEVEN COLWELL), Rosey Grant, Mairi Simms, Daniel Rylett, Carolyn Graves, Barney Barningham

Location: Antarctic Peninsula

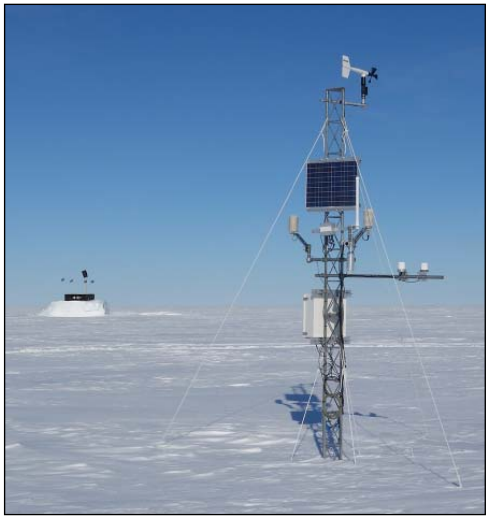
Timing: Opportunistic throughout the season

BAS runs a network of nine 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 V, Halley VI and Halley VIa (circles on Figure 1). The BAS AWS are just 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 that we have the best possible coverage of Antarctica in order to meet the needs of the scientific and forecasting communities. In addition to our own stations we also service stations for the Universities of Utrecht, Colorado and Wisconsin (crosses on Figure 1). 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 Halley and Rothera.

▲ *Locations of BAS AWS (circles) and collaborators' AWS (crosses)*



▲ *Site 8 AWS, Ronne Ice Shelf*

Sledge Bravo

Long-term microenvironmental 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

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.

This is a long-term data-gathering activity, designed to provide robust descriptions of the 'micro-environment' experienced at biologically-relevant small physical scales in different but typical Antarctic terrestrial habitats.

These observing sites were established mostly in the early to mid-1990s, when it was realised that biological responses to climate variability and change were a fundamentally important research area, and yet that there was no way of linking large-scale climate descriptions with biologically-relevant scales. 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. 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.

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

▲ *Coal Nunatak automatic weather station (AWS)*

▲ *Mars Oasis site*

Sledge Charlie

The contribution to sea-level rise of the Amundsen Sea Sector of Antarctica (iSTAR D)

(MIKE BENTLEY, PETER CLARKE, MATT KING), [BAS Engineers]

Location: Union Glacier

Timing: November 20107

The overall aim is to determine the long-term (last 20,000 years) thinning history of the Amundsen Sea glacier catchments and their environs, and to use this information to provide better estimates of how much ice is being lost today. One of the main ways we measure ice-mass loss from Antarctic is to use gravity satellites to determine the mass change over several years. However, the satellite data need to be corrected for an important effect called Glacial-Isostatic Adjustment (GIA), where the solid Earth rebounds after deglaciation. Our work here is to produce a better model of GIA for this part of Antarctica so as to reduce the uncertainty in estimates of the ongoing sea-level contribution of this part of Antarctica.

Once we know how much ice was lost from the area and when, then we can input these data to models which simulate the crustal rebound of the Earth following deglaciation. We can determine if these models are any good by using our GPS measurements of uplift to test if they predict the correct uplift rates in this part of Antarctica, which currently is the single most important contributor to sea-level rise from the continent.

GPS receivers were installed at three sites in 2013/14 to measure crustal uplift over the next few years. An account of GPS installation and ice history work in season 2013/14 can be found here: *www.istar.ac.uk/2014/02/24/the-istar-d-team-describe-how-their-mission-went*

The fieldwork this year will be for engineers to visit the sites using aircraft-supported day trips, download data, and to make any repairs or upgrades necessary.

▲ *Example of a GPS receiver installation at Mt Woollard*

Sledge Delta

Finlandia Foothills protected area investigation

KEVIN HUGHES, Peter Convey, Peter Fretwell, Richard Phillips, Ali Massey, *Julie Baum, *Ali Rose

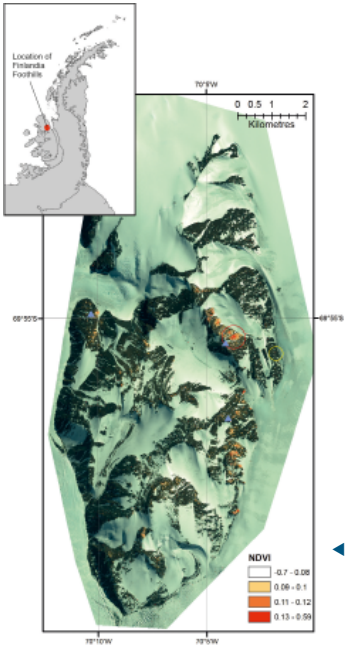
Location: Finlandia Foothills, Alexander Island

Timing: January to February 2018

Through the Environmental Protocol, Antarctic Treaty Parties agreed to establish a systematic network of protected areas to protect the many exceptional environmental and scientific values present in the region. The UK continues to lead activities to deliver this goal.

Available evidence suggests that the Finlandia Foothills (just north of Fossil Bluff on Alexander Island) contain unusually rich communities of birds and plants. We want to gather baseline data to determine whether or not the area is appropriate for designation as an Antarctic Specially Protected Area (ASPA). We also want to see if relevant information on protected areas can be collected largely using remote sensing techniques (satellites and UAVs) and thereby promote the use of these methods in other locations suitable for ASPA designation, but which are remote from existing research stations and difficult to get to. Hopefully this will allow ASPA monitoring to be undertaken more easily and cost-effectively.

We also want to undertake an environmental management visit to ASPA 147 Ablation Valley and Ganymede Heights, which is located on Alexander Island, and investigate the options for protecting of habitats on the islands in Ryder Bay.



◀ *Location map of Finlandia Foothills showing potential vegetated areas in orange and possible bird colonies as blue triangles. The red circle denotes the primary proposed area of survey and the yellow circle indicates a possible campsite*

▲ *Finlandia Foothills from the window of a Twin Otter aircraft looking from south to north*

Sledge Echo

Basal conditions on Rutford Ice Stream: BEd Access, Monitoring and Ice-Sheet History (BEAMISH)

ANDY SMITH, Rebecca Schlegel, Keith Makinson, Paul Anker, [*Field Guide]

Location: Rutford Ice Stream

Timing: December 2017 to February 2018

BEAMISH is all about being able to make better predictions of future ice-sheet change and its effects on sea level. At the moment, the biggest uncertainty in our ability to predict sea-level rise comes from the ice sheets. The BEAMISH project aims to improve understanding of two aspects of this uncertainty, the past behaviour of the West Antarctic Ice Sheet, and the flow of the glaciers that drain it. By choosing the right location, we can address both of these with a single project.

This season is the second of four. There are a number of tasks which will be spread over two phases. Firstly, two people (Smith and Schlegel) will spend December and January collecting geophysical data. Most of the work will be driving grids of survey lines, towing the BAS 'DELORES' radar behind a skidoo to map the shape of the bed beneath the ice. This work will be concentrated in the BEAMISH area, 40km upstream from the grounding line – the location where the ice enters the Ronne Ice Shelf. Long-term instruments already installed at BEAMISH will be serviced and set running again. Some work will also be carried out at the grounding line, measuring how the ocean tides further downstream can affect the ice stream and its bed.

The second phase of this season's work will begin when the iBEAM traverse arrives from Three Ronnies Depot with equipment and fuel offloaded from RRS *Ernest Shackleton*. Makinson will replace Schlegel in the field and the rest of the season will be spent working on the BEAMISH drill equipment in preparation for the major deep-drilling activities to the bed of the glacier in 2018/19.

▲ *Deep drilling on Rutford Ice Stream*

▲ *BEAMISH site location on Rutford Ice Stream*

Sledge Foxtrot

Observing the turbulent oceanic boundary layer beneath ice shelves (SIBLEX)

(KEITH NICHOLLS), [BAS Engineers]

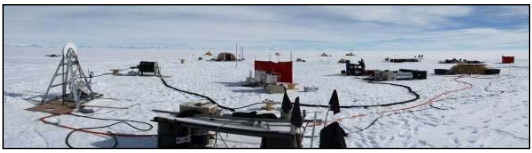
Location: Larsen C Ice Shelf and King George VI Ice Shelf

Timing: Opportunistic throughout the season

Antarctic ice shelves act as a restraint on the flow of ice from the continental interior into the ocean, and as such act as a control on the Antarctic Ice Sheet's contribution to global sea level. Satellite data have shown the Amundsen Sea sector of the ice sheet to be reducing in size, indicating increased ice flow into the ocean. The continental shelf in that sector of Antarctica is flooded with relatively warm water, resulting in high melt rates at the base of the ice shelves. It is thought likely that changes in ocean conditions are causing increased melting, and, therefore, a reduction in the restraining effect of the ice shelves. We need to be able to predict the response of these ice shelves to the changing ocean conditions in order to predict how Antarctica's contribution to sea-level change will be affected by a changing climate.

These predictions will ultimately be made using numerical models of the ocean, including that part of the ocean occupying the cavities beneath the floating ice shelves. The key driver for the circulation of water in the Amundsen Sea sub-ice shelf cavities is the release of buoyant meltwater at the base of the ice shelves. So the crucial process is the one by which the heat gets from the ocean up to the ice base through the ice-ocean boundary layer, that is, the layer of water, some tens of metres thick, that is affected by the presence of the ice base. The physics of the boundary layer beneath rapidly-melting ice shelves is particularly poorly understood, and as a result inadequately represented in numerical models. One of the problems is that the melting itself increases the buoyant flow up the inclined ice-shelf base, and the increased speed increases the turbulence and therefore the rate of transfer of heat towards the ice. At the same time, the increased buoyancy near the ice base makes it more difficult for the warmer, but denser, ocean water to be lifted through the boundary layer. The subtle interplay between competing effects results in a complicated, but fascinating, geophysical problem.

Six years ago, we used a hot-water drill to make access holes through both a rapidly-melting ice shelf and a slowly-melting ice shelf and made measurements in the boundary layers at their base to enable us to improve the way they are represented in models. Instruments were left suspended beneath the ice shelf so that they could monitor the speed of flow of the boundary layer, its temperature, and the rate of basal melting. The data will provide, for the first time, a comprehensive view of the boundary layer beneath a rapidly-melting ice shelf, to be contrasted with the slowly-melting counterpart, providing a step forward in our understanding of the physics of a unique environment. This year we will revisit the sites to replace/maintain data loggers and battery boxes.



▲ *Hot water drilling field site*

Sledge Golf

Geological mapping of the Gutenko Mountains area

TEAL RILEY, *Bradley Morell

Location: Palmer Land plateau

Timing: Early December 2017 to late January 2018

This project continues the geological mapping programme of eastern and central Palmer Land in an attempt to fully understand the stratigraphy and geology of this region. Previous mapping campaigns have identified the key geological units: the crystalline basement, the metasedimentary rocks and the overlying volcanics and terrestrial sedimentary rocks. However, the exact relationships between these units is still poorly known, as is their relationship to their probable extension into southern South America and elsewhere in West Antarctica.

The planned field area is the Gutenko Mountains region of Palmer Land, which is an area that remains poorly investigated on the Antarctic Peninsula and may form an important link to understanding the basement geology of West Antarctica.

Part of the remit of the geology and geophysics team is to provide national capability for understanding the geological evolution of British Antarctic Territory, to produce geological maps and also a full understanding of resource potential.

▲ *Geological fieldwork in eastern Palmer Land*

Sledge India

Understanding how penguins find their prey in a dynamic ocean

PHIL TRATHAN, Jean-Baptiste Thiebot, Jessica Phillips, Vicky Warwick-Evans, *Steve Windross

Location: Harmony Point on Nelson Island in the South Shetland Islands and Gourlay Peninsula and North Point at Signy, South Orkney Islands

Timing: December 2017 to February 2018

The fishery for Antarctic krill is managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and takes place across the west Antarctic Peninsula and nearby Scotia Sea. Following regional decreases in seasonal sea-ice extent and duration, it is now increasingly operating during the summer months at a time when land-based krill predators are breeding. The fishery has the potential to impact upon all krill predators, including penguins, other seabirds, seals, whales and finfish. Such impacts potentially include the depletion of prey or the disturbance of krill swarm structure. Quantifying the actual threat afforded by the krill fishery is now vital not only for understanding how the fishery should be managed, but also for how marine protected areas might be developed.

