Annual Report

2008-2009

British Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

Above and cover: *A BAS geologist and accompanying field assistant collect data high on the west ridge of Mount Spaaman, South Georgia. Access to such remote spots is only possible via helicopter support from the aircrew on HMS Endurance.*

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Our vision

British Antarctic Survey aspires to become, by 2012, the leading international centre for global science in the Antarctic context.

Our mission

To undertake a world-class programme of scientific research and to sustain for the UK an active and influential regional presence and a leadership role in Antarctic affairs.

British Antarctic Survey is a wholly-owned component of the UK Natural Environment Research Council.

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PLAIN LANGUAGE COMMISSION
Clear English Standard
WINNING DOCUMENT

Director's introduction

In the following pages you will find examples of British Antarctic Survey's wide-reaching activities, from delivering world-leading science and advising international policy-makers to drawing up guidelines to minimise the potential damage caused by tourists to unique and fragile Antarctic environments.

This year saw the formal conclusion of our science programme 'Global Science in the Antarctic Context' (GSAC) and the science highlights reported in the following pages are arranged according to the eight GSAC research programmes. Each of these has delivered important findings, more of which will continue to emerge over the coming months and years. Many of the emerging projects in our new science programme 'Polar Science for Planet Earth' evolve from GSAC science – progression in science is achieved by both revolution and evolution! This ability to develop long-term strategic science with supporting long-term data and survey, and the capability and skills to carry out these activities, are among the defining characteristics and strengths of British Antarctic Survey (BAS).

This year also saw the conclusion of International Polar Year 2007-2008 (IPY). IPY was initiated in recognition of the importance of the polar regions in the functioning of the Earth System as a whole and also, especially in the Arctic, the importance of their role in human society. This highly complex programme, involving 62 countries and 231 projects (of which BAS was involved in 56) was co-ordinated by the International Programme Office, hosted by BAS and part-funded by the Natural Environment Research Council (NERC).

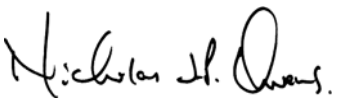
I am pleased to report that an international consortium of funders have agreed to support the IPY International Programme Office for a further period to co-ordinate the outputs from the huge IPY endeavour, and to initiate long-term IPY legacy activities.

One such legacy for the UK was NERC's decision to support the creation of an Arctic Office at BAS Cambridge to co-ordinate NERC-funded science in the Arctic. BAS is delighted to host this office and doubtless we will be reporting on its successes in the future. Another IPY success is a new polar research agreement between the UK and Canada to share ships, aircraft and polar stations and increase scientific co-operation, which paves the way for greater understanding of the rapidly changing polar regions.

Progress continued towards the completion of BAS's latest research station, Halley VI, with the new, state-of-the-art facility due to become operational during the 2011-12 season.

Our new science programme – Polar Science for Planet Earth (PSPE) – was formally introduced on 1 April 2009 and we will report on PSPE activities in future annual reports.

Change is always challenging and, during 2008-09, considerable preparation and reorganisation was carried out, involving individuals, teams and groups across BAS. I would like to take this opportunity to thank them for helping to prepare BAS for a bright future and also for delivering another outstanding year of achievements across all our activities. With the implementation of PSPE, BAS is in an excellent position to continue our world-leading science in both of the planet's polar regions.



Images: Above: *BAS Director, Professor Nicholas Owens.* **Top Right:** *Logo of International Polar Year 2007-2008.* **Middle Right:** *SWATH bathymetry data from RRS James Clark Ross, showing sea-bed topography in the Amundsen Sea sector of Antarctica.* **Far Right:** *BAS Twin Otter VP-FBL at an international aerial survey field camp high on the East Antarctic Ice Sheet.*

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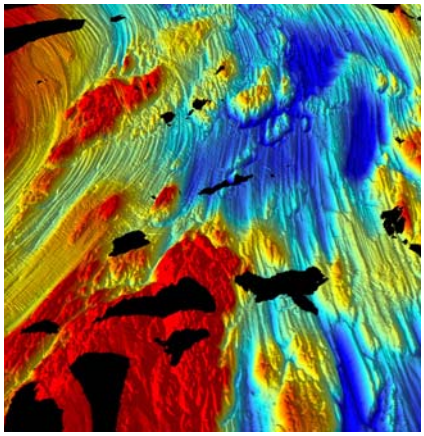

Global Science in the Antarctic Context

Global Science in the Antarctic Context (GSAC) comprised eight interconnected research programmes plus long-term monitoring and survey. It addressed Antarctica as a pivotal component of the Earth system and a unique source of environmental knowledge. It covered the period from 30 million years in the past to 100 years in the future and focused on issues of climate, sea level, and biological evolution and adaptation. GSAC increased our skill in predicting the future behaviour of the planet and the effects of environmental change, for the benefit of society, policy-makers and business. GSAC involved over 120 national and international collaborations. BAS has undertaken and continues to undertake commissioned research on behalf of the Government of South Georgia and the South Sandwich Islands as well as receiving grants for complementary UK and European research projects.

Image: *The Milky Way is clearly visible in the cold, clear air above Halley Research Station. Halley's remote location on the Brunt Ice Shelf makes it an ideal place for atmospheric science.*

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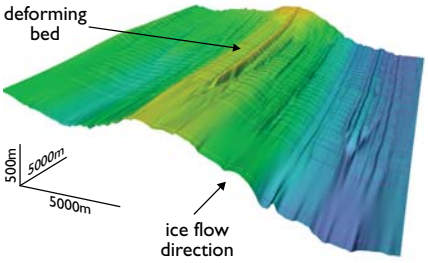
GRADES Glacial Retreat in Antarctica and Deglaciation of the Earth System

Principal Investigator: **Prof David Vaughan dgv@bas.ac.uk**



Beneath an Antarctic ice stream

The Antarctic Ice Sheet loses ice to the ocean, mostly through fast-flowing ice streams. The interaction between the ice and the bed on which it lies largely controls where ice streams develop and how fast they can flow. Understanding these basal processes will enhance our ability to predict ice-stream changes. GRADES has developed a technique to build up images of ice-sheet beds using radar. The first such image was acquired by mapping the Rutford Ice Stream in West Antarctica in early 2008. It shows the relative distribution of deforming sediment and lodged (non-deforming) sediment. The sediment is organised into highly elongated and streamlined bedforms that are identical to the 'mega-scale glacial lineations' (MSGL) observed on polar continental shelves and on the former bed of the Laurentide Ice Sheet in Canada. These new images prove that MSGL are formed beneath ice streams, and have allowed us to discount several hypotheses proposed to explain their formation. By understanding better the interaction between ice streams and their underlying morphology, we can improve predictions relating to the amount of Antarctic ice contributing to future sea-level rise.

Contact: **Dr Ed King ecki@bas.ac.uk**

Introduction

A multidisciplinary programme, GRADES has sought to understand past and future changes in the Antarctic ice sheet, and the ice sheet's potential impact on global sea level.

Focusing on the areas of most rapid ice-sheet change, GRADES has mapped how ice sheets have altered in the past and has unravelled the processes that control how they behave today. We are using this knowledge to develop new computer simulations to predict how ice sheets will change in the future.

An unprecedented new view of ice-sheet change

Changes in the volume of ice contained in the Antarctic and Greenland ice sheets directly affect global sea level. Accelerating ice loss has been reported from a growing number of glaciers along the Greenland and Antarctic ice-sheet margins. GRADES has developed a new technique to use high-resolution data acquired by satellite (43 million satellite measurements of the Antarctic and seven million of Greenland), which reveals recent change in unprecedented detail over the entire coastal margin of both ice sheets. The results show that the most profound changes occur as glaciers, which drain the ice sheets from the high plateaux down to the coast, transmit any coastal changes back up into the ice sheets. Retreating ice shelves and accelerating glaciers cause ice-sheet thinning, which now reaches all latitudes in Greenland and has intensified around some key parts of Antarctica. Around the Antarctic Peninsula, where ice shelves have been retreating due to climate change, ice-sheet thinning still persists decades after ice-shelf collapse. While the current contribution to sea-level rise from global ice loss is ~1.8mm per year, our findings indicate that this could grow rapidly in the coming decades.