As part of an international collaboration that will help inform CCAMLR, we will investigate how penguins forage and how they actually find and utilise krill swarms; this remains a key challenge, not only for understanding how penguins and the fishery may compete, but also for how penguins provision themselves and their offspring in a variable and changing environment.

We propose to deploy GPS tracking devices, dive loggers, accelerometers and miniature video cameras on Adélie and chinstrap penguins to determine whether penguins feed preferentially on the same dense krill swarms used by the fishery, or on loose low-density krill aggregations. High-definition video cameras will be deployed on both species in order to best ascertain how penguins locate and utilise krill resources. We plan to use two sites, Harmony Point on Nelson Island in the South Shetland Islands and Gourlay Peninsula and North Point at Signy, South Orkney Islands.

▲ *Chinstrap penguins (Pygoscelis antarctica)*

Sledge Juliet

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

(PIPPA WHITEHOUSE), [BAS Engineers]

Location: Throughout West Antarctica

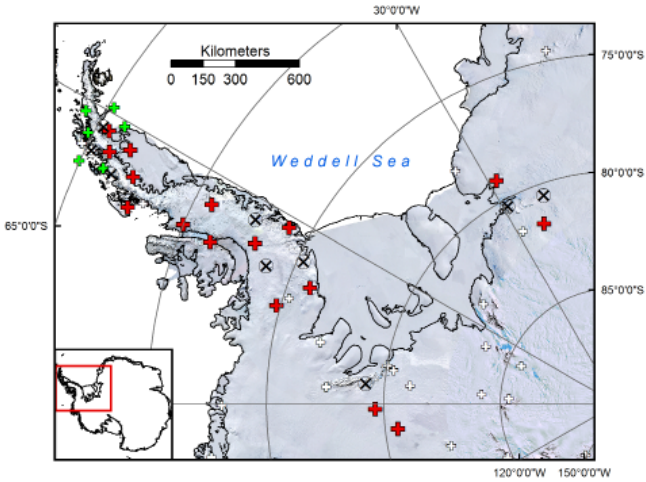
Timing: 2017 to 2022

Satellite measurements of ice-sheet change are necessary to understand and predict sea-level rise, but they are contaminated by a phenomenon known as Glacial Isostatic Adjustment (GIA). GIA is the ongoing solid Earth deformation that occurs in response to past ice-mass change. This process can be predicted using mathematical models, but the models must be calibrated and validated using precise measurements of Earth deformation made using GPS receivers sited on bedrock.

A network of GPS receivers already exists throughout the remit of UK logistical support in Antarctica. The majority of these instruments are associated with ongoing projects in which the PI and Co-Is of this project are also involved (Sledges Charlie, Juliet, November and Zulu). Under this new project we will upgrade the existing GPS network so that the data can be transmitted continuously off continent to open access servers via satellite.

The resulting step change in data accessibility, and the increased precision from the extended time series, will enable us to pioneer a new approach to determining spatially-variable mantle viscosity that involves analysing the response of the solid Earth to episodic snowfall anomalies. This information will be used to improve the accuracy of Antarctic GIA models.

▲ *GPS instrument adjacent to Larsen C Ice Shelf*



▲ *Map of GPS network (red shows existing UK sites to be upgraded, green shows existing US sites to be taken over, black indicates existing UK sites likely to be decommissioned, and white shows existing US sites not maintained by BAS)*

Sledge Kilo

Larsen B Ice Shelf and Glacier Flow: Instrument servicing

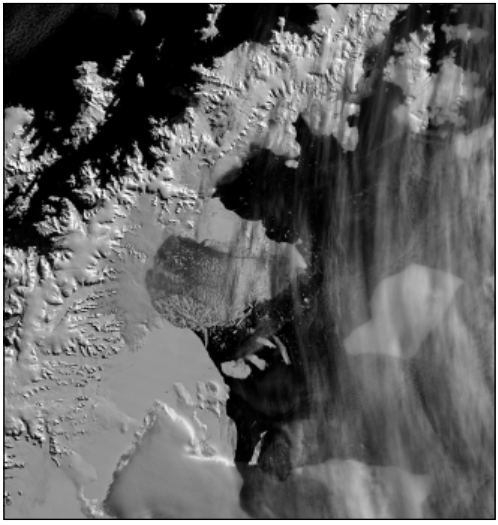
(HILMAR GUDMUNDSSON), [BAS Engineers]

Location: Larsen B Ice Shelf: Flask Glacier, Scar Inlet

Timing: November to December 2017

This fieldwork is part of a study on the interactions between ice shelves and glaciers. In 2002 most of the Larsen B ice shelf collapsed leaving a much smaller remnant ice shelf (Scar Inlet). Following this collapse, a number of glaciers feeding into the ice shelf have sped up and thinned and this thinning appears to be ongoing. Unfortunately, no in situ data on temporal variations in flow of the ice shelf and the glacier tributaries prior to and following the collapses could be collected. We therefore have limited means of testing numerical models.

During the 2012/13 season, five GPS were deployed on Scar Inlet and its tributary glaciers (Flask and Starbuck) to measure the velocity of the ice shelf and the glaciers. It is anticipated that Scar Inlet Ice Shelf is likely to collapse in the near future so the aim is to measure how the glaciers are moving before, during and after the collapse. The two GPS sites on Starbuck glacier were removed during the 2014/15 season. This season the remaining sites will be removed.



▲ *Satellite image showing the collapse of the Larson B Ice Shelf*

Sledge Lima

Low power magnetometer servicing

(MIKE ROSE, MERVYN FREEMAN), [BAS Engineers]

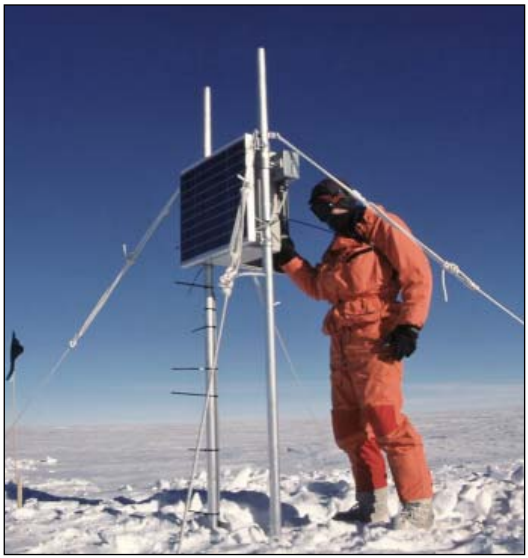
Location: Polar plateau

Timing: Throughout the season

The Low Power Magnetometers (LPMs) operate unmanned all year round, including the long winter, when continuous periods of darkness and temperatures as low as -80°C prohibit human intervention. This has been made possible by new technology which allows the magnetometers to use very little power and survive the winter on solar power stored during the summer. The network measures magnetic fluctuations over a wide area. The data can be used to produce maps of space weather in the region around the Earth where satellites orbit.

Information is recorded by the instrument and removed once a year during servicing.

This project will be supported out of Halley and Rothera.



▲ *BAS scientist checking the solar power unit for one of the remote low power magnetometers*

Sledge November

Reducing the uncertainty in estimates of the sea-level contribution from the westernmost sector of the East Antarctic Ice Sheet since the Last Glacial Maximum

(MIKE BENTLEY, PETER CLARKE), [BAS Engineers]

Location: Halley and Coats Land

Timing: January to February 2018

The project aim is to determine the long-term (20,000 years) Coats Land ice-thinning history, and to use it to better estimate current ice-loss rate. The main way we measure ice-mass changes is using gravity satellites, which need to be corrected for an important effect called Glacial Isostatic Adjustment (GIA), where the solid Earth rebounds after deglaciation. We aim to produce a better GIA model to reduce the error in estimating the ongoing sea-level contribution of this part of Antarctica.

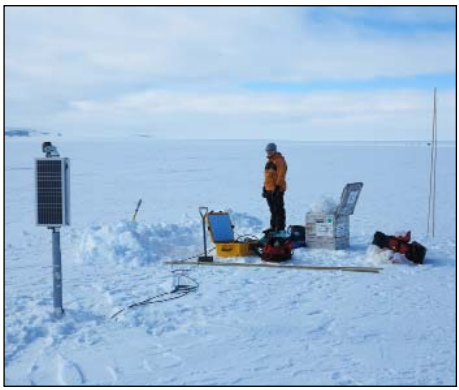
Skidoo-based Sledge India will identify geomorphological evidence of ice-thinning in Coats Land, and collecting samples of rock and mumiyo (solidified petrel stomach oil), for radio-isotopic dating, which can tell us when ice was absent.

Sledge November will be using aircraft to install GPS at four sites to directly measure the uplift, and two seismometers to rectify the regional Earth interior models.

Once we know the ice-loss history, we can input these data into models simulating the crustal postglacial rebound. We can evaluate these models by using our GPS measurements of uplift in this part of the continent, which currently has the highest uncertainty in its contribution to sea-level rise of any region of Antarctica.

This project will be supported out of Halley and Rothera.

▲ *GPS site*



▲ *Seismic site*

Sledge Oscar

BAS depot work

*Julie Baum, *Ali Rose, *Blair Fyffe, *Neil Philips

Location: Theron Mountains, Bluefields, Eagle, Castle, PIGE and Kenfield depots

Timing: Mid-December 2017 to mid-January 2018 (Halley), throughout the season (Rothera)

Raise and restock logistics depots in Coats Land and West Antarctica. Aiming to move approximately 200 barrels from Halley to deep-field depots, and raise West Antarctic depots in preparation for upcoming work in the Thwaites Glacier area.

▲ *Before*

▲ *After*

Sledge Romeo

ORCHESTRA – Measuring fluxes from the air

TOM LACHLAN-COPE, ALEX WEISS, Russ Ladkin, Ella Gilbert

Location: Rothera and Marsh

Timing: November to December 2017

Because the ocean absorbs vast quantities of heat and carbon dioxide it is critical in controlling how our planet's climate changes. A key region in this context is the Southern Ocean, the vast sea that encircles Antarctica. Although the Southern Ocean occupies only around 20% of the total ocean area, it absorbs about three-quarters of the heat that is taken into the ocean, and approximately half of the CO_2. However, our understanding of the detailed mechanisms by which heat and carbon is transferred across the sea surface and drawn down into the interior is incomplete and the ORCHESTRA project will investigate these processes. This season at Rothera we will use the Twin Otter equipped with atmospheric instruments (MASIN) to measure fluxes in association with oceanographic observations of the Northern Peninsula flying from the Chilean base Marsh on King George Island as well as taking observations in the Weddell and Bellingshausen Seas, flying from Rothera.

▲ *Twin Otter equipped with atmospheric instruments*

Sledge Whiskey

Long-range fixed-wing UAV flight testing and integration into BAS Antarctic airspace

(CARL ROBINSON, MIKE ROSE), Scott Polfrey, William Clark

Location: Antarctic Peninsula, Rothera

Timing: January to February 2017

BAS has a growing fleet of UAVs available to carry out science and operations tasks in Antarctica. One of the most recent additions to BAS capability is the purchase of two UAVE PRION3 airframes and ground system. During September 2016, BAS staff underwent training in Wales with the manufacturer and at the UK UAV test range at Aberporth, to learn how to operate and fly the PRION3 UAV.

This season will be the first time that a UAV has operated out of Rothera fully integrated with the normal BAS operations.

Aircraft operations	
Range	14 hours, 1,000+km
Airspeed	80km/hr data collection
Complement	One pilot and one ground controller
Altitudes	Up to 3,000m AGL plus

This year our objectives are to conduct flying from Rothera runway and ski-way to prove that the BAS PRION3 UAVs fly well in the Antarctic. Part of this test flying is to integrate long-range fixed-wing UAVs into the Antarctic airspace and to develop all the required protocols for the interfacing departments and sections.

▲ The BAS *UAVE PRION3*

Sledge X-Ray

University of Utrecht IMAU AWS in the Antarctic Peninsula

(CARLEEN REIJMER, MICHIEL VAN DEN BROEKE, WIM BOOT), Daniel Rylett, Mairi Simms

Location: Larsen B and Larsen C Ice Shelves

Timing: Opportunistic throughout the season

In close collaboration with BAS, UU/IMAU operates automatic weather stations, so called iWS, at two sites in the Antarctic Peninsula (AP), which are serviced each year by BAS personnel from Rothera. These iWS 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 last year to the latest iWS 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 Adrian Luckman), the station is still operational. In the 2017/18 season data will be collected and the iWS 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 the snow temperature sensors.*

Sledge Zulu

Lithospheric structure of West Antarctica to control Glacial Isostatic Adjustment (GIA) models (UKANET) (CAPGIA)

GRAHAM STUART, (PIPPA WHITEHOUSE, ALEX BRISBOURNE), [BAS Engineer]

Location: Southern Antarctic Peninsula and Ellsworth Land

Timing: December 2017 to January 2018

To estimate future global sea-level change, it is vital to predict the evolution of the West Antarctic Ice Sheet. Fluctuations in the ice-sheet mass cause fluctuations in the Earth's gravity field, so gravity data can be used to track ice loss. However, the total gravity signal also reflects other Earth processes, the most problematic of which is Glacial Isostatic Adjustment (GIA) in response to ice load changes. During GIA, the Earth's mantle slowly flows back toward equilibrium following the advance or retreat of a significant surface ice load. The viscosity of the Earth's mantle means that this internal mass re-distribution can lag the actual ice-sheet change by thousands of years. Therefore, we can only isolate the gravity signal caused by present ice-mass change by removing the GIA signal caused by past ice-sheet behaviour. To do this, we must know the viscosity of the mantle. In our case we will use seismic velocities to estimate lateral changes in viscosity. In 2015/16 we deployed a network of 10 seismic stations across eastern West Antarctica, complementary to the equivalent number of temporary US stations, to record seismic energy from earthquakes occurring worldwide over a two-year period.

In the 2016/17 season we serviced the stations (moving several to more optimal locations) and retrieved the first year of data. In the 2017/18 season we plan to retrieve the equipment. We will ultimately recover the viscosity of the mantle from the recorded waveforms. A network of 10 GPS sites is maintained in the same region as the seismic stations. These record rates of solid Earth deformation and the data are used to validate numerical models of the viscoelastic response of the Earth to past ice-sheet change, i.e. the GIA signal. At the end of this project the GPS sites will be maintained by a follow-on NERC project.

▲ *Installing a seismic station at McKibben nunatak on the Antarctic Peninsula*

▲ *Seismic station at Pine Island Glacier, Ellsworth Land*

EPICA

Beyond EPICA – Oldest Ice

ROBERT MULVANEY, Julius Rix

Location: Dome C, East Antarctic Plateau
Timing: November 2017 to January 2018

A decade ago, the European EPICA project completed drilling a deep ice core at Dome C, revealing the close link between climate and atmospheric greenhouse gases over the past 800,000 years. The record showed that the Earth's climate experienced a 100,000-year cycle of cold glacial periods (ice ages) interspersed with warmer interglacials. But marine sediment records show that earlier than one million years, glacial periods occurred once every 41,000 years. We feel that the clue to the change in glacial frequency lies in the greenhouse gases in the atmosphere, so a team of European scientists intend to drill another ice core that we hope will reach back 1.5 million years.

Candidate sites for the 'Oldest Ice' drilling project have been chosen using ice-sheet modeling, but need field observations to confirm and select the best site. In the 2016/17 season we deployed the BAS DELORES radar system to map the detailed bedrock topography around two candidate sites, and tested our Rapid Access Isotope Drill (RAID) ready for the coming season. This year, working with our Italian and French colleagues, we will add additional DELORES radar lines close to the one candidate site that we found most favourable for the deep drilling last year. We will also drill with the RAID system through the upper part of the ice sheet to recover ice back to the last glacial period to confirm age-depth models, and measure the borehole temperature to check for absence of melting at the bed. By re-measuring with the ApRES radar sites that were measured last year, we hope to provide supporting detail of the local ice-sheet dynamics.

▲ *Remote camp at Little Dome C (candidate site for the Oldest Ice deep drilling)*

▲ *Using a PistenBully to pull the DELORES radar*

Ice shelves in a warming world: Filchner Ice Shelf System, Antarctica (FISS)

Sledges Hotel, Papa, Sierra, Tango, Uniform

Ice shelves in a warming world: Filchner Ice Shelf system, Antarctica

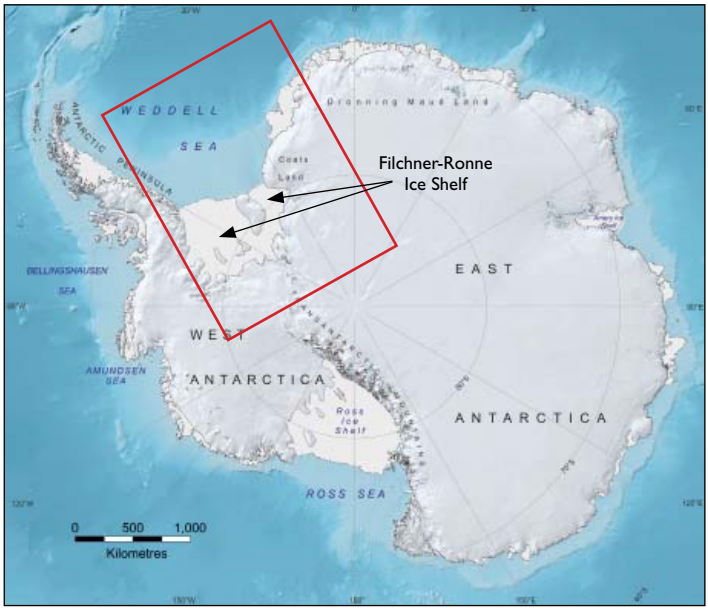
(HUGH CORR, HILMAR GUDMUNDSSON, KEITH NICHOLLS, ANGELIKA HUMBERT, SVEIN ØSTERHUS), Daniel Steinhage, [BAS Engineers]

Location: Filchner Ice Shelf

Timing: November 2017 to January 2018

The primary aim of the project is to determine how a large sector of the Antarctic Ice Sheet will evolve in a warming world. The prospect is for atmospheric and oceanic forcing to reduce the thickness and extent of floating ice shelves as a result of increased melting at their base. A thinned ice shelf has a lowered ability to buttress the flow of its grounded tributary ice-streams. Removal of an ice shelf therefore allows the restrained ice to flow faster, drawing down the vast interior reservoir and resulting in global sea-level rise. However, the rate, pattern and timing of the ice-shelf melt and the associated sea-level rise are uncertain. We propose a carefully targeted observational programme, in support of a comprehensive modeling activity. The sector to be studied is the Filchner Ronne Ice Shelf and its five tributary ice streams, which spans sections of both the East and West Antarctica Ice Sheet. Specifically, projections will be made out to the end of this century of the contribution to global sea-level rise from this sector.

continued ▷



▲ *The red box shows the area of study*

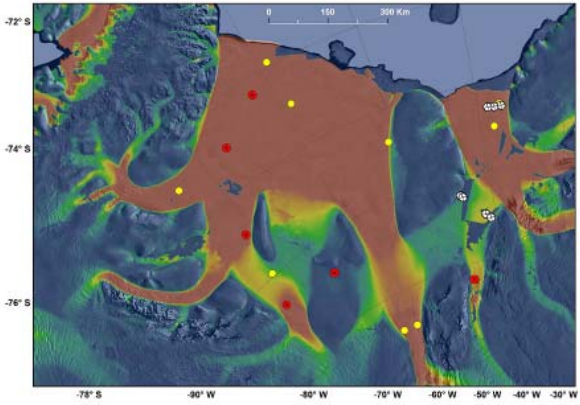
Ice shelves in a warming world: Filchner Ice Shelf System, Antarctica (FISS) *continued*

During the last two seasons a suite of instruments were deployed across the ice shelf. Now these instruments have to be visited and the data that was recorded over the last 12 months will be retrieved, then the stations will be either maintained or removed. The fieldwork consists of three primary tasks:

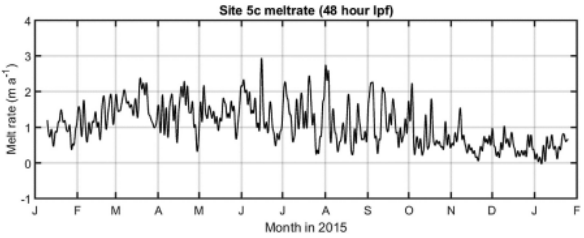
1. The uplift of seven and the maintenance of another seven BAS ApRES radar sites across the Filchner Ronne (Sledge Sierra)
2. The uplift of 11 GPS stations recording tidal movement and flexure on Foundation Ice Stream, Moller Ice Stream and recovery ice stream (Sledges Hotel and Papa).
3. Servicing of equipment at the ice-shelf bore holes. There are seven sites (FSE1, FSE2, FSW1, FSW2, FNE1, FNE2 and FNE3) at each site there are oceanographic and associated data loggers (Sledge Tango)

The deployed instruments were designed and deployed in key locations to supply a physical understanding of Filchner Ice Shelf, its tributary ice streams and the sub-ice-shelf ocean, in the present atmospheric and oceanographic regime. By using the hard-won datasets, numerical simulation of the complete system will be optimised and validated such that the various interconnected physical processes can be demonstrated. Our goal is then to show how the coupled atmospheric, ocean and ice sheet will respond to a change in climatic forcing and ultimately deliver reliable projections on how the Filchner region will contribute to sea-level rise over the 21st century.

This project will be supported out of Halley and Rothera.



The fieldwork area showing the seven instrumented boreholes, as black crosses, that will be maintained. The yellow dots are the seven ApRES instruments that have operated over the last two years; these will be removed. The red dots are the location of an existing seven ApRES instruments that will be maintained



A remarkable year-long record from one of the ApRES instruments. What is striking is how the spring-neap tides alter the basal melt rate and how there is annual variability. At this site the mean annual melt-rate was 1.25ma^{-1}

iBEAM

iBEAM logistic traverse

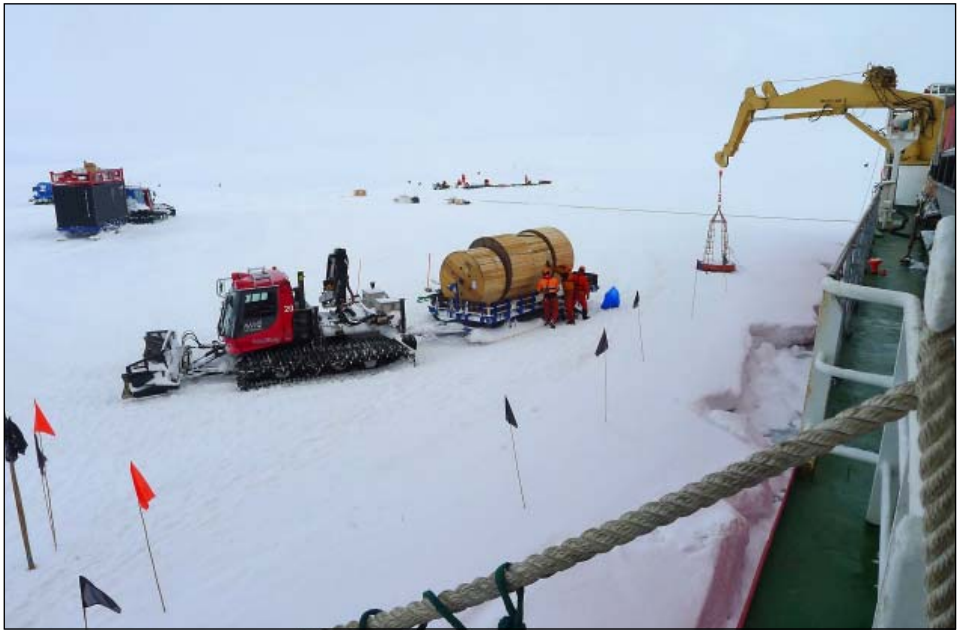
Tim Gee, Nick Gillet, Steve Pollitt

Location: Ronne Ice Shelf

Timing: Mid-December 2017 to late-February 2018

The iBEAM logistic traverse will support future projects BEAMISH drilling, WACSWAIN ice core, and Thwaites Project. The traverse is currently at Three Ronnies Depot (TRD) on the Ronne Ice Front. RRS *Ernest Shackleton* will call at the ice front in early January where cargo and vehicles from the FISS project will be collected and new traverse infrastructure, fuel and science cargo will be delivered.