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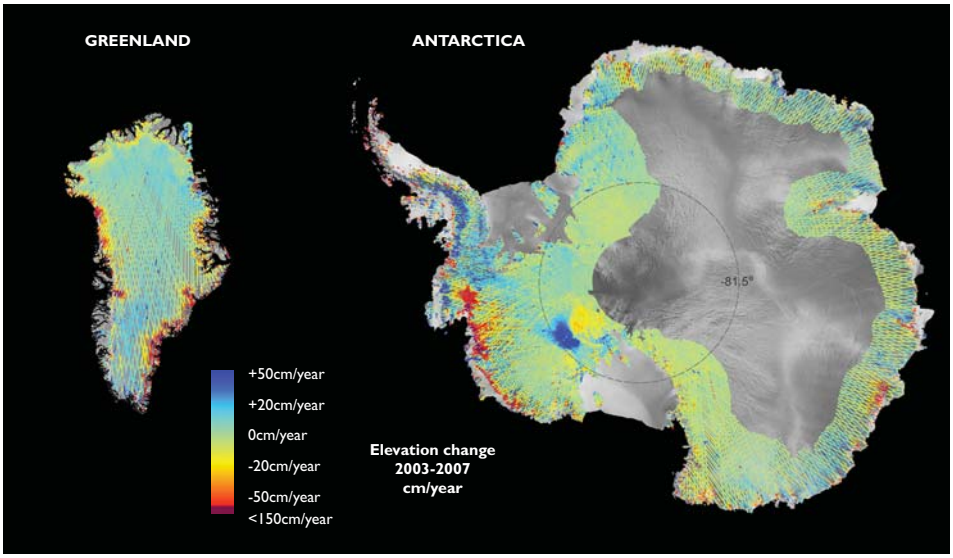

Technical Terms: Bedforms: *Features formed in the sediment beneath, in this case, an ice sheet formed by the movement of the ice above.* **Deforming sediment:** *Material (in this case beneath the ice sheet) that is shaped by movement of the surrounding ice or water.* **Ice sheet:** *A mass of ice that covers surrounding terrain and is greater than 50,000km².* **Ice shelf:** *A continuous plate of floating ice that extends seaward from a glacier or ice sheet.* **Ice streams:** *Fast-flowing rivers of ice that drain the Antarctic ice sheet.* **Laurentide Ice Sheet:** *A massive ice sheet that spread over most of Canada during the Pleistocene ice age.* **Lodged sediment:** *Material (in this case beneath the ice sheet) that resists being shaped by movement of the surrounding ice or water.* **Mega-scale glacial lineations:** *Large-scale (10-100km) landforms that have been formed under continental-scale ice sheets.* **Morphology:** *Form and structure.* **Radar:** *Instrument which uses the echo of a pulse of electromagnetic radiation to detect, in this case, features beneath an ice sheet.*

Images: Above: *A 3-D map of the bedforms beneath the Rutford Ice Stream.* **Right:** *Elevation change for the Antarctic and Greenland ice sheets between 2003 and 2007.*

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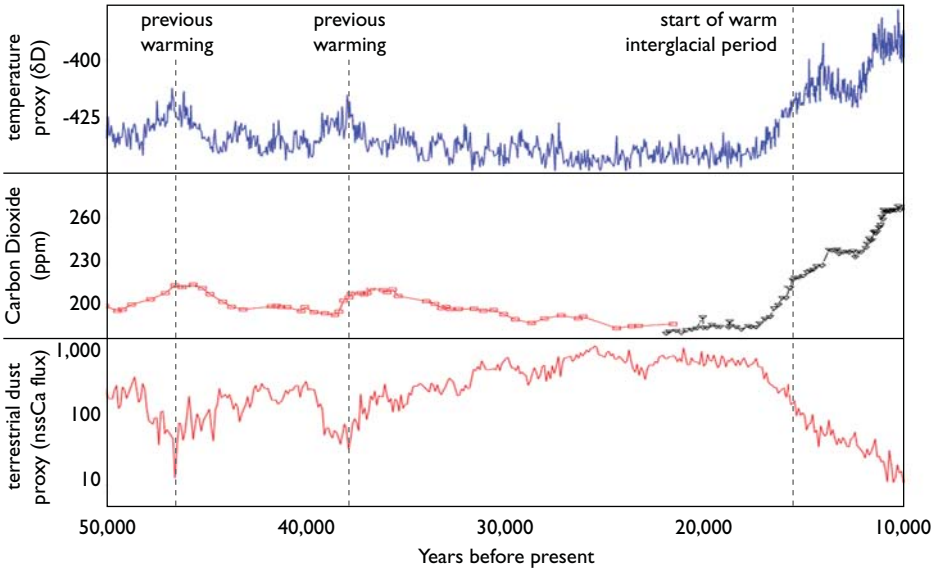
CACHE Climate and Chemistry: Forcings, Feedbacks and Phasings in the Earth System

Principal Investigator: **Dr Eric Wolff ewwo@bas.ac.uk**

Introduction

CACHE has used ice cores, along with marine and lake sediment records collected in Antarctica, to examine past climates. Present-day atmospheric chemistry and models help us interpret past data, so that we can understand how climate and atmospheric composition were linked in the past, and suggest how they may interact in the future.



What causes the end of an ice age?

Earth flips roughly every 100,000 years from long cold periods (ice ages) to warm periods (interglacials). Numerous studies have sought a trigger, either in the southern hemisphere, where slow warming seems to start, or in the north, where the largest changes occur. Ice cores show that Antarctica often started to warm up during previous cold periods but cooled off again after a relatively short time. The changes in climate and chemistry seen during these tentative warmings were almost identical to those seen during the first 1,500 years of a full transition to an interglacial. The warmings halted when a rapid jump in Greenland temperature occurred, probably associated with a change in ocean heat transport. During actual ice-age terminations, such jumps occurred only at a late stage, when the southern climate had changed so much that the transition to an interglacial was inevitable. We can therefore hypothesise that the immediate cause of a global change from ice age to interglacial is the failure of the mechanisms that would otherwise bring the southern warming back under control.

Contact: **Dr Eric Wolff ewwo@bas.ac.uk**

Year-round deployment of ozone sensors

For the first time, BAS scientists have successfully collected surface ozone concentration data for an entire year, at sites from the coast to the inland plateau, using ten autonomous instruments. In Antarctica, surface ozone is influenced by bromine emissions from the sea-ice zone, which destroy ozone, and nitrogen oxide emissions from the snowpack, which create it. However, until now there has been little information about the spatial extent of these two processes – routine measurements have only been made at (mainly coastal) research stations. BAS deployed autonomous surface ozone monitors, powered by wind and solar energy, along the coastal region of the Brunt Ice Shelf and on a 450km transect inland from Halley Research Station. Given the engineering challenges and harsh environment, it is remarkable that every system measured successfully throughout the year. Initial data analysis shows large-scale episodes of production and destruction, and will be used to test models that simulate chemistry on a continental scale. This will lead to a better understanding of the chemical processes controlling ozone at the surface, where levels cannot be monitored from space in the same way as stratospheric ozone and the 'ozone hole'.

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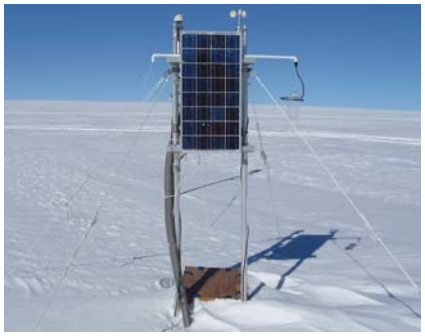

Technical Terms: Autonomous instruments: *Instruments that can operate and measure without human intervention, in this case powered by the sun or wind.* **Ocean heat transport:** *The distribution of heat around the globe via the major ocean currents.* **Stratospheric ozone:** *The thin layer of atmospheric ozone in the stratosphere – the layer of the atmosphere ranging, in polar regions, from approximately 10km up to 50km.*

Images: Above: *Antarctica started to warm several times during previous glacial periods (e.g. 48,000 and 39,000 years ago).* **Right:** *Autonomous ozone sensor deployed in the field.*

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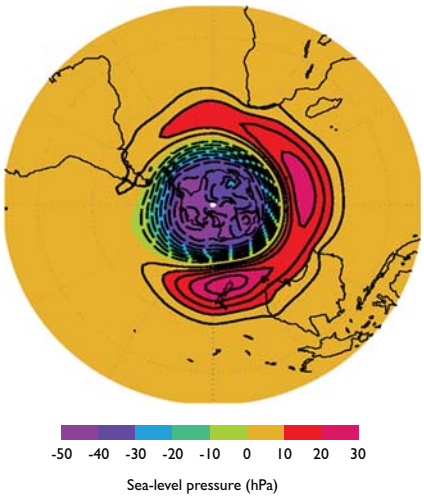
COMPLEXITY Natural Complexity Programme

Principal Investigator: **Dr Mervyn Freeman** mpf@bas.ac.uk



How to distinguish climate from noise

It is well known that not every winter season's weather is the same, but are the observed changes from one winter to another due to the complex interactions of the climate system or do they occur just by chance? The answer to this apparently simple question is not easy because even the most basic randomly-behaving systems can show trends over relatively long time-scales – these are known as 'climate noise'. BAS scientists have used a new procedure to analyse the natural trends of three climate indices, concerning surface weather, predictability and regional climate conditions. Results reveal that most of the natural variability, on timescales of years and decades, cannot be distinguished from climate noise. Consequently, long-term, large-scale atmospheric variations may be less predictable than first thought.

Contact: **Dr Christian Franzke** chan1@bas.ac.uk

Introduction

Complexity is the emerging science of systems with many interacting components, in which behaviours are as much to do with the system as a whole as with the details of its individual parts.

A key goal of the Natural Complexity Programme has been to distinguish the 'complex' from the 'complicated' and to identify and enhance appropriate models.