The traverse will then depart TRD for the Rutford Ice Stream and depot fuel and equipment for the BEAMISH project in 2018/19. At this point the traverse will split and two vehicles will depart the Rutford for Sky Train Ice Rise where they will depot fuel and equipment for the WACSWAIN ice core drilling project in 2018/19. The traverse will reunite at BEAMISH depot on the Rutford where it will overwinter.



▲ *Offloading cargo at Three Ronnies Depot*

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

Location: Anchorage Island and Leonie Island

Timing: January to February 2018

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. In this proposal, we aim 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.

▲ *Collecting penguin poo samples*

Rothera Research Station

Polar marine viral diversity and dynamics

CORINA BRUSSAARD, [PhD Student]

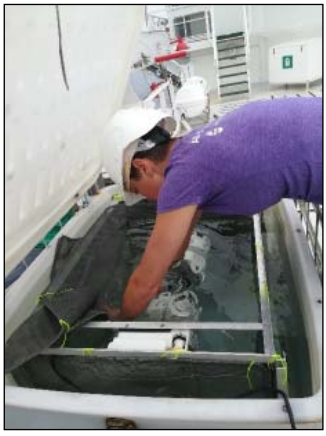
Location: Rothera RaTS monitoring site

Timing: January to April 2018 (and November 2018 to March 2019)

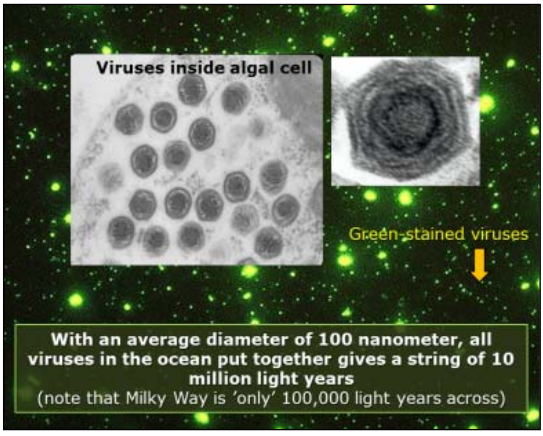
Nowhere are the effects of climate change more evident than at the poles of our planet. Micro-organisms (phytoplankton and bacteria) represent the vast majority of the living marine biomass, form the base of the foodweb, and are essential for global biogeochemical cycling. Their biomass is regulated by predation (grazers) and viruses. Viruses are parasites and after infection the unicellular host will (sooner or later) die while releasing newly produced virus progeny. Consequently, the flow of energy and matter is directed away from higher trophic levels and towards microbial decomposition.

To know the identity of the viruses infecting the ecologically relevant microbial groups is thus critical to ultimately developing predictive models and preparing for living on a changing planet. Preliminary results we obtained from earlier research at Rothera show that viruses kill Antarctic phytoplankton at rates comparable to grazing, revealing viral killing as a thus-far underestimated process affecting all polar phytoplankton groups. Although viruses appear to be an active and integral part of polar ecology, they are still largely uncharacterised.

Climate-change-induced shifts in microbial species composition and their specific viruses can be expected to affect biogeochemical cycling and therewith ecosystem functioning. Using state-of-the-art viral metagenomics sequencing, in combination with viral ecology will allow us to obtain new insights into the diversity and temporal dynamics of viruses with their specific hosts in Antarctic waters.



▲ *Outdoors incubator used to measure virus-induced mortality rates of phytoplankton populations*



▲ *Green fluorescently stained marine viruses (small dots; larger dots are bacteria) found in seawater with average concentration of 10 million per milliliter. Virus particles inside algal cell with a diameter of around 120 nanometer*

Rothera Research Station

Terrestrial and freshwater biodiversity and sample collections for BEA collaborations and associated PhD

PETE CONVEY, Ali Massey

Location: Alexander Island (Mars Oasis and Fossil Bluff), Rothera (local islands, Reptile Ridge, Stork Ridge)

Timing: November 2017 to February 2018

To support several different BEA collaborations and associated PhD students, specific collections are being requested this season of particular terrestrial and freshwater invertebrates and plants. These include the freshwater copepod *Boeckella poppei* from Alexander Island, the terrestrial flowering plant *Colobanthus quitensis* from Leonie Island, and the terrestrial springtail *Cryptopygus antarcticus* which is widely distributed around the Rothera local islands.

The copepod forms part of a much wider study of the biogeography and evolutionary history of this species across Antarctica, the sub-Antarctic and southern South America, as this species – possibly uniquely across all Antarctic invertebrates – is thought to occur across all of these regions. The subsequent analyses are being carried out by PhD student Claudia Maturana (who it is hoped will also be able to collect new material of the species on Signy this season), whose studentship is joint between BAS-BEA (supervised by Pete Convey, Jen Jackson) and the University of Chile in Santiago (Elie Poulin).

The *Colobanthus* collections are in support of an analogous NERC-CONICYT funded project being carried out by Elise Biersma, Kevin Newsham and Pete Convey in BEA, again with Chilean collaborators. This project again seeks to clarify the biogeographical relationships of this important Antarctic plant (one of only two species to occur in the Antarctic proper), and to analyse patterns and relationships with the associated rhizosphere soil surrounding the plant roots' microbial communities. The plant occurs throughout the Antarctic Peninsula and Scotia Arc, and up into the Andes of South America, hence the collaborative project and approach.

Finally, the springtail collections, which are achieved by collecting mats of the alga *Prasiola crispa* in which it is often extremely abundant, are to support ongoing ecophysiological and genomic work by another BEA-associated PhD student (Gemma Collins), supervised by Pete Convey at BAS and Ian Hogg at the University of Waikato, New Zealand, whose work includes comparative studies of springtails from the Antarctic continent (Victoria Land) and Antarctic Peninsula.

▲ *The terrestrial flowering plant Colobanthus*

▲ *The terrestrial springtail Cryptopygus*

Rothera Research Station

Monitoring of south polar skuas at Rothera

KEVIN HUGHES, RICHARD PHILLIPS, Ali Massey

Location: Rothera Point and Anchorage Island

Timing: Annual long-term monitoring (2005-present)

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 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 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.

▲ *South polar skuas on Rothera Point*

▲ *Weighing a skua chick*

Rothera Research Station

Ecology and biodiversity of seaweeds in inshore Antarctic benthic communities

FRITHJOF KEUPPER, Simon Morley, Aurelia Reichardt

Location: Ryder Bay, Rothera

Timing: December 2017 to March 2019

Based on year-round diving surveys, this project will provide unprecedented, new insight about the ecology and biodiversity of seaweed-dominated benthic communities at Rothera (Adelaide Island, Antarctica). In particular, it will:

1. Investigate the physiological mechanisms of overwintering of Antarctic seaweeds (How do they manage to spend more than six months a year in darkness?)
2. Assess biodiversity patterns of both key species and communities with habitat and depth by diving surveys, and also covering the hitherto-unexplored cryptic algal diversity using the Germling Emergence Method
3. Evaluate the invertebrate communities associated with different macroalgal species and how they vary throughout the year
4. Assess the energy and/or carbon input to the benthic foodweb from macroalgal communities by assessing grazing rates of the main invertebrates consuming macroalgae in the summer and winter seasons.

This work is complementary to the BAS Rothera Marine LTMS.

▲ *Red algal community in South Cove, Rothera*

Rothera Research Station

Investigating photosynthesis and productivity responses of Antarctic ecosystems to environmental variability through the use of solar-induced fluorescence

KADMIEL MASEYK

Location: Rothera local islands

Timing: January to February 2018

The Antarctic region is experiencing rapid and dramatic changes to many environmental factors, including temperature, precipitation, ultraviolet radiation and wind speed, that control vegetation growth and distribution. The vegetation of the Antarctic is largely comprised of slow growing mosses and lichens that are sensitive to these rapid environmental changes, and therefore it is important to understand how Antarctic ecosystems are being affected by these changes. An important indicator of ecosystem health is its carbon balance, or how productive the ecosystem is. Plants get their carbon through the process of photosynthesis, which provides the energy for growth and resistance to stress. Plants use light for photosynthesis, and as part of this process also re-emit some light, called fluorescence. This signal can be measured just above the plants, but also from UAVs, planes and satellites, which enables us to track ecosystem activity over large areas and in time. In this project we will make measurements of fluorescence from the plant communities together with the rate at which the plants are taking up carbon, to provide baseline information that can be used for the development of more widespread monitoring programmes.

▲ *Moss banks on Leonie Island*

Rothera Research Station

RaTS – Rothera biological and oceanographical Time Series

(MICHAEL MEREDITH, HUGH VENABLES, DAVE BARNES), Zoë Waring, Marlon Clark

Location: Ryder Bay, Rothera

Timing: Ongoing LTMS, 1997 to present

The Rothera Time Series (RaTS) has been measuring ocean properties year-round in Ryder Bay since 1997. This sampling, carried out from small boats by a series of wintering scientists at Rothera, has created a unique description of changes through the whole year as there is no other similar sampling within the Antarctic Circle. There are also enough years now to see physical changes occurring and the consequences these have to biology, both marine algae (phytoplankton) suspended near the surface of the ocean and benthic organisms that feed on the phytoplankton after they fall to the seabed.

The most dramatic change was in 2007/08 when there was very little sea ice in the winter compared to most previous years. The loss of a protective surface allowed the winds to drive deep mixing in the winter to three times the normal depth (150m rather than 50m), releasing large amounts of heat from the warm (about 1°C) water at depth and some of the carbon that has been stored in this water for centuries. The following summer also saw large changes, with phytoplankton reduced by about 90% and benthic organisms not breeding due to lack of food. This was due to the water column being easier to mix following the previous deep mixing and also led to summer surface warming extending much deeper, more than compensating for the winter heat loss to 90m and therefore delaying sea-ice formation. 2008/09 was similar but conditions are now returning to previous levels.

These changes are against a background of reducing sea-ice cover along the western Antarctic Peninsula, warming air temperatures and retreating glaciers, which are all likely linked. It is therefore extremely important to understand the causes, feedbacks and biological consequences of these changes and the winter sampling and at Rothera, together with the length of the time series, provides a unique contribution to this wider study.

More information can be found here: *www.bas.ac.uk/project/rats*

▲ *RaTS sampling*

Rothera Research Station

BAS Rothera marine long-term monitoring

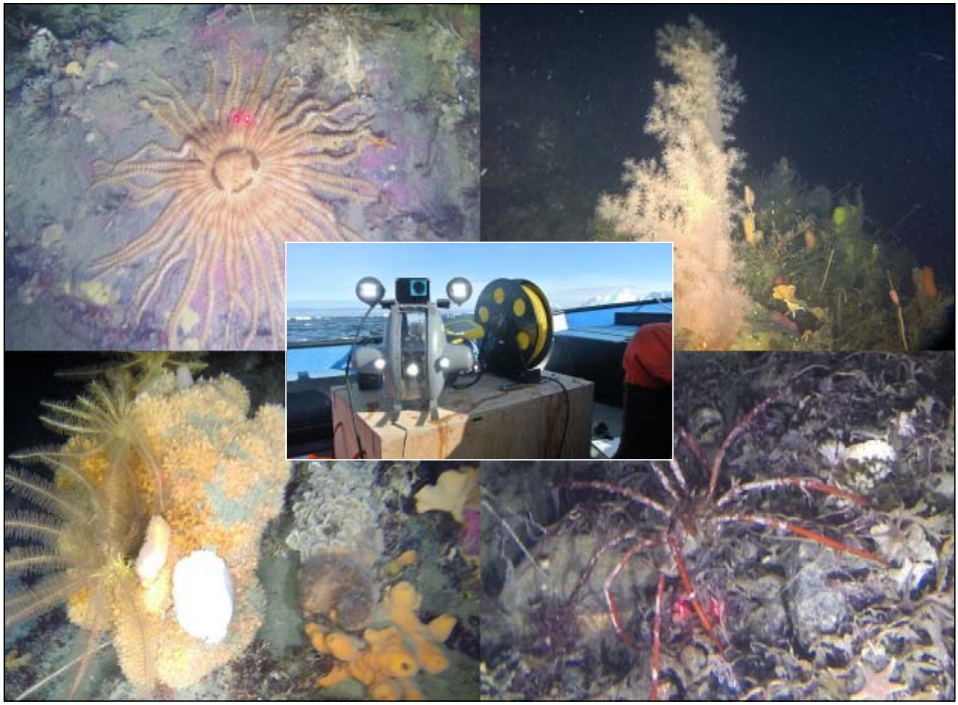
(LLOYD PECK), Simon Morley, Ben Robinson, Aurelia Reichardt

Location: Ryder Bay, Rothera

Timing: November 2015 to April 2019

The work consists of two parts:

1. Long-term monitoring of reproductive effort in Antarctic marine invertebrates (PI Lloyd Peck) and long-term sampling of metagenomics (PI Melody Clark) with samples taken year round by the Rothera marine biologist and the Rothera marine assistant
2. Marine biologist project within Adaptations group: this is currently an ROV project (operated by Ben, who is studying the biodiversity, structure and physiology of Antarctic benthos down to 100m depth), but will change with the incoming marine biologist (Aurelia) to be biodiversity surveys of animals associated with macroalgae (seaweed) and biotech evaluation of macroalgae biofilm



▲ *DEBRA and Rothera marine life photographed by the ROV (inset)*

Rothera Research Station

Seabird studies at Rothera

RICHARD PHILLIPS, KEVIN HUGHES, Ali Massey

Location: Rothera and local islands

Timing: January to February 2018

Adult skuas at Rothera Point will be captured, measured, weighed, ringed, a small blood sample (1-2ml) will be taken from the tarsal vein and feathers sampled (for sexing, stable isotope, health and pollutant analyses), and cloacal and oral swabs taken (for disease surveillance).

Birds will also be fitted for approximately one week with a GPS logger taped to mantle feathers and an immersion logger on the leg to track movements and at-sea activity patterns. Geolocators will be removed from skuas that have been tracked since last season. The plastic rings will allow long-term monitoring of adult survival, breeding frequency and breeding success, and the detection of runway incursions by breeding birds from the Point (important information for the Air Unit).

Anchorage, Lagoon, Leonie, Killingbeck and other islands will be visited to count skua pairs and estimate population size for potential important birds area/protected area designation (requested by the FCO). Tissue samples from dropped prey, pellets, carcasses, invertebrates etc. will be collected at each location for stable isotope analyses.

▲ *Ringed South Polar Skua*

▲ *South polar skua*

Rothera Research Station

INACH collaboration: freshwater crustacean and inter- and sub-tidal marine invertebrate biogeography and population genetics

(ELIE POULIN, CLAUDIO GONZALEZ-WEVAR), Johanna Marambio, Simon Morley

Location: Ryder Bay, Rothera

Timing: December 2017 to February 2018

A key element of BAS's BEA programme is describing and understanding patterns of biodiversity in the marine environment, both at the small scale (e.g. Ryder Bay), and the much larger scale of the Antarctic Peninsula, Scotia Arc, and links with South America. In this, we have long-standing but largely informal collaboration in part through the SCAR scientific programmes with the two named Chilean PIs, who are genuine world leaders in applying phylogeographic approaches to the Antarctic region and specifically to major groups within marine biodiversity. Thus, they are the 'partner of choice' for the collaborative work proposed here. Between them, they have a number of INACH or CONICYT funded projects studying the phylogeography of various marine invertebrate groups along the South American coasts, Tierra del Fuego, Falkland Islands, sub-Antarctic islands, Scotia Arc and northern Antarctic Peninsula.

This project makes an important step south in geographic coverage, reaching Marguerite Bay and taking advantage of BAS marine biodiversity and diving expertise based at Rothera, and giving BAS scientists direct involvement in their wide-scale studies. Field fresh collections made using BAS diving operations, will be processed by the Chilean collaborators and Simon Morley, following their established protocols.

▲ *Benthic marine life at Rothera*

Rothera Research Station

Snow algae – are they the most abundant photosynthetic organisms in terrestrial Antarctica?

(ALISON SMITH, PETE CONVEY, PETER FRETWELL, LLOYD PECK), MATTHEW DAVEY, Andrew Gray

Location: Rothera and local islands

Timing: January to February 2018

All ecosystems are dependent on the so-called primary producers, photosynthetic organisms that fix CO_2 using solar radiation, which then support growth of all the other species. In the polar regions, terrestrial life is able to flourish only on areas that are ice-free for at least part of the year, which is very limited. Along the Antarctic Peninsula for example, even though it is the most vegetated region of Antarctica, less than 2% of exposed ground is covered with plants, mainly mosses and lichens. Work by our group and others have started to establish that snow-algae may be important primary producers in coastal snow fields. These are single-celled photosynthetic organisms, which appear as highly visible red and green patches on the snow surface.

A single snow algal 'bloom' can cover tens to hundreds of square metres and when integrated across the entire Antarctic Peninsula region, the area (and possibly even the biomass) might exceed that of the true terrestrial vegetation. Given their potential importance, and in the face of rapid regional climate change, it is essential that we increase our understanding of these organisms to provide a balanced view of polar terrestrial biodiversity and its contribution to overall Antarctic ecosystem services.

▲ *Matt Davey and Anchorage snow algae*

Bird Island Research Station

Bird Island marine predators LTS

(RICHARD PHILLIPS), John Dickens, Camille Toscani, Carrie Gunn, Elizabeth Morgan, Tegan Newman, Derren Fox

Location: Bird Island

Timing: Year-round

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).

▲ *Antarctic fur seals*

▲ *Grey-headed albatross*

King Edward Point Research Station

South Georgia fisheries science

(MARK BELCHIER, SUE GREGORY), Vicki Foster, Kieran Love

Location: King Edward Point

Timing: Ongoing

BAS Fisheries scientists at KEP 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. The work involves monthly sampling of fish larvae in Cumberland Bay and Rosita harbour on the northern coast of South Georgia to assess changes in their composition, distribution and abundance. Samples of fish obtained from the South Georgia commercial fishery and the 2017 groundfish survey will be analysed to provide information on their ecology and diet. This information is used to assess potential fishery impacts on non-target species and provides data on long-term variability in the South Georgia ecosystem. These data will also contribute to the forthcoming review of the South Georgia MPA.

Scientists at KEP are deployed as scientific observers on commercial fishing vessels operating throughout the year on krill, icefish and toothfish vessels where they collect additional information on fishery/ecosystem interactions.

▲ *King Edward Point Research Station in Cumberland Bay, South Georgia*

▲ *Scientific sampling of survey catch on a commercial fishing vessel*

King Edward Point Research Station

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

(MARK BELCHIER, SUE GREGORY), Vicki Foster, Kieran Love

Location: King Edward Point

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. 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 additional observation and monitoring of breeding elephant seals will be carried out at King Edward Point.

▲ *King penguins at Maiviken, South Georgia*

King Edward Point Research Station

South Georgia Geomagnetic Observatory

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

Location: King Edward Point

Timing: Ongoing, started 2010

The project involves the creation (2010-2011) 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.

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

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

King Edward Point Research Station

Monitoring sea-level movement at KEP

ANGELA HIBBERT, JEFF PUGH, PETER FODEN

Location: King Edward Point

Timing: January to February 2017

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) Programme. 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 is to provide a means of monitoring the Antarctic Circumpolar Current, while providing 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 data logger 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.

▲ *Pressure sensor location*

▲ *NOC engineer installing the main logger cabinet*

King Edward Point Research Station

South Georgia right whale field survey

JENNIFER JACKSON, Emma Carroll

Location: South Georgia

Timing: January to February 2018

Southern right whales were intensively exploited on their winter calving grounds across the Southern Hemisphere in the 17th to 19th Centuries. By the 20th Century, their numbers were so low that they were only rarely targeted by the modern commercial whaling industry. South Georgia was the epicentre of modern whaling in 1910-1930, but only a few southern right whales were caught during this time. Nowadays they are 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, and are likely using this area as a summer feeding ground, migrating to waters off Southern Brazil and Argentina in the austral winter to calve. This project, funded by EU BEST and DARWIN+, will conduct the first dedicated survey of this recovering right whale feeding ground. A month of surveys will be carried out in January/February 2018 and in January/February 2019. The research crew (six-nine personnel) 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).

▲ *A southern right whale*

King Edward Point Research Station

SKiMET meteor radar

NICK MITCHELL, TRACY MOFFAT-GRIFFIN

Location: King Edward Point

Timing: 2015 to 2020

The radar detects meteor ion trails (shooting stars) as they enter the Earth's atmosphere and burn up. They burn up between 75km and 95km altitude. 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 a unique combination of meteor radars, one located at Rothera and this new radar on South Georgia, to measure the winds, waves and tides of the middle atmosphere. We will 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, when the northward winds of the general circulation appeared to briefly cease and when the occurrence frequency of polar mesospheric clouds was greatly reduced. We will also use meteor radars on the island of 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*

King Edward Point Research Station

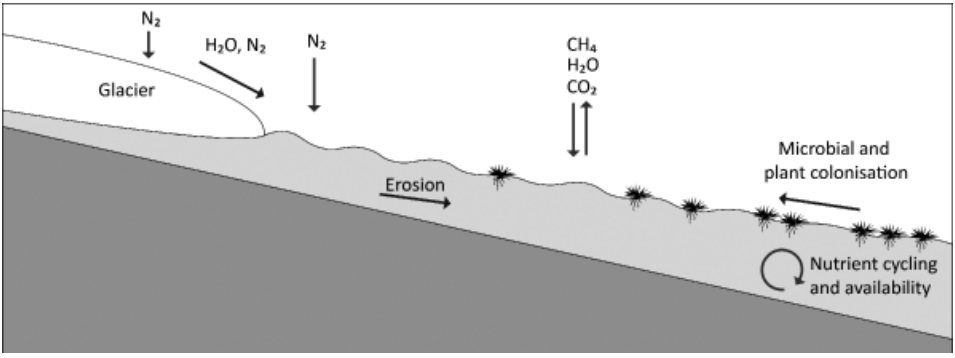
Development of plant-microbial-soil interactions along a glacial moraine in South Georgia

(KEVIN NEWSHAM), Elisabeth Biersma, Paulo Camara, Carolina Galleguillos, Rasme Hereme

Location: King Edward Point and Husvik

Timing: Late-December 2017 to late-January 2018

Chronosequences are important for understanding how landscapes evolve during succession, allowing for an assessment of the rate of change in community composition, productivity and ecosystem properties with a changing climate. In South Georgia, a unique well-described chronosequence of annual micro-moraines exists, with recordings of plant diversity and soil characteristics from 1981 and 1991. These recordings form the basis of our study, which consists of both a repetition and a general expansion of previous work, aiming for a more complete ecosystem approach linking above- and below-ground plant-soil interactions. The overall aim of this project is to quantify and scale changes and rates in biological and geochemical succession at a receding glacier in South Georgia.



▲ *Chronosequence of biological and geochemical succession*

King Edward Point Research Station

King Edward Point Geodetic Observatory (KEP-GO)

NORMAN TFERLE

Location: King Edward Point

Timing: February 2013 to present

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. The 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 the 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.

▲ *The GNSS monument and antenna of station KRSA at KEP with Mount Paget in the background*

Signy Research Station

Climate change impacts on vegetation – permafrost ecosystems in maritime Antarctic and the Antarctic Peninsula

(NICOLETTA CANNONE, MAURO GUGLIELMIN), Francesco Malfasi, Renato Roberto Colucci

Location: Signy, Rothera

Timing: 2017 to 2019

This project addresses the assessment of climate-change impacts and responses on terrestrial ecosystems in maritime Antarctic and is a continuation of previous collaborative projects (a) monitoring permafrost characteristics at Signy and Rothera, and (b) studying interactions between permafrost, climate change, and overlying biotic vegetation communities within a long-term monitoring network including continental Antarctica and the High Arctic.

The permafrost monitoring is carried out using standard International Permafrost Association boreholes installed close to both stations. These are routinely downloaded and simple maintenance carried out by station staff under existing/ongoing LoU, with any more committing maintenance or change to the sites being the responsibility of the Italian investigators.