Critical or turbulent? A new experimental test for natural systems

Some everyday things, such as people's height or the speed of cars on a motorway, have a typical size and extreme variations are rare. Others, such as the populations of cities, or the sizes of solar flares or earthquakes, vary in a much more unpredictable way, making extreme events much more common. To find a pattern in apparently unpredictable events, and so understand their causes, scientists need to use an appropriate theory. Several theories, such as self-organised criticality (SOC) and the theory of turbulence, seek to explain such wild fluctuations. Telling these theories apart simply by comparing the predicted distribution of their fluctuations is difficult, so other approaches are needed. Scientists at BAS and Warwick University have found a control parameter that is large in a model of turbulence but small in a model of SOC. This improves our ability to predict which theory is appropriate for a variety of natural systems, allowing better understanding of how they behave.

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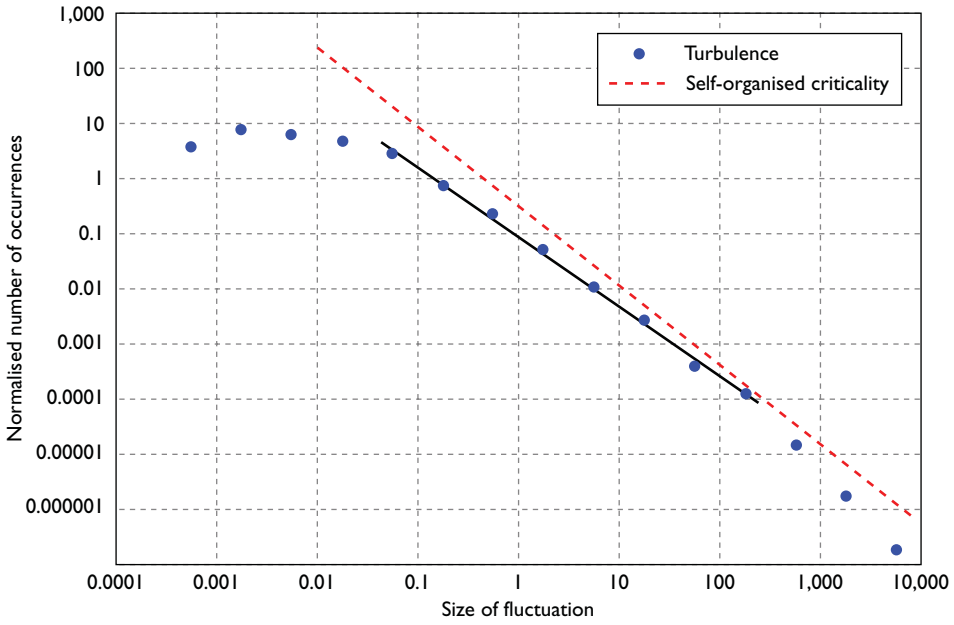

Technical Terms: Climate index: *A single number that represents a feature of climate at a given time, such as the Southern Annular Mode – a pattern of sea-level pressure over Antarctica that influences its climate.* **Control parameter:** *A factor that controls a system and determines (or limits) its performance.* **Self-organised criticality:** *A mathematical theory that describes how systems reach a critical state (a point at which a particular event happens) through their own dynamics, independent of any external control factors.* **Turbulence:** *Irregular motion, in this case of the atmosphere.*

Images: Above: *The Southern Annular Mode – a pattern of sea-level pressure over Antarctica that influences its climate.* **Right:** *Turbulence (blue dots) can easily be distinguished from an ideal self-organised criticality model (red dashes) when huge numbers of measurements are available. Distinguishing the two is much harder when the range accessible to measurement is restricted (black line).*

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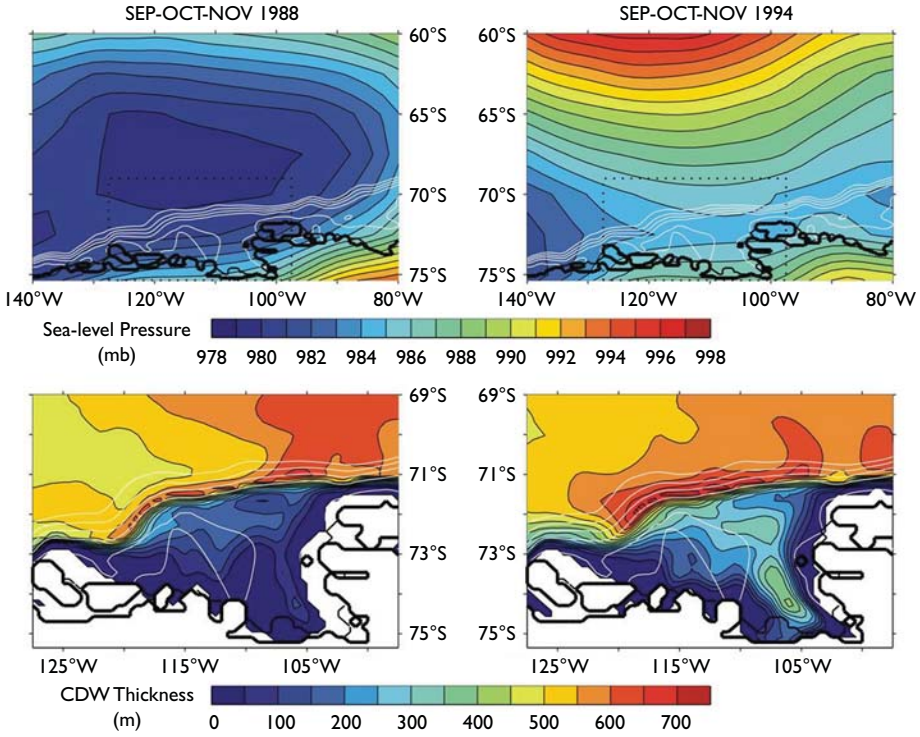
ACES Antarctic Climate and the Earth System

Principal Investigator: **Dr John King jcki@bas.ac.uk**

Introduction

Predicting how Earth's climate may vary in response to natural or man-made changes is one of today's greatest scientific challenges.

ACES has integrated studies of the Antarctic atmosphere, ocean and sea ice to provide a new perspective on the Antarctic climate system and how it affects, and is affected by, the global atmosphere and ocean.



Atmospheric circulation controls the ocean's impact on the West Antarctic Ice Sheet

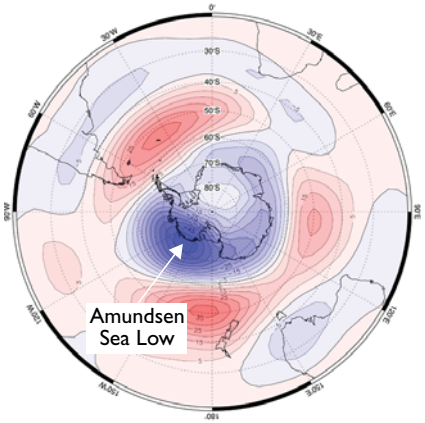
Ice streams feeding the ice shelves in the Amundsen Sea sector of Antarctica have accelerated and thinned in recent years, probably as a result of increased ice-shelf melting. BAS scientists have used an ice-ocean model to investigate how warm Circumpolar Deep Water (CDW) reaches the Amundsen Sea continental shelf, where it causes rapid melting at the base of the floating ice shelves. Our results show that variability in the inflow of CDW is related to the winds at the edge of the continental shelf. The winds at this location vary considerably in strength and this, in turn, drives variability in the CDW inflow. Periods when the modelled CDW inflow was above average correspond to times when ice streams were observed to accelerate, suggesting a direct link between the wind-driven ocean circulation and the mass balance of the West Antarctic Ice Sheet.

Contact: **Dr Adrian Jenkins ajen@bas.ac.uk**

Antarctic ozone hole drives increases in sea ice

Since the late 1970s there has been a well-publicised decrease in Arctic sea ice, particularly in the late summer/autumn. In contrast, over the same period Antarctic sea ice has actually increased at a statistically-significant rate, with the largest change being in the Ross Sea sector during the autumn. Analysis of atmospheric circulation data have shown that this increase in sea ice has primarily resulted from stronger southerly winds off the Ross Ice Shelf, which in turn are caused by a deepening of the Amundsen Sea Low (an area of low pressure that forms over west Antarctica and the Amundsen Sea region). Computer model experiments indicate that the Amundsen Sea Low has deepened mainly as a result of stratospheric ozone depletion. Linking depleting ozone with increasing sea ice helps us understand better the differences between natural and human-induced environmental change around Antarctica's coasts.

Contact: **Prof John Turner jtu@bas.ac.uk**



Technical Terms: Circumpolar Deep Water: *A warm, deep-water current that flows around Antarctica below the cold Antarctic Circumpolar Current.* **Ice sheet mass balance:** *The relationship between accumulation (snowfall) and melting/sublimation of the ice sheet, determining the rate of growth or decay of the ice sheet.* **Ice shelf:** *A continuous plate of floating ice that extends seaward from a glacier or ice sheet.* **Ice streams:** *Fast-flowing rivers of ice that drain the Antarctic ice sheet.* **Stratospheric ozone:** *The thin layer of atmospheric ozone in the stratosphere – the layer of the atmosphere ranging, in polar regions, from approximately 10km above the Earth's surface up to 50km.*

Images: Above: *Mean sea-level pressure (upper panels) and modelled thickness of the Circumpolar Deep Water (CDW) layer (lower panels) for the spring months of 1988 (left panels, weak CDW inflow) and 1994 (right panels, strong CDW inflow).* **Right:** *Ozone depletion drives deepening of the Amundsen Sea low (around 135°W), leading to stronger offshore winds in the Ross Sea sector.*

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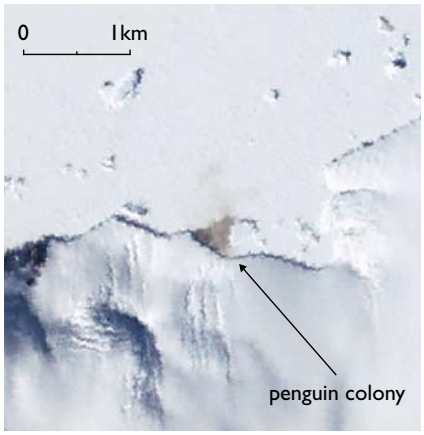
DISCOVERY 2010 Integrating Southern Ocean Ecosystems into the Earth System

Principal Investigator: **Prof Eugene Murphy ejmu@bas.ac.uk**



Introduction

Over the last 200 years, the Southern Ocean ecosystem has been affected by human activity, first from hunting whales and seals and more recently from fishing. It is now also being impacted by climate change.