The research project is based on a multidisciplinary approach coupling a) the prosecution and implementation of the existing long-term monitoring of vegetation, permafrost and active layer with b) large-scale vegetation, permafrost and soil mapping and c) the prosecution of ongoing and establishment of new field and laboratory manipulative experiments simulating different potential future climate-change impacts. These studies last took place under existing LoU in the 2015/16 season. For them to continue new Italian PNRA funding has been won to cover work and logistic contribution in 2017/18, along with a new high-level agreement between PNRA and BAS as to logistic costs. This proposal is to document the planned continuation of this work, which will then be covered by a new project-specific LoU.

▲ *Map of proposed field sites*

Signy Research Station

Ecophysiology and phylogeography of the wingless midge

(PETE CONVEY), Stacey Adlard

Location: Signy

Timing: All season

The flightless midge, *Eretmoptera murphyi*, was introduced to Signy from South Georgia in the 1960s. Collections of the introduced midge are required in continued support of ecophysiological and genomic studies in the PhD of Jesamine Bartlett (University of Birmingham/BAS), who visited the island in 2016/17, molecular phylogeographic studies of PhD student Felipe Simoes (BAS/University of Cambridge), and current NERC-IoF application of Convey (BAS) and Hayward (University of Birmingham). Peat substrate will be collected from the highly disturbed 'introduction site' immediately adjacent to the station buildings, where the substrate typically contains high densities of the fly larvae.

▲ *The flightless midge Eretmoptera murphyi*

Signy Research Station

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

(KATRIN LINSE), Stacey Adlard

Location: Signy

Timing: November 2017 to March 2018

Lissarca miliaris is a small, up to 5mm long, reddish-brown bivalve that lives on red and brown seaweed in the intertidal 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, sub-tidal 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.

▲ *Lissarca miliaris on seaweed*

Signy Research Station

Freshwater crustacean and marine invertebrate biogeography and population genetics

CLAUDIA MATURANA

Location: Signy

Timing: November to December 2017

This fieldwork is part of an ongoing bio/phylogeographic collaboration between University of Chile, Santiago (Elie Poulin, Claudia Maturana), the University of Magallanes (Claudio Gonzalez-Wevar) and BAS (Pete Convey, Simon Morley). Claudia's own part of this work, which will form her PhD, involves molecular biogeographic studies of the exceptional freshwater crustacean *Boeckella poppei*. This crustacean is currently the only known invertebrate whose distribution includes the continental, maritime and sub-Antarctic regions, as well as southern South America (and other genus members also occur on New Zealand and associated islands). Understanding the species phylogeography, and in particular the timing of colonisation, radiation and isolation events in relation to glacial cycles across these regions, is a scientifically extremely exciting prospect.

Within the project we already have analysed samples from two lakes, in order to be able to fit Signy into the wider biogeographic analysis, which includes samples BAS has collected for her from South Georgia, and that Claudia has collected in INACH-supported fieldwork on the Antarctic Peninsula, as well as in southern Chile. Signy is an exceptional location for the species, where it is known to occur in most if not all of the island's c. 18 lakes. This gives an unparalleled opportunity to study the species' population genetics at island (intra-regional) scale, providing a very valuable additional dimension to this project, and potentially identifying radiation timescales on the island that can then be used to ground truth reconstructions of the island's glacial history. If encountered, a second crustacean, *Branchinecta gainii*, will also be collected to provide a parallel dataset. Finally, as part of the wider collaborative studies between our institutions, Claudia will be collecting and preserving a range of intertidal and subtidal marine invertebrates in order to contribute to similar studies in the marine environment; these will complement further collections being made this season at Rothera by other members of the UK and Chilean groups.

▲ *Signy Island has approximately 18 lakes*

Signy Research Station

Signy Island marine predators long-term monitoring and survey programme

(RICHARD PHILLIPS, MIKE DUNN), Stacey Adlard

Location: Signy

Timing: All season

The British Antarctic Survey carries out Long-Term Monitoring and Survey (LTMS) work to measure changes in Antarctic ecosystems and carry out research on the processes that drive them. Marine predators are thought to be 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). Monitoring breeding populations of seabirds and seals are therefore an important part of the BAS LTMS programme. The BAS LTMS data provide scientists with seabird and seal indicators for the Scotia Sea, part of the south-west Atlantic, including population estimates, reproductive success and the quality and abundance of food eaten by predators.

One of the programme objectives is to help inform the regional conservation and management authority for Southern Ocean fisheries, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR). Work will deliver priority, primary data to CCAMLR and the BAS Ocean Ecosystems research group on annual seabird and seal population sizes, breeding success, diet, condition and at-sea foraging behaviour during chick rearing. This data is collected annually at Signy Island and follows approved, internationally-recognised standard CCAMLR methods and parameters for surveying and measuring animals.

▲ *Adélie penguin colony*

Signy Research Station

LTS seabird and seal monitoring at Signy Island: Unmanned Aerial Vehicle survey

(RICHARD PHILLIPS, MIKE DUNN), Stacey Adlard

Location: Signy

Timing: All season

Collecting data on breeding populations of seabirds and seals is an important part of the BAS Long-Term Monitoring and Survey (LTMS) programme, providing scientists with information including population estimates and reproductive success. These data are essential to modeling studies that relate population and breeding performance of seabirds and seals to environmental variability and change. These in turn help inform the regional conservation and management authority for Southern Ocean fisheries, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

This project will use a small unmanned aerial vehicle (UAV) to carry out aerial surveys of Adélie, chinstrap and gentoo penguin colonies, blue-eyed shag and southern giant petrel colonies and seal haul out beaches on Signy Island. The project builds on a highly successful trial use of the same UAV technology to survey selected penguin colonies during the previous 2016/17 season at Signy Island. All colonies involved are currently surveyed annually by standard ground counts, the data being delivered to CCAMLR and the BAS Ecosystems research team. Our aims are:

1. To reduce disturbance to wildlife from fieldworkers accessing colonies from the ground during surveys
2. Reduce need for fieldworkers to traverse difficult/dangerous terrain
3. Obtain accurate survey data from otherwise difficult to access colonies

▲ *Chinstrap penguin colonies surveyed at Gourlay peninsula, Signy Island using a UAV during the 2016/17 season*

▲ *The UAV in action at Signy (Stacey Adlard and Alex Taylor) during the 2016/17 season*

Multiple stations

Sampling of terrestrial invertebrates, plants and soils for ongoing BEA projects, South Georgia

(PETE CONVEY), [Zoological Field Assistants]

Location: Bird Island and King Edward Point Research Stations

Timing: All season

Several specific projects within the BAS Biodiversity Evolution and Adaptations Programme, and with established collaborators, are examining the biogeography of terrestrial and freshwater invertebrates across the Antarctic Peninsula, Southern Ocean islands and southern South America. As part of this season's requirements, BAS zoological field support staff on station at Bird Island and King Edward Point on South Georgia will make collections of terrestrial invertebrate and freshwater invertebrate samples required to support these projects.

▲ *Adult beetle Hydromedion sparsutum*

▲ *The freshwater copepod Boeckella poppei*

Multiple stations

Microbial interactions with Antarctic pearlwort Colobanthus quitensis along a latitudinal transect

(KEVIN NEWSHAM); Elisabeth Biersma (Falkland Islands, South Georgia and Chile); Francesco Malfasi, Renato Roberto Colucci (Signy)

Location: Signy, Falkland Islands, South Georgia and Chile

Timing: Late-December 2017 to mid-February 2018

The Antarctic Pearlwort *(Colobanthus quitensis)* is one of two native flowering plants found in the Antarctic region. To grow, this plant may require a symbiotic root-associated fungal microflora, which has been shown to help plant acclimatisation, adaptation, nutrient uptake and performance under stressful conditions such as in cold environments. Therefore, these fungal endophyte-plant symbioses are expected to play a key role in the adaptation and survival of *C. quitensis* in the Antarctic.

In this project we aim to increase the knowledge of the diversity, specificity and biogeography of fungal endophytes in the adaptation of *C. quitensis*. This will help to gain a better understanding of the potential role of the root-associated microflora of this Antarctic vascular plant, provide an insight into plant-microbe biogeographic patterns, adaptation to cold environments, and potential responses (of both plant and microbe) to environmental change. For this project we will apply phylogeographic and population genetic analyses, using plant and soil samples along a latitudinal transect spanning the distribution of *C. quitensis* (Antarctic Peninsula, South Georgia, South Orkney Islands, South America).

▲ *The Antarctic Pearlwort (Colobanthus quitensis)*

Multiple stations

Investigating microplastics in beach sediments

CLAIRE WALUDA, Tegan Newman (Bird Island), Vicki Foster and Kieran Love (KEP), Kevin Hughes (Rothera), Phil Trathan (Nelson Island, South Shetland Islands)

Location: Rothera, King Edward Point, Bird Island, Signy, Nelson Island, South Shetland Islands
Timing: 2017 and 2018

Plastic pollution of the oceans is recognised as a global issue, but we have limited knowledge about the presence and impact of plastics in the Antarctic and sub-Antarctic regions. While we know that large plastic items can be ingested by seabirds or cause entanglements in seals, we have only recently recognised the potential impact of microplastics on the environment and marine animals of the Southern Ocean.

Microplastics are particles less than 5mm in diameter and are present in many everyday items such as toothpaste, shampoo, shower gels and clothing. They can also result from the breakdown of larger items of plastic ocean debris. Microplastics have the potential to accumulate up the food chain and which can result in harmful physical and chemical impacts on marine biota.

We wish to investigate the presence of microplastics in the Antarctic and sub-Antarctic by collecting samples of beach sediments. This is part of a larger project investigating microplastic contamination in the Southern Ocean. We will obtain sediment samples from suitable beaches at various sites along the Scotia Sea coastal margins to assess the presence of microplastics pollution across a latitudinal gradient from the Antarctic Peninsula to the South Orkneys and South Georgia.

▲ *Debris in the main bay at Bird Island Research Station*

RRS *James Clark Ross*

JR17001 – Drake Passage repeat hydrography

YVONNE FIRING, Oana Dragomir, Anna FitzMaurice, Alethea Mountford, Rachel Sanders, Dafydd Stephenson

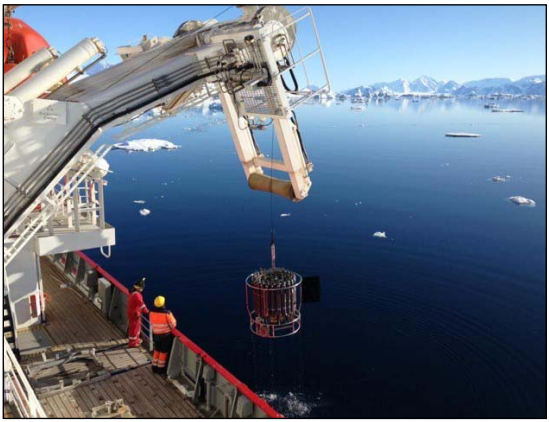
Location: RRS *James Clark Ross*, Drake Passage

Timing: 21st November to 7th December 2017

As part of the Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) programme, we will observe the volume and properties of water masses transported by the Antarctic Circumpolar Current (ACC), and how these vary in time. We have two main methods:

We will use the JCR's CTD to measure temperature, salinity, and oxygen throughout the water column, from the sea surface to the seabed, at sites spanning Drake Passage from Burdwood Bank to Elephant Island. The CTD section has been occupied almost every Antarctic summer since 1993; continuing this time series allows us to monitor changes in this crucial region. This year we will also collect water samples to be analysed for ratios of different oxygen isotopes, which tell us about the sources of the water.

We will deploy autonomous profiling floats, which will record many vertical profiles of temperature, salinity, and oxygen, as well as obtaining information on deep ocean currents, as they drift with the ACC over the next several years. Several of the floats are a new design, capable of reaching 6,000m depth. All are part of the Argo global observing system and their data will be publicly available in near real-time.



▲ *CTD deployment from RRS James Clark Ross*

RRS *James Clark Ross*

JR17001 – ORCHESTRA glider programme

ALEX BREARLEY

Location: RRS *James Clark Ross*

Timing: 21st November to 7th December 2017

The Southern Ocean is one of the most important regions for the subduction of heat and carbon into the interior. However, the movement of these climatically important variables from the atmosphere, through the mixed layer, into the deep ocean, is not well quantified, and the controlling processes are not well understood.