The goal of DISCOVERY 2010 has been to understand enough about this unique environment to predict how climate change and modern fisheries may change the ecosystem in the future.

Satellite detection of emperor penguin colonies

BAS scientists have used images from the Landsat Image Mosaic of Antarctica to survey almost the whole Antarctic coastline for emperor penguin colonies. By searching the sea ice for the brown guano stains that surround each colony, it was possible to locate both known and previously undetected colonies. Thirty-eight emperor penguin colonies were found, ten of which had not been seen before. Two of these have already been independently verified on the ground. Of particular interest were six places where colonies were previously thought to exist but were not detected. All these 'lost' colonies are in the warmer areas of the continent, suggesting that climate change may be affecting breeding sites. Several international studies predict that emperor penguin numbers will decline due to the loss or early break-up of Antarctic sea ice. This innovative study presents the first comprehensive distribution map and the first step in calculating a total world population for this iconic and threatened species.

Contact: **Dr Phil Trathan pnt@bas.ac.uk**

Shining a light on lanternfish

Lanternfish are one of the most abundant organisms in the mid-depths of the ocean. They migrate upwards in large numbers from their daytime habitat in the ocean depths to the surface waters at night. In the Southern Ocean, they are an important alternative food source for the many higher predators, such as seals and penguins, that otherwise depend on Antarctic krill. BAS scientists have examined their ecological role around South Georgia. They found the lanternfish community consisted of several species that occupy different depths in the water column and with varying vertical migration patterns. This results in species having contrasting diets, with some eating larger items such as amphipods while others feed on smaller species such as copepods. Predators that feed on lanternfish vary in their diving behaviours and so target different lanternfish species. Antarctic krill stocks are known to fluctuate greatly from year to year around South Georgia and, for some predators, lanternfish appear to be the stop-gap when times get harsh.

Contact: **Dr Geraint Tarling gant@bas.ac.uk**

Technical Terms: Amphipod: *Crustaceans of the order Amphipoda, mostly around 1-2cm long, particularly abundant in polar marine habitats.* **Copepods:** *Minute aquatic crustaceans.* **Krill:** *Shrimp-like crustaceans that form a key part of the Antarctic food web.* **Landsat Image Mosaic of Antarctica:** *Virtually cloudless, seamless, and high-resolution satellite view of Antarctica, created from more than 1,000 satellite images, published in 2007 by BAS, NASA, the US National Science Foundation and the United States Geological Survey.*

Images: Above: *Emperor penguin colonies can be identified from space by their guano stains on the ice.* **Right:** *Lanternfish play an important role in the marine food web around South Georgia.*

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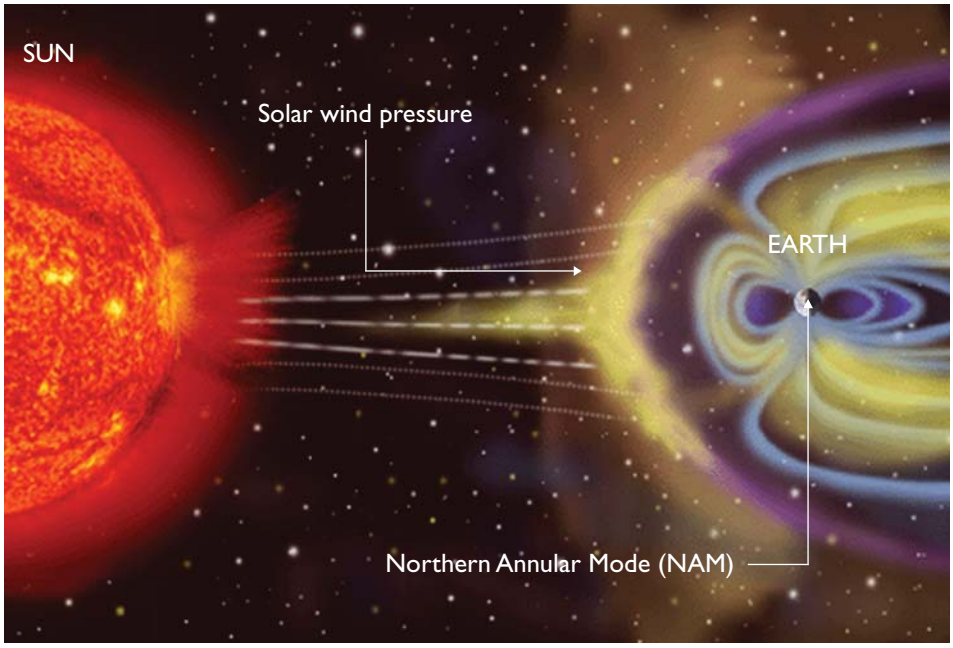
SEC Sun-Earth Connections

Principal Investigator: **Prof Richard Horne rh@bas.ac.uk**

Introduction

Over the 11-year solar cycle there are small changes in the heat and light output of the Sun, which affect Earth's atmosphere and influence the planet's climate.

The Sun also emits bursts of charged particles, which cause geomagnetic storms, damage satellites, disrupt aviation, and interrupt power supplies. The Sun-Earth Connections programme looked at how these solar variations affected the Earth System, so that we can build better climate models and better predict the radiation environment around the Earth for commercial operations.



Solar influence on European weather

The Northern Annular Mode (NAM) is a major oscillation of the atmosphere in the northern hemisphere which influences the path of storms across the Atlantic and hence affects European weather. Using nearly 50 years of atmospheric data from the European Centre for Medium-Range Weather Forecasts, and data from 18 satellites, BAS scientists have found a statistically-significant correlation between the NAM and the pressure of the solar wind buffeting the Earth's magnetic field. This correlation is strongest in the northern winter, during the maximum half of the 11-year solar cycle, and is evident all the way from the stratosphere down to the surface. Results suggest that the solar wind may have a direct influence on European weather as high solar wind pressure has been linked to wetter, stormier winters in the UK. This information will improve climate modelling and help refine predictions of future climate change.

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Radiation belt losses

The Earth is surrounded by two doughnut-shaped regions of energetic charged particles known as the Van Allen radiation belts. These are usually separated by a gap which contains very few particles. During exceptionally large geomagnetic storms driven by the Sun, this gap is filled with energetic electrons. Existing models indicate that these electrons should be lost to the atmosphere within six months. However, recent satellite observations show that the electrons are lost much faster than predicted, within just 20 days. Using satellite data, BAS scientists found that radio waves originating from lightning in the atmosphere were combining with natural radio waves in space to cause rapid electron losses into the atmosphere. This is rather unexpected because radio waves from lightning are up to 100 times weaker than those in space. The result will improve forecasts of radiation hazards to help protect astronauts and satellites.

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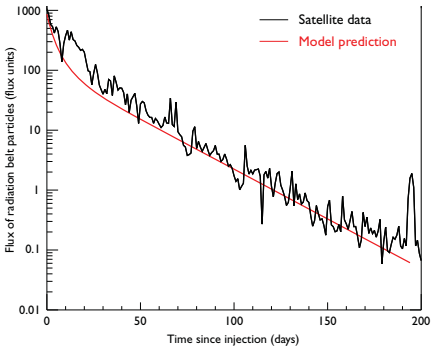

Technical Terms: 11-year solar cycle: *The number of sunspots visible on the Sun waxes and wanes in an approximate 11-year cycle.* **Energetic electrons:** *Energetically charged particles from the Sun.* **Geomagnetic storm:** *A temporary disturbance of the Earth's magnetic field caused by a disturbance in space weather, usually a solar flare.* **Solar wind:** *The outward flow of electrically charged particles from the Sun.* **Stratosphere:** *The layer of the atmosphere ranging, in polar regions, from approximately 10km above the Earth's surface up to 50km, where temperature increases with height. The ozone layer is situated in the stratosphere.*

Images: Above: *Data show that increasing solar wind pressure is linked to wetter, stormier winters in the UK.* **Right:** *Plot showing the agreement between the satellite measurements of the decay of the radiation belt particles and our model predictions.*

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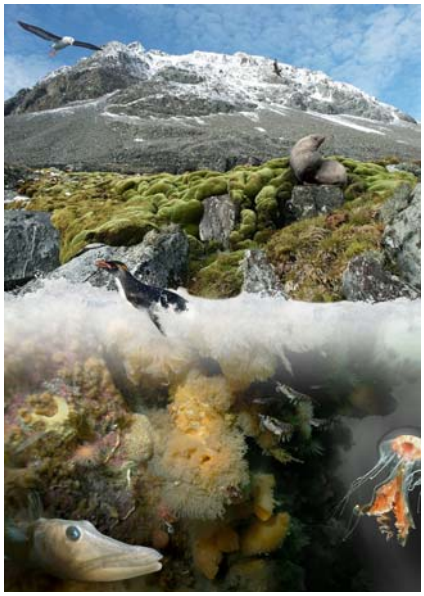
BIOFLAME Biodiversity, Function, Limits and Adaptation from Molecules to Ecosystems

Acting Principal Investigator: **Dr Pete Convey pcon@bas.ac.uk**



First comprehensive inventory of life in Antarctica

As part of the Census of Marine Life – an international effort to assess and explain the diversity and distribution of marine life in the world's oceans – BAS scientists and colleagues from the University of Hamburg have conducted the first comprehensive inventory of land and sea animals around a group of Antarctic islands. The survey has revealed a region that is rich in biodiversity and has more species than the Galapagos. The scientists combed the land, sea and shores of the South Orkney Islands, near the tip of the Antarctic Peninsula, using scuba divers and trawled nets to catch creatures at depths of up to 1,500m. Animals recorded were then checked against a century of literature and modern databases, and over 1,200 known marine and land species were identified. Five were new to science. The study provides an important benchmark for monitoring how species will respond to future environmental change.

Contact: **Dr David Barnes dkab@bas.ac.uk**

Introduction

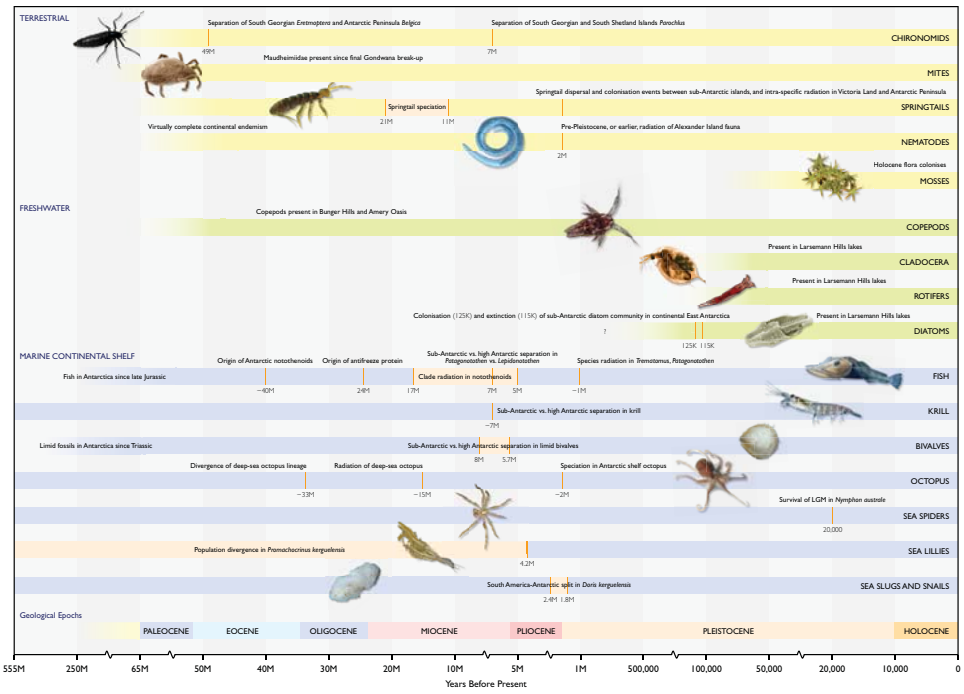
To trace the way species adapt to environmental extremes, BIOFLAME has exploited some of the unique natural features of Antarctica.

These include: the presence of some of the simplest biological communities on Earth, its well-understood geological history, its physical isolation over evolutionary timescales, and an extreme climate that renders life particularly vulnerable to the effects of environmental change. Using diverse approaches, BAS scientists have investigated how biological systems adapt and respond to their environment across different scales of life, from the genome to the ecosystem.

Terrestrial biogeography – ancient signals from modern fauna

BIOFLAME research has contributed greatly to a major shift in the understanding of Antarctic terrestrial biogeography. Combining evidence from classical biogeographical sources and new molecular biological approaches, BAS scientists have demonstrated that most of the major components of today's Antarctic terrestrial diversity have an ancient and continuous history in Antarctica, pre-dating both the Pleistocene (1.8M to 10,000 years ago) and in several cases Miocene (24M to 5M years ago) episodes of glaciation. This long history sets a new framework for the glaciological reconstruction of Antarctica's past, and so helps explain the continent's influence on global climate.

Contact: **Dr Pete Convey pcon@bas.ac.uk**



Technical Terms: Biodiversity: *The variety, function and abundance of organisms.* **Biogeography:** *The study of the distribution of organisms across the Earth.* **Biota:** *Plant, animal and microbial life.* **Ecosystem:** *An interacting community of organisms (e.g. plants and animals) and their physical and chemical environment.* **Endemism:** *The existence of species found only in one particular region.* **Genome:** *The complete genetic information of an organism.* **Glaciological reconstruction:** *Determining the history of ice sheets in the past, usually through the use of ice-sheet models and geological data.*

Images: Above: *An illustration of the abundance of life on and around the South Orkney Islands.* **Right:** *Terrestrial, marine and freshwater biota with evidence for ancient origins or endemism in Antarctica.*

For more information, please visit our website: **www.antarctica.ac.uk**

GEACEP Greenhouse to Ice-House Evolution of the Antarctic Cryosphere and Palaeoenvironment

Acting Principal Investigator: **Dr Alan Vaughan** **apmva@bas.ac.uk**

Introduction

GEACEP investigated the evolution of the Antarctic Ice Sheet and the changing global environment over the last ~30 million years.

The programme explored the nature of warm climates in Earth history and investigated how glaciation began on Antarctica. GEACEP also examined the stability of the Antarctic Ice Sheet in the recent geological past.

Multiple ice expansion events during warm interglacials

Glacial sediments on James Ross Island in the Antarctic Peninsula have been interpreted as deposits of marine and subaerial debris flows laid down at the margins of ancient glaciers during the warm Pliocene period (~6M to 2M years ago). They can be up to 150m thick and individually over 4km long. Many of the deposits contain remarkably well-preserved fossil bivalve molluscs. These scallop-like *Austrochlamys* lived where sea ice was seasonally scarce and their pristine state of preservation suggests that they were alive immediately before being engulfed in the debris flow associated with overriding glaciers. Thus, these deposits signify episodes of ice expansion during interglacial warm periods. This surprising result has implications for ice-sheet stability since it indicates that even periods of global warmth were, at times, able to sustain an expanding ice sheet.

Contact: **Dr Alan Vaughan** **apmva@bas.ac.uk**

Vegetation distribution – the past as a guide to the future?

During the Middle Pliocene geological stage (3.6 to 2.6M years ago), Earth experienced greater global warmth than today. To evaluate how far the Middle Pliocene can be used to model future warming, data and model-based Middle Pliocene vegetation were compared with simulated global distributions for the mid and late 21st century. The best agreement is found when the Middle Pliocene biome reconstruction is compared with a future scenario with an atmospheric CO_2 concentration of 560 parts per million (current levels are 387ppm). However, the comparison reveals differences in the distribution of polar vegetation, which indicate that, at high latitudes, the Middle Pliocene world was still warmer than its predicted modern analogue by several degrees. This suggests that changes in global temperature and thus biome distributions at higher atmospheric CO_2 levels (400 or 560ppm) will not have reached an equilibrium state (as was the case for the Middle Pliocene) by the end of this century.

Contact: **Dr Alan Vaughan** **apmva@bas.ac.uk**

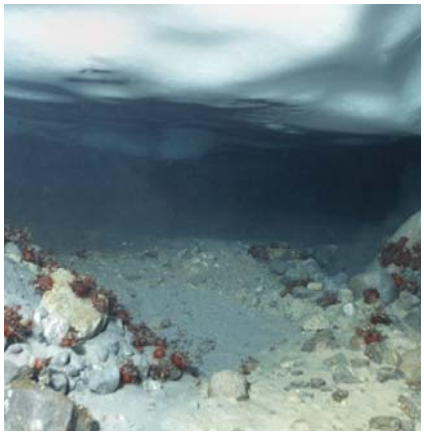
Technical Terms: **Biome:** *Major regional biological community (e.g. forest, desert).* **Biome reconstruction:** *The geographical distribution of the Earth's major biological communities from a period of the geological past.* **Bivalve molluscs:** *Animals belonging to the class Bivalvia with hinged shells divided into two halves.* **Equilibrium state:** *The condition of a system in which competing influences are balanced, resulting in no net change.* **Ice sheet:** *A large mass of ice that covers surrounding terrain and is greater than 50,000km².* **Subaerial debris flow:** *A flow of material along the Earth's surface.*

Images: **Above:** *Austrochlamys, an extinct bivalve related to the scallop, from Pliocene interglacial sediments on James Ross Island.* **Right:** *The Earth's Middle Pliocene biome distribution can be compared to that predicted for the near future.*

For more information, please visit our website: **www.antarctica.ac.uk**

LTMS Long-term Monitoring and Survey

Contact: **Mike Pinnock mpi@bas.ac.uk**



Iceberg scour affects biodiversity

Antarctic worms, sea spiders, urchins and other marine creatures living in near-shore shallow habitats are regularly pounded by icebergs scouring the sea bed. Data from a five-year study suggest that this will happen more often because the number of icebergs will increase as a result of shrinking winter sea ice. BAS scientists have shown how the rate of iceberg scouring on the western Antarctic Peninsula seabed is affected by the duration of winter sea ice, which has dramatically declined (in space and time) over the last few decades due to climate warming. This increase in sea-bed disturbance, where 80% of all Antarctic life occurs, could severely affect marine creatures living as deep as 500m underwater and the type and number of creatures found on the seabed, leading to changes in the distributions of key species.