To tackle this, we will deploy three underwater gliders to the north of King George Island, each of which are capable of profiling to 1,000m depth. Two of the gliders are equipped with microstructure packages, from which we can quantify directly the water column mixing. The gliders will be deployed for three months, during which the summertime seasonal stratification will form in response to surface heat input and be destroyed by storm events. In addition, surface flux measurements from the RRS *James Clark Ross*, the BAS Twin Otter, and an autonomous surface vehicle, will also be acquired.

This deployment will fulfill three key objectives:

1. Understand how surface fluxes affect the breakdown of the wintertime mixed layer, and the role of submesoscale processes in these changes
2. Quantify the changes in turbulent mixing that occur during the summer season and how these affect nearsurface stratification
3. Understand the magnitude and timescales of mixing of heat from the surface layer into the ocean interior

▲ *Glider at Rothera*

▲ *Glider launched from the ship*

RRS *James Clark Ross*

JR17001 – Ice loss and deglaciation impacts on the benthic Antarctic species

JAMES SCOURSE, David Barnes, Chester Sands, Will Goodall-Copestake, Floyd Howard and others

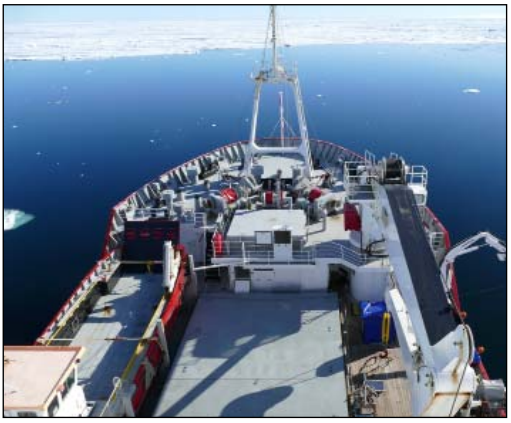
Location: RRS *James Clark Ross*

Timing: 16th November to 7th December 2017

One of the major impacts of climate change on the Arctic and Antarctic Peninsula is glacier retreat. This joint UK-Chile-funded NERC-Conicyt project (ICEBERGS) investigates the effect of glacier retreat along the West Antarctic Peninsula. We will sample three fjords for which the glacier retreat history is well recorded and for which the seabeds have already been mapped (using multibeam sonar). The aim is to sample these three fjords, at each of King George Island, Palmer Station and near Rothera, with an array of equipment, where the glaciers were 40 years ago, 30 years ago, 20 years ago and just a decade ago to see how they have changed physically, chemically and biologically. We will use a multidisciplinary approach from individual to ecosystem level, and from an ecological to evolutionary scale, evaluating genetic, physiological, population, community and ecosystem impacts of this perturbation. Fjords and glaciers are a major component of high latitude habitats, yet little is known about how their ecology is responding to physical changes – especially on the seabed (which is most of their biodiversity lives).

The project brings together scientists from BAS, Exeter, Bangor and Concepcion universities in UK and Chile as well as additional scientists who join the cruise from the University of West Florida and a NERC fellow Amber Annett.

▲ *Soft corals are affected by glacier retreat*



▲ *RRS James Clark Ross in calm waters off the Antarctic Peninsula*

RRS *James Clark Ross*

JR17001 – Ocean impacts of Cryospheric TransformatiON by Antarctic Underwater Turbulence (OCTONAUT)

KATY SHEEN, Mike Boniface

Location: RRS *James Clark Ross*, Marian Cove (South Orkney Islands), Ryder Bay (WAP), Moider and Forel Glaciers (WAP)

Timing: 21st November to 7th December 2017

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 water 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.

▲ *RRS James Clark Ross near Rothera Research Station*

▲ *Vertical Microstructure Profiler (MPV)*

RRS *James Clark Ross*

JR17001 – Surface heat flux and wave measurements in the Southern Ocean from a Wave Glider

MIGUEL ANGEL MORALES MAQUEDA, Liam Rogerson

Location: RRS *James Clark Ross*

Timing: 21st November to 7th December 2017

Measurements of in situ surface air and ocean temperatures, and surface air humidity, pressure and wind in the Southern Ocean are very rare. This scarcity is an important gap in our datasets, especially given the fact that the Southern Ocean is estimated to absorb about 75% of the heat generated by anthropogenic greenhouse gas emissions. We propose to use a Wave Glider vehicle to acquire time series of these key variables in the Drake Passage during the austral late spring/early summer season. State-of-the-art bulk formulae applied to these data will then allow us to calculate surface heat and momentum fluxes and their variability. The Wave Glider experiment will be carried out concurrently with underwater glider deployments in support of work packages 1 (air-sea fluxes) and 2 (surface layer to interior) of the National Capability ORCHESTRA programme, led by BAS. This will be the fourth deployment of our Wave Glider and the first in the Southern Ocean. Previous deployments took place in Loch Ness (NOC National Capability), the Celtic Sea (MASSMO 1) and the North Sea (GNSS-Wave Glider).

▲ *The Wave Glider in Loch Ness, Scotland*

▲ *A deployment in the North Sea*

RRS *James Clark Ross*

JR17002 – Western Core Box

CLARA MANNO, Sophie Fielding, Gabi Stowasser, Peter Enderlein, Victoria Peck, Claire Waluda, Kirstie Williams, Petra Ten Hopen, Vicky Flower, Alejandro Ariza, Franki Perry, Elisa Bergami

Location: RRS *James Clark Ross*

Timing: 21st December 2017 to 15th January 2018

Since 1981 BAS have undertaken cruises to monitor krill biomass as part of the ongoing assessment of the status of the marine ecosystem in the region of South Georgia. This unique time series, known as the Western Core Box series, is part of the Ecosystem Programme contribution to BAS's LTMS National Capability. In addition to the acoustic survey, which covers a wide area but has limited temporal coverage, it deploys moorings in the Western Core Box and South Georgia region to complement the annual surveys by providing year round temporal sampling of environmental conditions and acoustic backscatter. Mooring are also equipped with sediment traps which provide seasonal and inter-annual trend of biogeochemical flux and carbon export in the region.

This cruise will undertake the regular Western Core Box survey; an acoustic grid survey of eight transects each 80km in length, together with associated net and oceanographic sampling, acoustic calibration, plus the refurbishment of three long-term moorings in the South Georgia region. During the cruise, Incubation experiments will be performed in order to investigate the impact of anthropogenic stressors (such as Ocean Acidification and Plastic Litter) on the foodweb and biogeochemical cycles.

▲ *Sorting biological samples*

▲ *Pteropods*

RRS *James Clark Ross*

JR17003 – ORCHESTRA – A23 section

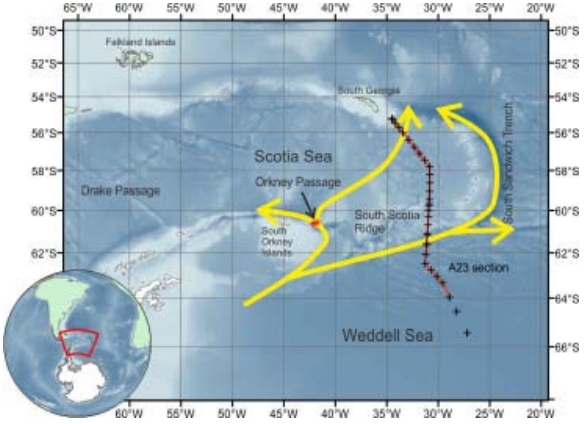
(MIKE MEREDITH), Povl Abrahamsen, David Bett, Pete Davis, Elaina Ford, Michael Hemming, Hugh Venables

Location: RRS *James Clark Ross*

Timing: 20th January to 11th February 2018

As part of the ORCHESTRA (Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports) project, we will be repeating the A23 section from South Georgia, south across the Scotia Sea and into the Weddell Sea. This will include 31 CTD (conductivity-temperature-depth)/ LADCP (lowered acoustic Doppler current profiler) casts, collecting samples for later oxygen isotope analysis at BGS Keyworth. In addition, we will recover a glider for NOCS en route to the study area (deployed earlier in the season on the COMICS cruise from RRS *Discovery*). If time permits after completion of the section, some opportunistic multibeam surveying will be undertaken in South Sandwich Trench, with one or two additional CTD casts in this region.

The A23 section (or parts of it) has been occupied 11 times since 1995, including nine times on RRS *James Clark Ross*. Its location, crossing the Scotia Sea and extending into the northern part of the Weddell Sea, is ideal for monitoring long-term changes in globally important Antarctic Bottom Water (ABW) as it leaves the Weddell Sea, and as it circulates within the Weddell Gyre. Annual repeats of this section are needed to disentangle the year-to-year variability from the long-term warming trend, and hence understand the causes of both.



▲ *Map of the A23 section, showing main outflow pathways of AABW (yellow arrows)*

▲ *CTD deployment from RRS James Clark Ross*

RRS *James Clark Ross*

JR17004 – South Atlantic islands: underpinning complex fisheries with multidisciplinary science

SIMON MORLEY, Dave Barnes, Will Goodall-Copestake, Chester Sands, Floyd Howard, [Additional personnel from BAS AME, UK Universities, Cefas, SAERI, RSPB, Tristan da Cunha, St Helena and Ascension Island Government]

Location: Rothera

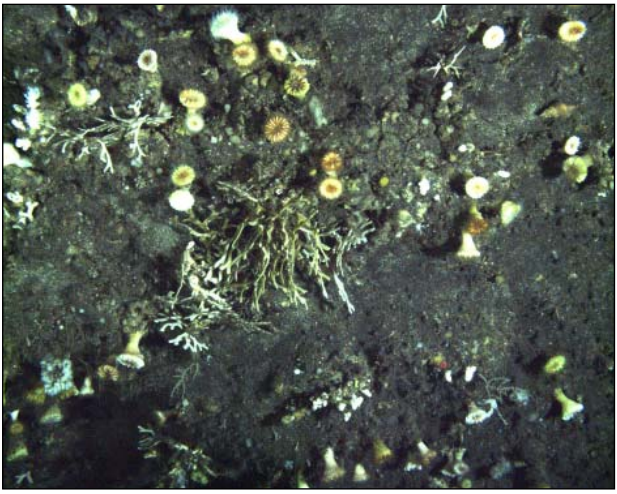
Timing: 15th February to 21st March 2018

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 foodweb 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 foodweb to be constrained.

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



▲ *Seabed at Tristan da Cunha*

RRS *Ernest Shackleton*

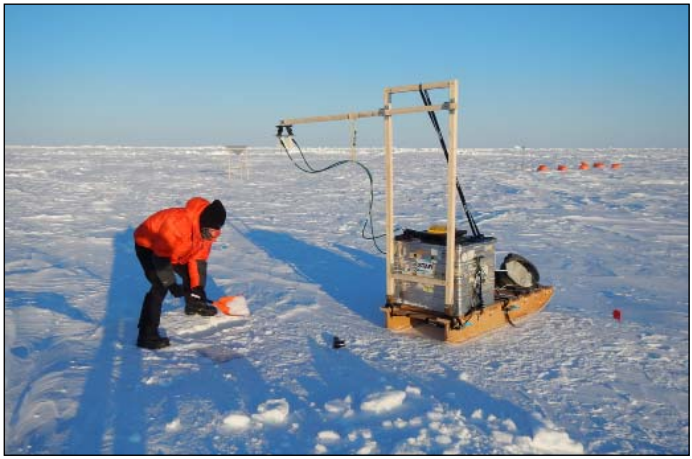
Investigating Ground Penetrating Radar interaction with the snow cover on Antarctic sea ice

ANDREW SHEPHERD, Rachel Tilling, Adriano Lemos

Location: RRS *Ernest Shackleton* (Halley relief call)

Timing: December 2017 to February 2018

The Earth's sea-ice cover is a critical component of our global climate. Sea ice reflects a large fraction of sunlight, provides an insulating layer between the Polar Oceans and overlying atmosphere, and regulates freshwater input into the Polar Oceans. Long-term observations of the area and thickness of sea ice are needed to understand how changes in the ice cover influence global atmospheric and oceanic circulation. It is possible to measure sea-ice thickness using radar satellites. The technique requires accurate knowledge of how the radar signal penetrates through snow cover on the ice surface. With this experiment we will investigate radar interaction with the snow on Antarctic sea ice using a ground-operated radar along with detailed snow pack measurements. The radar echoes collected can then be compared with those from the CryoSat-2 and AltiKa radar satellites, to improve satellite estimates of sea-ice thickness.