Contact: **Dr David Barnes dkab@bas.ac.uk**

Introduction

BAS undertakes a wide range of long-term monitoring and survey activities that underpin national and international research, and government and international policies.

We are building on a legacy of more than 50 years of observations and measurements, and continue to survey some areas for the first time.

Unlocking the time capsule of historic aerial photography

Recent studies by BAS scientists and their collaborators have reported widespread retreat and acceleration of glaciers on the Antarctic Peninsula, attributed to regional warming. The loss of glacier ice is a contributor to sea-level rise, but the volume of ice and its impact on sea level are at present poorly known. An accurate assessment of changes in surface height, and hence ice volume, of glaciers on the Antarctic Peninsula over past decades is needed to improve estimates of their past and future impact on sea-level rise.

BAS has an archive of over 30,000 aerial photographs going back to the 1940s for parts of the Antarctic Peninsula. Three-dimensional measurement from these historic photographs, using photogrammetry, is now the only way to reconstruct past changes in glacier surface height. However, the historic photographs are difficult to use due to inadequate ground-surveyed control points, unfavourable flight-patterns, incomplete camera calibration information and the unavoidable use of old, distorted, paper prints. BAS scientists have developed a new method of control for historic photos, without the need for fieldwork on the ground, by linking them to newly-acquired aerial photography with GPS-measured camera positions. Overall measurement accuracy of better than two metres in all three dimensions has been achieved, which is enough to allow meaningful measurement of changes in ice thickness over decades, and so improve understanding of the Peninsula glaciers' contribution to global sea-level change over the past 60 years.

Contact: **Dr Adrian Fox ajfo@bas.ac.uk**

Technical Terms: Benthic: *Bottom dwelling – living on the floor of the sea or lake.* **Biodiversity:** *The variety and abundance of species.* **Photogrammetry:** *Making maps from photographs, especially from aerial surveying.*

Images: Above: *As icebergs driven by wind and tide scrape along on the seabed, benthic communities are obliterated.* **Right:** *Aerial photograph of the terrain around Rothera Research Station in the Antarctic Peninsula, taken in 1957.*

For more information, please visit our website: **www.antarctica.ac.uk**

Delivering the Science

Image: *Royal Research Ship Ernest Shackleton steams north through a freezing sea after resupplying Halley Research Station.*

For more information, please visit our website: **www.antarctica.ac.uk**

UK influence in global affairs

Contact: **Dr John Shears jrs@bas.ac.uk**

Introduction

Sustaining a scientific leadership role for the UK in global affairs, as well as in the Antarctic, is a key part of the BAS mission.

We ensure that the UK Government, key decision-makers and international organisations are scientifically well advised about important areas of concern, such as global climate change, sustainable fisheries management, and protecting the Antarctic environment.

High-level climate change briefings at BAS Cambridge

Over the past 12 months, BAS has undertaken a series of important briefings and seminars on climate change for high-level influencers and decision makers. These included HRH The Prince of Wales, UK Ministers Ed Miliband MP Secretary of State for Energy and Climate Change and the Rt Hon Hilary Benn MP Secretary of State for Environment, Food and Rural Affairs, as well as hundreds of senior decision makers from industry and business.

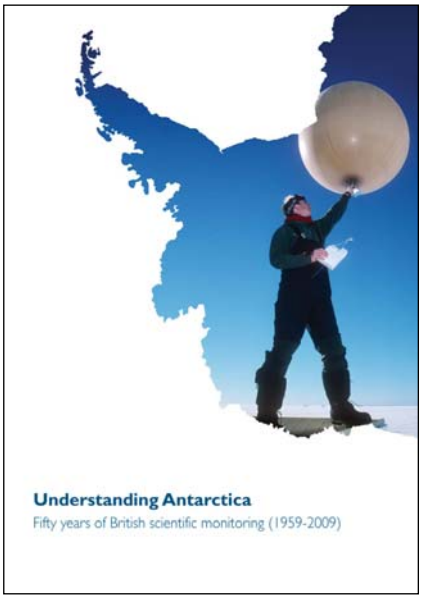
Many of the seminars were undertaken in partnership with the University of Cambridge Programme for Industry (now called the Cambridge Programme for Sustainability Leadership). During the period April 2007 to March 2009, BAS hosted 15 corporate events and over 750 senior business leaders and executives visited BAS Cambridge to learn more about the science of climate change and to address the challenges and opportunities of climate change for their businesses and their customers. This work has included two special briefings by senior BAS scientists to the highly influential Prince of Wales Corporate Leaders Group on Climate Change.

Contact: **Dr Tim Moffat tjmo@bas.ac.uk**

50th anniversary of the Antarctic Treaty

The UK played a key leadership role at the 2009 Antarctic Treaty Consultative Meeting (ATCM) in Baltimore, USA, which was attended by nearly 400 diplomats, Antarctic programme managers, logistics experts and polar scientists from 47 countries. Six members of BAS, led by Professor Nicholas Owens, assisted the Foreign and Commonwealth Office in drafting and presenting 11 working papers and three information papers, covering a wide range of topics including climate change, Marine Protected Areas, non-native species, Environmental Impact Assessments, data management and tourism. The ATCM was opened by US Secretary of State Hillary Clinton at a special joint Ministerial meeting between the Antarctic Treaty nations and the Arctic Council. BAS also produced a commemorative publication, *Understanding Antarctica*, which celebrates 50 years of British science and monitoring in Antarctica. This was presented at the ATCM by the UK Foreign and Commonwealth Office and presented to every delegate.

Contact: **Dr John Shears jrs@bas.ac.uk**



Images: Above: *HRH The Prince of Wales visits BAS Cambridge.* **Right:** *BAS produced a commemorative publication for the UK Foreign and Commonwealth Office Polar Regions Unit to distribute at the 2009 Antarctic Treaty Consultative Meeting in Baltimore, USA.*

For more information, please visit our website: **www.antarctica.ac.uk**

Infrastructure and operations

Contact: **John Hall jhal@bas.ac.uk**

Introduction

To deliver world-class science 16,000km away, BAS needs modern technology for science and infrastructure, up-to-date facilities and effective operational management.

We have long-term planning horizons, a flexible and innovative approach, and an ongoing programme to introduce new facilities and technology. Success depends on excellent teamwork across many disciplines, a continuous search for better ways of working, and collaboration with other NERC programmes and national Antarctic operators.

Major international logistics collaboration

The Antarctica's Gamburtsev Province project (AGAP) was a highly ambitious, multinational project undertaken during the 2008-09 Antarctic season involving five national programmes – from the UK, USA, Australia, Germany, and China. An aerial survey of the subglacial Gamburtsev mountains, thought to be the birth-place of the East Antarctic Ice Sheet, was successfully completed in January 2009. Logistic planning began in April 2008 and the project got under way in November 2008. The 117,000km of survey lines were flown by two Twin Otter aircraft (one from BAS and one from the United States Antarctic Programme) but the logistic effort to move fuel, equipment and personnel involved 11 different aircraft (five different aircraft types), tractor trains and small vehicles. The survey area was divided into two parts, AGAP North and AGAP South, each with its own field camp. The BAS operation was run largely out of AGAP North and operated by BAS and the Australian Programme (ANARE). Waste and empty drums were removed by a Chinese tractor train. The team achieved an impressive 96% of the original survey plan and the data collected will be analysed over the coming years.

Contact: **Mike Dinn medi@bas.ac.uk**

Energy reduction across BAS

The installation of new solar-energy systems to heat air and hot water at three BAS research stations marks the beginning of a new era of low-carbon Antarctic infrastructure for BAS. Three new solar heating systems were installed at Rothera, Bird Island and Signy research stations. These projects were part of the BAS Carbon Reduction Strategy, which seeks to cut fuel use and carbon emissions throughout BAS operations. The largest is at Rothera and consists of 36 solar panels, each containing 16 evacuated tubes. Even in cloudy conditions, the panels can heat the glycol fluid – designed not to freeze in low temperatures – that flows through the tubes. Once heated, the fluid is pumped through a coil that heats cold fresh air before it enters the building. In total, the panels can provide more than 15kW of free heating from the Sun. At Rothera, the system reduces the amount of heat that oil-fired boilers need to produce, saving over 1,000 litres of fuel each year. Bird Island and Signy have smaller solar systems that heat hot water for showers and sinks. These are expected to reduce energy requirements for heating by more than 30%.