▲ *Ground operated radar*

RRS *Ernest Shackleton*

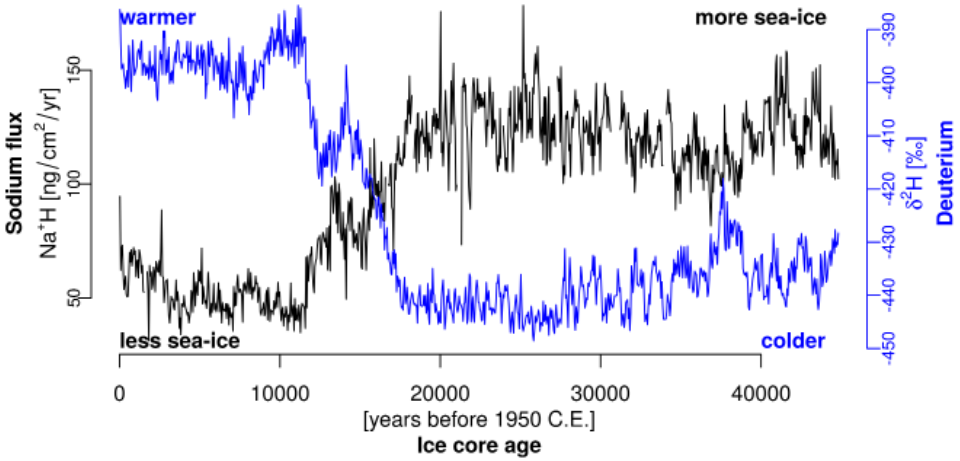
Surface snow sampling to validate stable isotopes and major ions as paleoclimate proxies for past temperature and sea ice extent

LOUISE SIME, Kira Rehfeld, Max Holloway

Location: RRS *Ernest Shackleton* (between the Falkland Islands and Weddell Sea – visiting KEP, Halley, Ronne Ice Front)

Timing: December 2017 to February 2018

Sea ice is a key player in global climate dynamics. Facing a warmer future, it is important to understand the relationship between temperature and sea-ice extent changes in the past. Water stable isotope ratios have been used as a proxy for past temperature changes, and Na+ concentrations as proxy for sea-ice extent. There is evidence that confounding correlations exist, but few datasets bridge the seasonal to interannual scale variations in West Antarctica. Sampling the surface along the whole gradient from the open sea onto the ice shelf and inland will allow us to determine the spatial covariability of sea salt and water isotope variations. This will help us to evaluate climate and chemistry models, which are used to predict future climate, and to refine the interpretation of these parameters as paleoclimate proxies in ice cores.



▲ *Sodium vs deuterium water isotope data shows the correlation between sodium and isotope variations – the proxies for sea-ice cover and temperature respectively (Data: EPICA Dome C Ice Core)*

Appendix

List of non-BAS personnel and their associated institutes

Field-based

Name	Institute
Mike Bentley	*Durham University*
Wim Boot	*Utrecht University*
Peter Clarke	*Newcastle University*
Angelika Humbert	*Alfred Wegener Institute*
Matt King	*Australian Antarctic Division*
Svein Osterhus	*University of Bergen*
Jessica Phillips	*Merton College, University of Oxford*
Carleen Reijmer	*Utrecht University*
Rebecca Schlegel	*Alfred Wegener Institute*
Daniel Steinhage	*Alfred Wegener Institute*
Graham Stuart	*University of Leeds*
Jean-Baptiste Thiebot	*National Institute of Polar Research, Tachikawa, Tokyo, Japan*
Michiel Van Den Broeke	*Utrecht University*
Pippa Whitehouse	*Durham University*

Rothera Research Station

Name	Institute
Rein Aerts	*VU University, Amsterdam*
Stef Bokhorst	*VU University, Amsterdam*
Corina Brusaard	*Royal Netherlands Institute for Sea Research (NIOZ), Netherlands*
Matthew Davey	*University of Cambridge*
Claudio Gonzalez-Wevar	*University of Magallanes, Punta Arenas*
Andrew Gray	*University of Edinburgh*
Frithjof Keupper	*University of Aberdeen*
Johanna Marambio	*Laboratorio de Ecosistemas Antárticos y Subantárticos (LEMAS), Punta Arenas*
Kadmiel Maseyk	*Open University*
Elie Poulin	*Univeristy of Chile, Santiago*
Alison Smith	*University of Cambridge*

Appendix *continued*

List of non-BAS personnel and their associated institutes

Islands and ships

Name	Institute
James Bell	*Cefas*
Elisa Bergami	*Siena University, Italy*
Andy Bodle	*Cefas*
Mike Boniface	*University of Exeter*
Paul Brewin	*SAERI*
Paul Brickle	*SAERI*
Judith Brown	*Ascension Island Government*
Paulo Camara	*University of Brasília, Brasil*
Nicoletta Cannone	*Insubria University, Italy*
Emma Carroll	*University of St Andrews*
Martin Collins	*Cefas*
Renato Roberto Colucci	*National Research Council, Italy*
Alex Cotton	*University of East Anglia*
Oana Dragomir	*National Oceanographic Centre*
Yvonne Firing	*National Oceanographic Centre*
Anna FitzMaurice	*Princeton University*
Simon Flower	*British Geological Survey*
Carolina Galleguillos	*Universidad de Talca, Chile*
Mauro Guglielmin	*Insubria University, Italy*
Michael Hemming	*University of East Anglia*
Rasme Hereme	*Universidad de Talca, Chile*
Vlad Laptikhovsky	*Cefas*
Francesco Malfasi	*Insubria University, Italy*
Miguel Angel Morales Maqueda	*University of Newcastle*
Stephanie Martin	*Independent Sea Mammal Observer*
Claudia Maturana	*University of Chile*
Nick Mitchell	*University of Bath*
Alethea Mountford	*University of Newcastle*
Franki Perry	*Plymouth Marine Laboratory*
Liam Rogerson	*University of Newcastle*

continued ▷

Appendix *continued*

List of non-BAS personnel and their associated institutes

Islands and ships continued

Name	Institute
Andy Schofield	*RSPB*
Katy Sheen	*University of Exeter*
Tammy Stamford	*Cefas*
Dafydd Stephenson	*National Oceanographic Centre*
Anthony Swan	*British Geological Survey*
Tim Taylor	*British Geological Survey*
Chris Turbitt	*British Geological Survey*

Feedback and further information

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

Rosey Grant

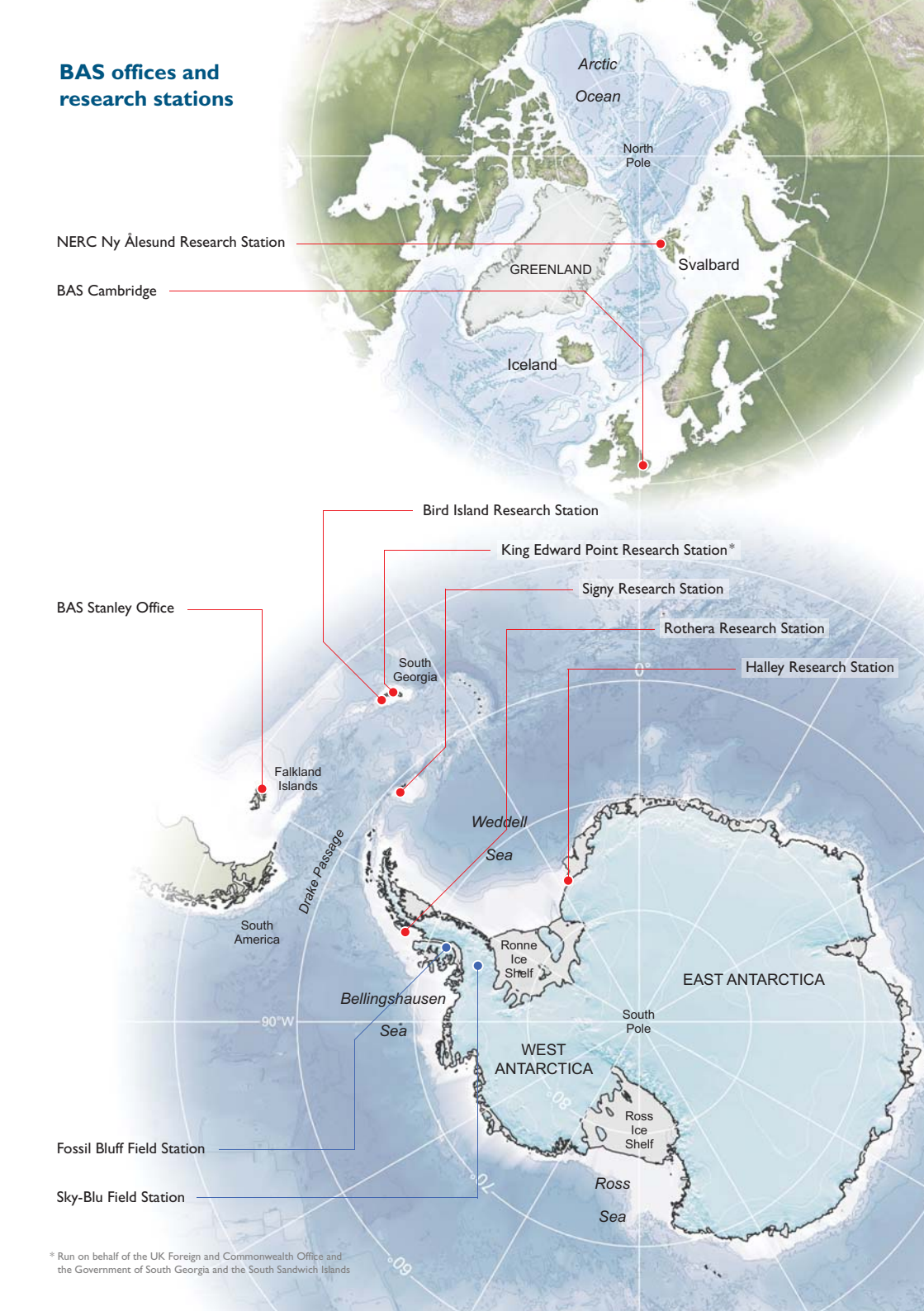
British Antarctic Survey
High Cross, Madingley Road
Cambridge, CB3 0ET, UK

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

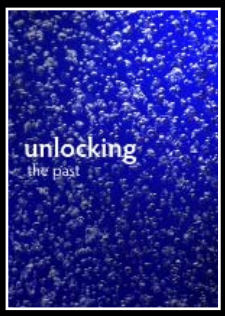
For further information about BAS, please visit:
www.bas.ac.uk

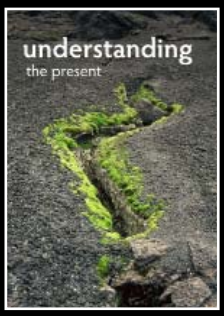
Published by British Antarctic Survey

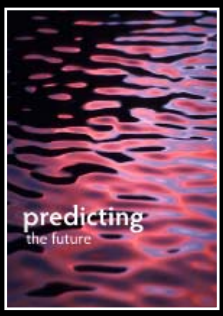
BAS offices and research stations

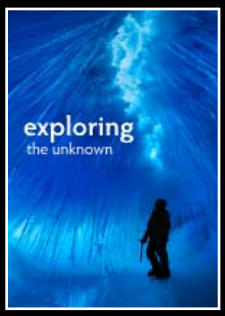


* Run on behalf of the UK Foreign and Commonwealth Office and the Government of South Georgia and the South Sandwich Islands









British Antarctic Survey (BAS), a component of the Natural Environment Research Council, delivers 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 underpins a productive economy and contributes to a sustainable world. Its numerous national and international collaborations, leadership role in Antarctic affairs and excellent infrastructure help ensure that the UK maintains a world-leading position. BAS has over 450 staff and operates five research stations, two Royal Research Ships and five aircraft in and around Antarctica.

www.bas.ac.uk

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC
SCIENCE OF THE ENVIRONMENT