Energy use at BAS Cambridge has been reduced by installing new lighting and refrigeration controls and improvements to the heating system. During 2008-09, a new coating was painted on the hull of RRS *James Clark Ross* to improve fuel efficiency. This will be repeated in the 2009-10 season and extended to BAS's other ice-strengthened research vessel RRS *Ernest Shackleton*.

Contact: **William Ray wray@bas.ac.uk**

Images: Above: *Logo of the AGAP project.* **Right:** *RRS James Clark Ross has had a new coating applied to improve fuel efficiency.*

For more information, please visit our website: **www.antarctica.ac.uk**

UK and international collaborations

Contact: **Prof Alan Rodger asro@bas.ac.uk**

Introduction

Many of the problems posed by Antarctica cannot be answered by BAS alone. Therefore we collaborate extensively with the environmental community in the UK and overseas to share best practice and to maximise scientific impact.

Robot submarine searches for signs of melting under an ice shelf

Scientists from BAS, the National Oceanography Centre in Southampton and the American National Science Foundation successfully deployed an autonomous robot submarine on six missions beneath an Antarctic glacier, using sonar scanners to map the seabed and the underside of the ice. The research is part of an international collaboration to study the dynamic Pine Island Glacier in the Amundsen Sea region of Antarctica and to understand how changes in ocean temperatures or currents could affect the melting of the West Antarctic Ice Sheet. The data will help understand why the glacier has been thinning and accelerating over recent decades – with neighbouring glaciers it is currently contributing about 0.25mm/year to global sea-level rise.

Contact: **Dr Adrian Jenkins ajen@bas.ac.uk**

Fellowships in Antarctic Air-Sea-Ice Science (FAASIS)

BAS and the University of East Anglia (UEA) bid successfully for support for a Marie Curie Early Stage Training Network. FAASIS involved seven PhD studentships that were jointly supervised between BAS and UEA. A condition of the award was that all students must come from overseas, and the majority from the EU. Their home countries ranged from Ireland to eastern Europe and Fiji. The topics studied included abrupt climate changes during the last glacial period; whale biology using their calls; modelling zooplankton in the southern ocean and also examining the impacts of ocean acidification; and ocean circulation and katabatic winds – strong winds that blow off the continent and have an important role in sea-ice formation.

As the students were approaching the end of their PhDs, a symposium was held at UEA where all the students gave a brief overview of the highlights of their research. The scheme has certainly helped to develop the strategic alliance between UEA and BAS. This particular implementation of the Marie Curie Training network is no longer available, so new ways of establishing a cohort of PhD students are being examined.

Contact: **Prof Paul Rodhouse pgkr@bas.ac.uk**

University of East Anglia

Technical Terms: Sonar scanner: *An instrument that sends out an acoustic pulse in water to measure distances in terms of the time for the echo of the pulse to return.* **Zooplankton:** *Animal component of the plankton community.*

Images: Above: *The autonomous, unmanned vehicle known as 'Autosub'.* **Right:** *Logo of the University of East Anglia.*

For more information, please visit our website: **www.antarctica.ac.uk**

Protecting the environment

Contact: **Rachel Clarke racl@bas.ac.uk**

Introduction

BAS is committed to delivering its science programme and associated logistics with the minimum environmental impact.

BAS strives for continuous improvement and achieves this by using an environmental management system (certified to the internationally recognised ISO 14001 standard), and environmental impact assessment and monitoring. We also maintain a leadership role in Antarctic environmental affairs, for example by supporting the UK Government in Antarctic Treaty Consultative Meetings.

South Georgia clean-up

Two abandoned huts, debris and redundant scientific equipment were removed from Mount Hodges and Glacier Col on South Georgia during November and December 2008 by a clean-up team from the BAS Environment Office and Morrison Construction, with helicopter support provided by HMS *Endurance*. Hazardous materials such as fuels, asbestos and batteries were removed and sent to the UK for safe disposal. Combustible materials (largely the wooden hut structure) were burnt *in situ* as the project's Environmental Impact Assessment showed this method to have the least environmental impact. Non-combustible materials such as scrap metal were collected for later removal by helicopter and safe disposal. This field work completes the clean-up of the BAS legacy on South Georgia and helps demonstrate our commitment to long-term environmental protection of the island.

Contact: **Rachel Clarke racl@bas.ac.uk**

Unique Antarctic biological site gets special protection

Marion Nunataks are remote outcrops of rock on Charcot Island, west of the Antarctic Peninsula, with an ecosystem that is unique within the maritime Antarctic. BAS scientists found no sign of springtails and predatory arthropods, which are common everywhere else in the region. Their absence may provide new insights into ecosystem structure and function, and historical patterns of glaciations. However, these unique characteristics are at extreme risk from the accidental introduction by visitors of species native elsewhere in the Antarctic. To avoid this, the UK proposed that the area be protected, and, at the 2008 Antarctic Treaty meeting in Kiev, Marion Nunataks were accepted as Antarctic Specially Protected Area No. 170. The detailed management plan for the area, written by the BAS Environment Office, strictly requires anyone visiting the site to protect the unique ecology, for example by cleaning all clothing and equipment.

Contact: **Dr Kevin Hughes kehu@bas.ac.uk**

Technical Terms: Arthropods: *Invertebrate animals with jointed legs and segmented bodies, such as insects, crustaceans, and arachnids.* **Ecosystem:** *An interacting community of organisms (e.g. plants and animals) and their physical and chemical environment.* **Springtails:** *Primitive wingless insects with 'spring-like' legs.*

Images: Above: *A helicopter from HMS Endurance air-lifting waste from the hut demolition.* **Right:** *Moss and lichen community on the north-facing crag of Marion Nunataks, Charcot Island.*

For more information, please visit our website: **www.antarctica.ac.uk**

Science in society

Contact: **Linda Capper lmca@bas.ac.uk**

Introduction

BAS is committed to explaining its science and operations to as wide an audience as possible.

BAS's science communication portfolio blends corporate communications, media relations, education, event management and publishing, as well as directly supporting scientists in their media and outreach activities. It is designed to engage different sectors of society in BAS science and operations and shares the Government and NERC's vision for science in society.

Reuters news agency visit Rothera Research Station

The Reuters News media visit to Rothera Research Station in January 2009 brought BAS science to a global audience. Reuters is the world's largest international multimedia news agency, serving most major newspaper and television networks in the world, reaching hundreds of millions of people every day.

Reuters produced six TV news reports about BAS science which were syndicated worldwide, generating a total of 106 individual television broadcasts. In addition, 16 news and feature articles were written and syndicated, resulting in 227 'hits' in newspapers, radio stations and online news outlets. This coverage reached audiences in 33 countries. Two of the UK broadcasts on the Wilkins Ice Shelf show the size of audiences reached; the BBC1 six o'clock news report reached 4.6 million viewers and the Sky News report reached 145 million people in 36 countries in Europe. The Wilkins Ice Shelf story on *Reuters.com* had 94,925 unique visitors and was the most visited story of the day for 26 January 2009.

Contact: **Athena Dinar amdi@bas.ac.uk**

New scientific data section for *Discovering Antarctica*

The development and launch of a scientific data section for BAS's flagship educational resource, *Discovering Antarctica*, allows teachers and students to access real Antarctic marine, atmospheric and geological data for use in the classroom. To get the data, the user follows a series of video diaries featuring real BAS scientists at Rothera Research Station, creating an interactive experience that highlights the complexity and importance of collecting scientific data in Antarctica. The new section expands the award-winning web resource, created in partnership with the Foreign and Commonwealth Office Polar Regions Unit and Royal Geographical Society, to provide relevant resources for the science curriculum as well as its established links to the geography syllabus. Discovering Antarctica averages nearly 7,000 unique visitors per month, peaking to over 35,000 during exam periods, and can be seen at *www.discoveringantarctica.org.uk*.

Contact: **Jamie Oliver jaol@bas.ac.uk**

Images: Above: *The Reuters camera crew filming a weather balloon launch at Rothera Research Station.* **Right:** *A screenshot from the new scientific data section of Discovering Antarctica.*

For more information, please visit our website: **www.antarctica.ac.uk**

Health and Safety

Contact: **Robert Culshaw** **rocu@bas.ac.uk**

Introduction

BAS attaches the utmost importance to the health, safety and well-being of its staff. The Antarctic, and increasingly the Arctic, are challenging and hazardous environments to have as your workplace.

This is a day-to-day reality at BAS and we are committed to ensuring safety is at the heart of all we do. BAS has a pragmatic, positive and open culture which engages its staff in eliminating or reducing the risks of our work in the polar regions. An essential aspect of managing these risks is the training, competence and experience of our staff, and this continues to be our top priority.

BAS has retained certification to BS OHSAS 18001, the occupational health and safety management standard. Our health and safety improvement programme identifies the most significant areas for improvement from our accident reporting and audit systems. This year, we targeted some specific hazards to health – we improved the way we deal with noise, chemical and carbon monoxide hazards, and training has taken place.

Health and safety policy and performance is monitored by the BAS Board through a standing item in monthly Board meetings. We have continued to consult with staff on changes to the management of health and safety through committees at Cambridge, the stations and on the ships. An extensive programme of training is always of major importance in delivering a safe workplace in the UK and the polar regions.

Images: Above: *Working at height on a meteorology mast at Halley Research Station.* **Right:** *Noise survey onboard RRS Ernest Shackleton as a part of the noise assessment programme across BAS.*

For more information, please visit our website: **www.antarctica.ac.uk**

Recruitment and career development

Contact: **Linda Symons limo@bas.ac.uk**

Introduction

It has been a challenging year, characterised by change. Preparation for a new science programme, the implementation of the new NERC Shared Service Centre and a fundamental change in the BAS funding model have affected all parts of the organisation.

INVESTOR IN PEOPLE

The planning and implementation of the new BAS science programme, Polar Science for Planet Earth, has re-focused skills and shown a need for greater flexibility at BAS. Emphasis has been placed on equipping staff and managers with the skills needed to cope with change, as well as developing specific skills, such as writing grant applications, and implementing a comprehensive training programme for managers. Preparation for the transition to a Research Councils UK Shared Service Centre has involved much work. This includes preparing for a change in infrastructure and recruitment, and career development policies, as well as ensuring retained finance, procurement and HR teams will have the skills and knowledge required for the new methods of working. We must ensure BAS has an environment which enables individuals and teams to achieve their potential and deliver excellence.

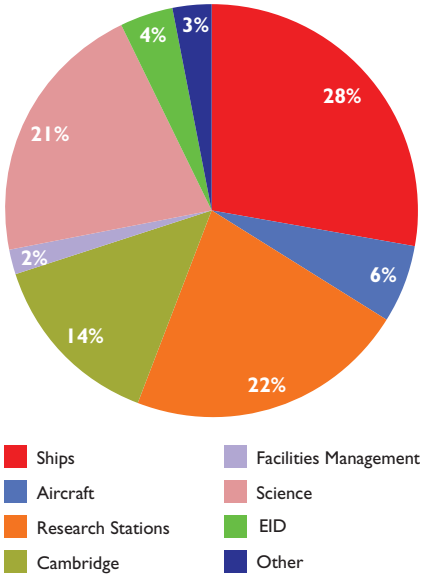
Recruiting and retaining top-quality people remains a challenge, particularly for Antarctic trades where BAS is competing with organisations in the private sector. This year, BAS used a range of creative media in our advertising campaign, resulting in greater coverage and a high calibre of applicants. As part of our long-term engagement programme, we introduced an enhanced Antarctic bonus scheme to retain talent and increase the number of staff returning to BAS to work in the Antarctic.

Images: Above: *Working in the pump room in the Bonner Laboratory at Rothera Research Station, Antarctica.* **Right:** *Logo for Investors in People.*

For more information, please visit our website: **www.antarctica.ac.uk**

Facts and figures 2008-2009

Analysis of Expenditure 2008-2009



Total budget 2008-09: £44.2 million (£41.3 running costs, £2.9 capital spend), excluding Halley VI capital budget of £10M

Full figures can be found in the BAS Business Plan, which can be viewed at: *www.antarctica.ac.uk/about_bas/publications/corporate.php*

Total staff employed
568 staff worked for BAS during the reporting period

UK staff, based at BAS Cambridge
185 scientists contributing to the BAS science programme
48 scientific support staff, including Directorate
115 staff in the Administration and Logistics Division, including technicians, aircrew and shore-based marine personnel

Overwintering Antarctic staff
21 at Rothera Research Station
11 at Halley Research Station
8 at King Edward Point Research Station
4 at Bird Island Research Station

Ships
Two complements of 28 crew on RRS *James Clark Ross*
Two complements of 21 crew on RRS *Ernest Shackleton*
79 scientific cruise staff working on RRS *James Clark Ross* and RRS *Ernest Shackleton*
125 staff transported to and from Antarctic destinations on RRS *James Clark Ross*, RRS *Ernest Shackleton* and HMS *Endurance*

Summer participants in Antarctic operations
119 at Rothera, including 12 scientific collaborators from the UK and overseas
28 at Halley, including two contractors
38 at Signy, Bird Island and King Edward Point, including 11 scientific collaborators from the UK and overseas
53 in the field and on various projects off HMS *Endurance* and on South Georgia, including 9 scientific collaborators from the UK and overseas

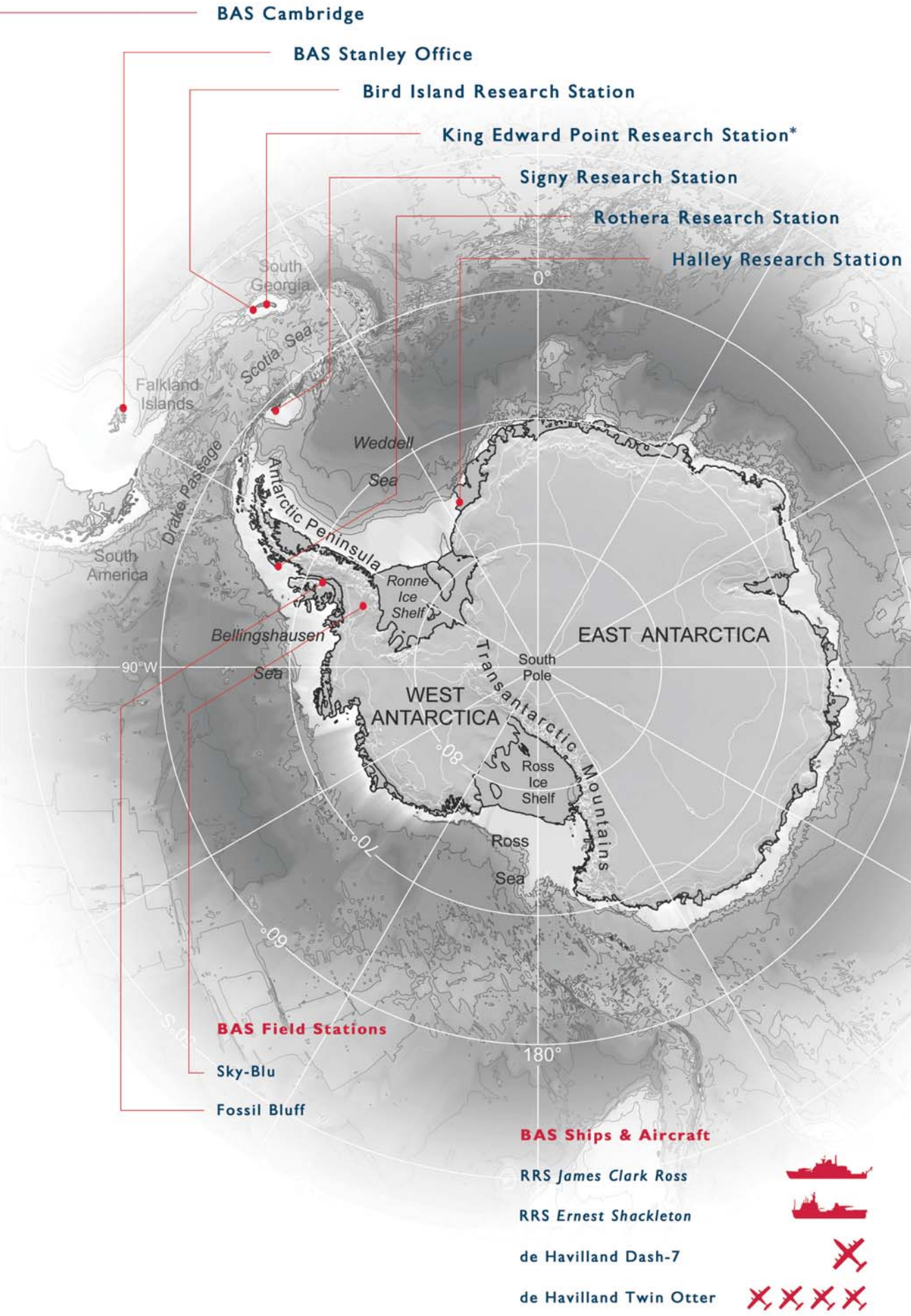
Summer participants in Arctic operations
32 at Ny Ålesund, Svalbard, nine of whom were BAS personnel

Research students
46 registered for higher degrees (co-supervised by BAS staff)

Publications
250 peer-reviewed research papers listed in the ISI database of high-quality journals, including nine published in the leading science journals *Science* and *Nature*
Details of all BAS papers can be found at:
www.antarctica.ac.uk/about_bas/publications/science_publications.php

BAS website (*www.antarctica.ac.uk*)
~142,000 individual visits per month (average for reporting period)

BAS offices and research stations



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

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

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For further information about BAS, please visit our website: **www.antarctica.ac.uk**

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British Antarctic Survey (BAS), part of the Natural Environment Research Council, is a world leader in global science in an Antarctic context. Based in Cambridge, BAS is the UK's national Antarctic operator and has an active and influential role in Antarctic affairs. BAS has over 450 staff and operates five research stations, two Royal Research Ships and five aircraft in and around Antarctica. By undertaking a world-class programme of science in the Antarctic and related regions, BAS addresses key global and regional issues. This involves joint research projects with over 40 UK universities and more than 120 national and international collaborations.

www.antarctica.ac.uk

British
Antarctic Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL