

## EVALUATION OF NERC CENTRES 2013

### IMPACT CASE STUDIES: BRITISH ANTARCTIC SURVEY

Note: confidential aspects of the case studies have been deleted where necessary.

BAS1	Space Weather forecasts helps business and Government risk management
BAS2	Valuing and managing sustainability the Antarctic and Southern Ocean Ecosystem
BAS3	BAS climate research influences international policy makers
BAS4	BAS 4 Polar View: Operational sea ice information serves science and business users
BAS5	Sea-level research leadership advises UK and EU policy and sea defence planning
BAS6	Antarctic Media Visits engage a mass audience in polar research
BAS7	Science in the classroom: – award-winning curriculum-relevant resource influences teaching in schools and national exams
BAS8	Bespoke events engage business leaders on sustainability and climate change

## BAS 1 Space Weather forecasts helps business and Government risk management

### 1. Summary of the impact (words - 99)

The global impact of a severe space weather event has been estimated at US\$ 2 trillion<sup>1</sup>. The major risk to the UK is a partial power blackout, loss of several satellites and satellite services, and disruption to aviation and transport. BAS has developed research models into a system that forecasts the risk of damage to satellites (SPACECAST project) in collaboration with two commercial companies. BAS also advises Government on the impact of space weather which led to its inclusion on the Cabinet Office National Risk Register of Civil Emergences (2012) at the same level as heat-waves and heavy snow.

### 2. Nature of the impact

Decades of space radiation environment expertise, combined with knowledge of user needs gained through direct interaction with commercial satellite operators, Government policy officials and insurance underwriters, has enabled BAS to lead an international scientific project called SPACECAST to develop a space weather forecasting system. BAS knowledge and expertise in this field provides also advice to Government that helps inform policy.

NERC-BAS has adapted its research models into the SPACECAST system ([www.fp7-spacecast.eu](http://www.fp7-spacecast.eu)) to forecast risk of satellite damage. This system is being used by commercial companies including the largest satellite operator in Europe, SES (Luxembourg). Other companies such as *Atrium Insurance*, *Willis Analytics* in London, *Paradigm* (UK), *Inmarsat* (UK), and *EUMETSAT* (Germany) and the UK Met Office have expressed their interest in the SPACECAST system and indicated their future needs. Satellite operators control approximately 1,000 satellites on orbit. About 380 satellites are for telecommunications and generate about \$128m each year.

Benefits of the SPACECAST system to **satellite operators** are three-fold:

1. Forecasting provides 'situation awareness' which can be used as an early warning system by operators on the ground to deal with any potential problems, and, given enough warning, to have more staff available
2. Forecasting and 'situation awareness' enables satellite operators to take action to mitigate the risk of service interruptions, e.g. by switching off non-essential systems, re-scheduling orbit manoeuvres and software upgrades, and by ensuring spare capacity is immediately available to re-route communications traffic
3. SPACECAST models can help identify the cause of a satellite outage rapidly by re-constructing the radiation environment during a space weather event, particularly for locations where there are no measurements. In March 2012 three satellites suffered outages and BAS provided information for one satellite operator.

Approximately 35% of all space insurance is contracted through London. **The UK insurance industry** insures approximately 170 satellites on orbit, mostly in geostationary orbit, for up to US\$ 165m or so each. Insurers require satellite operators to take all reasonable precautions to ensure the safe operation of their satellites, and need to understand the cause of an outage as this could affect an insurance claim. BAS has developed close contacts with underwriters *Atrium Insurance* in London and provided information to help disaster scenario planning and the radiation risk associated with the new method of launching all electric satellites into geostationary orbit recently introduced by Boeing. One small business (DH Consultancy bvba) has also benefitted from developing systems to access, store and display real-time data which are now being included in new European project proposals.

**UK and US Governments** recognised the importance of low probability high impact events such as severe space weather after the Icelandic volcano in 2010, and the Japanese Tsunami in 2011, demonstrated the need for contingency plans. In 2011 President Obama and Prime Minister Cameron agreed a special scientific collaboration on space weather. **Professor Richard Horne** of BAS has been informing national policy directly by providing advice to the House of Commons Select Committee on defence, the Cabinet Office Civil Contingencies Unit, the Government Office of Science and briefing the NATO Parliamentary Assembly Committee on Energy and Environmental Security (2012) over a period of two years. This consultation has led to severe space weather being included on the Cabinet Office's 'National Risk Register of Civil Emergences 2012'.

### **Future impacts**

The Met Office has requested access to SPACECAST models for forecasting which will take place at the end of the current project in 2014. *Surrey Satellite Technology* (UK) and *Atrium Insurance* have written letters of support for a new €2m proposal to the EU, which will analyse severe space weather events and their impact on the satellite fleet. BAS impact at the government level is long-term as BAS scientists would be called on to provide advice for Cabinet Office Briefings (COBR) in case of a severe space weather event, and will continue to provide risk assessments for the Cabinet Office and the Government Office for Science via the Space Environment Impacts Expert Group (SEIEG). **Satellite designers** benefit from the rapid resolution of anomalies which might affect other satellites and the use of physical models to define the worst case space weather event and improve future design.

### **3. How the Centre contributed to the impact**

Using BAS core research funding Horne *et al.* (2005, 2007) showed that very low frequency radio waves (detected by receivers at Halley Research Station) can accelerate electrons in space and help form the Earth's radiation belts. These high energy electrons known as "killer electrons" cause damage to satellite components and in exceptional cases total satellite loss. The wave acceleration idea, which changed ideas lasting 40 years or more, was developed more fully (Horne, 2007), and tested successfully against satellite data using global radiation belt models (Fok *et al.* 2008; Albert *et al.*, 2009). It was also applied successfully to Jupiter as a wider test of theory (Horne *et al.*, 2008). Professor Horne developed the SPACECAST proposal and leads the €2 million project. The project delivers a forecast of high energy electrons in the Earth's radiation belts and converts this into a risk index for satellite operators. The forecasting system is fully automatic and is updated every hour. It operates 24 hours a day, 7 days a week. It became publicly available from 1 March 2012 and is, at present, freely available via the web ([www.fp7-spacecast.eu](http://www.fp7-spacecast.eu)). The system has three unique features:

1. It uses physics based models derived from many years of research at Halley Research Station, Antarctica.
2. It is the only system to provide a forecast of the entire outer radiation belt including geostationary orbit, where most commercial satellites operate, and medium Earth orbit where the GPS satellites operate.
3. It is truly international, led by the UK and with 6 research Groups across Europe, 2 European companies, 4 Groups in the USA, and data from Japan.

In addition to leading the project, Professor Richard Horne (BAS) initiated and nurtured close contacts with commercial companies, organised workshops at international science conferences and led or facilitated discussions with business and policy users about how the science community can meet their needs. His group contributed data at meetings in Boulder Co, USA, in April 2012 and Brussels in Nov 2012; and to a study led by University of California, Los Angeles which showed that satellites in medium and lower Earth orbit would be most at risk from a Space Weather event (Shprits *et al.*, 2011); as well as organising stakeholder discussions at the European Space Weather week events in Belgium in 2011 and 2012

BAS scientists attended meetings of the UK-USA collaboration organised by the FCO (11-13 Oct, 2011, 28 Apr 2012, and 26 Jun, 2012) and set up collaboration with the National Geophysical Data Center in Boulder Co., USA. They provided written evidence at the House of Commons Science and Technology committee (2011), oral evidence to the Defence Committee (2012), and gave a briefing to Ministers of the NATO Science and Technology Committee at the House of Commons (27 Nov 2012). They have also attended meetings on space weather with the Government Chief Scientist (17 Jan, 11 Jun, and 5 Dec 2012) and are a member of the Space Environment Impacts Expert Group, which provides advice to the Cabinet Office and the Government Office of Science. The UK decided to invest €7m in the European Space Agency's "Space Situation Awareness" program, following advice from BAS and other scientists, and which was announced by the Minister David Willetts in Nov 2012.

### **4. Evidence and sources to corroborate the impact**

Since SPACECAST went live in March 2012, there have been >4000 website visits ( $\approx$ 1,600 unique visitors from 10 countries) mostly from the UK (35%) but also from Europe, North America (11% USA) and South America.

## Policy

1. BAS submission to Government Office for Science (GO Science) for briefing the Prime Minister on space weather. 27 July 2010. Contact GO Science.
2. House of Commons Science and Technology Committee, "Scientific advice and evidence in emergencies", Third Report of Session 2010-11, HC498, (2011).  
<http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/498/498vw01.htm>
3. House of Commons Defence Committee "Developing Threats: Electro-Magnetic Pulses (EMP)", Tenth Report of Session 2010-2012, HC1552, (2012).  
<http://www.publications.parliament.uk/pa/cm201012/cmselect/cmdfence/1552/155202.htm>
4. National Risk Assessment on severe space weather events. This report is classified. The existence of the BAS contribution to this report can be confirmed by contacting the Civil Contingencies Unit of the Cabinet Office. BAS work, along with other contributions, led to the inclusion of severe space weather on the National Risk Register of Civil Emergencies in 2012 along with a direct link to the BAS website.  
[http://www.cabinetoffice.gov.uk/sites/default/files/resources/CO\\_NationalRiskRegister\\_2012\\_acc.pdf](http://www.cabinetoffice.gov.uk/sites/default/files/resources/CO_NationalRiskRegister_2012_acc.pdf)  
NATO Parliamentary Assembly Sub-Committee on Energy and Environmental Security, Briefing to the committee on 27 November 2012 at the House of Commons.

Proactive **media** activity has generated 33 popular and business press articles worldwide about space weather and the SPACECAST system since 2011. These include BBC World Today, and the International Business Times, with national media reports generated as far afield as India, Hong Kong and Australia and various radio and TV coverage, e.g. Swedish TV2 documentary interview with **Professor Horne**: <http://www.svt.se/vetenskapens-varld/se-program/del-14-12?autostart=true>

## References and Business contacts

1. Severe Space Weather Events - Understanding Societal and Economic Impacts Workshop Report  
<http://www.nap.edu/catalog/12507.html>
  - 1). The SPACECAST forecasting system is used by SES the largest satellite operator in Europe.
  - 2). The Meteorological Office requested a copy of the SPACECAST forecast system in 2012. This is being taken forward by collaboration.
  - 3). Satellite risks and extreme events, and support for new EU research proposal on severe space weather (SPACESTORM) is an area of collaboration with Atrium Insurance.

## 5. Contacts for further information

Professor Richard Horne, IMP scientist, [R.Horne@bas.ac.uk](mailto:R.Horne@bas.ac.uk) tel: 01223 221542  
Dr Nigel Meredith, [nmer@bas.ac.uk](mailto:nmer@bas.ac.uk) tel: 01223 221299  
Dr Sarah Glauert, [sagl@bas.ac.uk](mailto:sagl@bas.ac.uk) tel: 01223 221533

## 1. Summary of the impact (- 98 words)

For over 30 years the British Antarctic Survey's pioneering conservation biology research has provided critical expertise and evidence to support the UK Government's leadership role in influencing national and international policies and agreements to protect, conserve and sustainably manage Southern Ocean fisheries as well as marine and terrestrial ecosystems in Antarctica and the Sub-Antarctic.

Research, technological developments and strong scientific leadership have resulted in sustainable fisheries, the designation of large-scale Marine Protected Areas, the virtual elimination of seabird mortality associated with fishing, and a license agreement with a small business for production and marketing of in-house bird-tracking technology.

## 2. Nature of the impact

The Southern Ocean that surrounds Antarctica is rich in fish and krill – the food source for penguins, other seabirds, seals, whales and now humans. In spite of over-exploitation of marine living resources in the 18<sup>th</sup>, 19<sup>th</sup> and early 20<sup>th</sup> Centuries these productive waters are now being managed well. The Antarctic and the surrounding oceans south of 60°S are protected by the Antarctic Treaty System (ATS). The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) established in 1980 regulates commercial fisheries in waters south of the Antarctic Polar Front. UK compliance with the ATS, enshrined in UK law by the Antarctic Act (1994; with a revised Act currently being debated by Parliament), and with CCAMLR, is administered by the Polar Regions Department of the Foreign & Commonwealth Office (FCO).

BAS's long-running biological conservation research within its *Ecosystem* programmes influences significantly the sustainable stewardship of the globally important Southern Ocean resources in three ways:

- a) BAS ecosystems research informs and underpins UK and international policy-making for conservation through its expertise and leadership role within UK Government delegations;
- b) This research benefits ecosystem management and food security by providing data and expertise that influences setting of catch limits and licenses for commercial fishing activity;
- c) Data from innovative bird tracking devices developed in-house have been critical for reducing incidental bird mortality resulting from long-line fishing. A commercial spin-off from this research is a business deal to license production of devices.

### a) **BAS conservation biology research underpins UK Government policy and UK leadership within the Antarctic Treaty System and other international agreements**

BAS conservation biology researchers play an active leadership role in the development of UK and international conservation policy through their provision of expert scientific advice to Government, and by applying their expertise and knowledge to underpin Southern Ocean ecosystem management. They influence international conservation policy through their leadership role within the UK delegations (led by FCO) to the Antarctic Treaty Consultative Party meetings and the Committee for Environmental Protection (CEP established in 1991), and to CCAMLR; and the UK delegations (led by Defra) to the Scientific Committee for the International Whaling Commission (IWC), and the International Agreement on the Conservation of Albatrosses and Petrels (ACAP).

Specific examples of where this expertise has shaped or changed international policy include:

- The establishment in 2009 of the South Orkney Islands Southern Shelf as the first CCAMLR Marine Protected Area which prohibits all fishing activities, waste disposal and discharge from fishing vessels, and improves coordination of scientific research activities. The South Orkneys MPA is the world's first entirely 'High Seas' marine protected area.
- Playing a major role in developing the implementation framework that secured international agreement in CCAMLR in 2010 of a General Conservation Measure on the Establishment of Marine Protected Areas in line with the UN Convention of Biological Diversity.
- Proposing management measures in 14 of the 71 Antarctic Treaty's Antarctic Specially Protected Areas;

achieving in 2008 protection for Marion Island.

- Contributing to the implementation strategy of ACAP – the multilateral agreement which seeks to conserve albatrosses and petrels by coordinating international activity to mitigate known threats to their populations.
- Leading discussions, tabling expert research papers and highlighting the importance of climate change at the first ever joint CCAMLR and ATS CEP meeting in 2009. This scientific contribution led to CCAMLR forwarding a resolution on climate change to the UN Framework Convention on Climate Change, Copenhagen 2009 and continues to influence debate on this issue.
- Population assessment of Southern Ocean humpback and right whales at the IWC; this work led to a 2008 IUCN 'Endangered' relisting for South Pacific humpback whales.

**b) Influencing Southern Ocean commercial fisheries management operations and informing regulatory and licensing actions relating to global food security by:**

- Delivering data, expert knowledge and chairmanship of working groups to develop CCAMLR's management strategy for sustainable krill harvesting through its Ecosystem Monitoring System.
- The establishment by the Government of South Georgia in 2012, with added provisions in 2013, of the South Georgia and South Sandwich Islands marine protected area, the World's largest sustainably-managed marine protected area.
- Working in partnership with the scientific community, fishing industry and NGOs (RSPB and including Birdlife International's Global Seabird Programme) to advise fishing companies on ways to reduce the unintentional by-catch of birds by fleets in the Southern Ocean.
- Contributing data and expertise to aid the international agencies who regulate, set catch limits and make informed decisions to ensure sustainable harvesting of krill (including leading research in 2010 to estimate krill biomass), mackerel icefish and Patagonian toothfish.
- Delivering an expert perspective at CCAMLR Symposia on the Feedback Management of krill in 2011 and 2012. BAS researchers expect to continue with this strand of work for at least another 3-5 years.
- Delivering expertise about the impact of fisheries on seabirds in 2007-2009 to the International Committee for the Conservation of Atlantic Tuna (ICCAT).

**c) Development of innovative technologies to enhance understanding of albatross behaviour and distribution and reduce seabird mortality, create benefits for commercial fishing and create a spin-off for a UK Small to Medium Enterprise (SME)**

Pioneering developments in bird tracking technology, stimulated by the scientific need to understand the movements of albatrosses and other seabird species during the non-breeding periods, advanced significantly the knowledge about the at-sea activity patterns of these long-lived charismatic birds. Using innovative micro-electronic tracking technology BAS scientists identified areas of intense fishing activity where albatrosses and large petrels either drown as they take bait from long-lines, or are killed when in collision with trawl warp cables. BAS researchers engaged with NGOs and fisheries regulatory bodies to establish vessel operational practises that mitigate bird by-catch. A business spin-off from this research licenses production and marketing of bird-tracking devices (a geolocator) to a SME that has widened the international market that not only benefits bird research but also contributes to the economic growth of a small UK enterprise.

**3. How the Centre contributed to the impact**

British Antarctic Survey's long running core-funded ecosystems research and environmental monitoring programmes produce a suite of interdisciplinary research, including biological studies of marine and land-based predators, fisheries biology and surveys as well as physical oceanography, benthic surveys and remotely sensed data.

Head of Conservation Biology, **Dr Philip Trathan** is a senior scientific advisor to the UK Foreign Office, Polar Regions Department and to CCAMLR and leads the BAS contribution. The BAS team, including senior bio-acoustician **Dr Jonathan Watkins**, co-convenor of the CCAMLR acoustic group, **Dr Simeon Hill** and **Dr Sophie Fielding**, generate scientific evidence that influences the sustainable management of the multi-national exploitation of Antarctic krill – a marine crustacean at the heart of the Southern Ocean food chain. This work also creates new knowledge and understanding about how climate change will impact fisheries management. **Dr Susie Grant**, convenor of the CCAMLR MPA correspondence group, works with Dr Trathan on the establishment of Marine Protected Areas. Since

2007 they have contributed 18 papers to CCAMLR on the topic of protected areas. **Dr Mark Belchier** is convenor of the CCAMLR Working Group on Fish Stock Assessment (2012-). **Dr Jennifer Jackson** is convenor of the IWC Scientific Committee Working Group on stock definition (2012-). **Dr Kevin Hughes** from the BAS Environment Office provides expertise on terrestrial ecosystems and contributes to scientific and policy papers for the Committee for Environmental Protection.

BAS research and working relationships with CCAMLR, NGOs (including BirdLife International) has directly or indirectly led to reductions in sea bird mortality resulting from incidental by-catch on long-line fisheries. As part of conservation biology with BAS *Ecosystem* programme, seabird ecologist, **Dr Richard Phillips** leads the long-term monitoring of population trends and demography of albatrosses and giant petrels on the Sub-Antarctic island of South Georgia. Data from these studies are among the most comprehensive available for any albatross population and have contributed to the designation of 17 of 22 albatross species being listed by the World Conservation Union (IUCN) as 'Vulnerable' to 'Critical' with the remainder listed as 'Near-Threatened'. Since 2004 Dr Phillips has played a leading role within the Agreement on the Conservation of Antarctic Albatrosses and Petrels ACAP; as Convenor of the Breeding Sites, UK member of the Status and Trends working groups; Convenor of the Population and Conservation Status working group; Adviser to the UK Delegation to the ACAP Advisory Committee. He is also a member of the Scientific Committee on Antarctic Research (SCAR) Expert Group on Birds and Marine Mammals.

The BAS engineering and technology programme, led by **David Blake** develops innovative technologies to support BAS research. Pioneering work to design and produce miniaturised electronic devices to track the movements and behaviour of albatrosses was developed by BAS instrumentation engineer **Vsevelod Afanasyev**. In 2011, in-house production and marketing of geolocators was licensed to Biotrack, an SME specialising in bird and animal tracking. This successful commercial arrangement continues to support BAS and international studies on other species, attracts a wider market and contributes to the economic success of a UK company.

#### 4. Evidence and sources to corroborate the impact

Redacted

#### 5. Contacts for further information

*Please list two Centre staff that could provide further information about the case study if required (name, position, email address, telephone number).*

**Dr Phil Trathan**, [pnt@bas.ac.uk](mailto:pnt@bas.ac.uk); tel: 01223 221602

**Dr Richard Phillips**: [raphil@bas.ac.uk](mailto:raphil@bas.ac.uk); tel: 01223 221610

## 1. Summary of the impact (88 )

Three influential reports published by the Intergovernmental Panel on Climate Change (IPCC) feature British Antarctic Survey climate science. Many of the statements in these internationally recognised reports are underpinned by BAS research. IPCC reports are the authoritative consensus of climate scientists, and are accepted by 120 governments. The reports are valued as the source of policy advice on climate change. Through its involvement in this activity BAS influences thinking about the wide-ranging implications for economic and societal well-being, which leads to direct impact on international agreements and legislation.

## 2. Nature of the impact

Following the successful participation by BAS in the Third Assessment report (2001), five BAS climate scientists were invited by the IPCC to serve on the writing teams of the Fourth Assessment Report (2007). British Antarctic Survey has supported the development of the Third, Fourth and Fifth assessment reports (TAR, AR4, and AR5 respectively) of the Intergovernmental Panel on Climate Change by:

- a) providing climate experts (see below) to serve as authors,
- b) providing a body (see below) of peer-reviewed literature that was cited to support many statements concerning current and future change in polar regions, and,
- c) being highly-active during the review process in ensuring the quality and reliability of statements in the assessments (see below).

As demonstrated in peer-reviewed literature, BAS core scientific programmes and grant-funded activities have substantially improved understanding of the climate change in the polar, and particularly, the Antarctic region. A substantial number of BAS publications were cited in the TAR and AR4, reports in the report (see below for details) indicating the significance and policy-relevance of the output from BAS scientific programmes.

This international reputation of the organisation and that of its scientists, led to the nomination of several BAS staff by the UK Government to serve as authors on the IPCC writing teams (see below for details). After scrutiny by the plenary group of international governments that owns the IPCC process, two members of BAS staff were invited to serve as coordinating lead author, lead author for the IPCC Assessment Reports (TAR, AR4, AR5). One of these staff, **Professor David Vaughan**, has now served in three such roles, in three successive assessments, and most unusually, has been a coordinating lead author for both Working Group II (Impacts, Adaptation and Vulnerability) and Working Group I (The Physical Science Basis).

The contribution made by BAS authors by the articulation and explanation of specific areas of its relevant research within the chapters of Working Groups I & II, and especially in the Summary for Policymakers issued by each of the working groups, draws policy makers' attention to the importance of polar regions in regulating and affecting the global climate system. Most significantly, the, high-level Summary for Policy Makers (SPM) which were approved line-by-line by governmental plenary contain specific statements that are traceable to sections of text that cite BAS research. For example:

- TAR, WGII – “There is evidence from polar ice cores suggesting that atmospheric regimes can change within a few years and that large-scale hemispheric changes can evolve as fast as a few decades.”
- TAR, WGII – “Polar regions contain important drivers of climate change. Once triggered, they may continue for centuries, long after greenhouse gas concentrations are stabilized, and cause irreversible impacts on ice sheets, global ocean circulation, and sea-level rise (*medium confidence*).”
- AR4, WGI – “The corresponding increased ice sheet mass loss has often followed thinning, reduction or loss of ice shelves or loss of floating glacier tongues”
- AR4, WGII – “In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered.”



This contribution to understanding of the Earth's climate system, and its vulnerability to human influence, has led directly to the United Nations Framework Convention on Climate Change and agreements reached at its annual meetings (COP); in Europe with the EU Emissions Trading Scheme, in the UK, the Climate Change Act 2008, and Climate Change (Scotland) Act 2009, which emplace actions on climate change and emissions targets into UK law.

**Sustainability of the impact** – BAS continues to have a high level of influence in the preparation of the upcoming fifth assessment reports which will undergo government acceptance review in 2013 (WGI), and 2014 (WGII and WGIII). BAS is crucially involved in authorship in WGI and WGII, expects that its science will also be prominent in the report. Crucially, Professor Vaughan is serving as Coordinating Lead Author in WGI, and is part of the compilation team for the WGI Summary for Policy Makers. He has been invited by the IPCC Co-chairs, to attend the Plenary meeting in Stockholm in Sept, 2013, and during their line-by-line scrutiny of the WGI SPM will be required to defend and justify statements before they are accepted.

### **3. How the Centre contributed to the impact**

BAS's long-running core and grant-funded research on climate change forms the foundation of knowledge that is synthesised, 'translated' and presented in these important IPCC reports. In addition, specific involvement of Coordinating Lead Authors in the Fourth IPCC Assessment Report was funded directly by Department of Energy and Climate Change.

BAS contribution to the leadership and authorship of IPCC reports is as follows:

1. Third Assessment Report, 2001.
  - a. Drafting Author for the WGII Summary For Policymakers: DG Vaughan
  - b. Lead Author for the WGII Technical Summary: DG Vaughan
  - c. Lead Author: DG Vaughan WGII Ch16 (Polar Regions - Arctic and Antarctic)
  - d. Contributing Author: DG Vaughan, WGI Ch1
2. Fourth Assessment Report, 2007.
  - a. Coordinating Leader Author: DG Vaughan WGII Ch15 (Polar Regions - Arctic and Antarctic) This task occupied several months activity and was supported by specific annual funding from DEFRA to cover travel and staff costs.
  - b. Lead Author: C. Le Quéré (joint appointment with UEA) WGI Ch5
  - c. Contributing Authors: G Marshall, WGI Ch3; DG Vaughan, GH Gudmundsson and A. Jenkins, , WGI Ch4; C. Le Quéré (joint appointment with UEA) WGI Ch7; DG Vaughan, WGI Ch10
3. Fifth Assessment Report, 2013/14. (currently in draft for release in Sept., 2013)
  - a. Coordinating Lead Author: DG Vaughan, WGI (Observations of the Cryosphere). This task has already occupied several months activity and was supported by specific annual funding from DEFRA to cover travel and staff costs.
  - b. Contributing authors – not yet finalised, but BAS will be represented in WGI and WGII.

During the AR4 review process BAS provided advice to WGI through eight expert reviewers and to WGII through three expert reviewers.

### **4. Evidence and sources to corroborate the impact**

The full text of the IPCC for each of the Working Groups, is available at:

[http://www.ipcc.ch/publications\\_and\\_data/publications\\_and\\_data\\_reports.shtml](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml)

- In the Assessment Report 4, several headline statements highlighted within the Summary for Policymakers can be tracked directly to BAS research. In particular, "changes in Antarctic ecosystems, including those in sea-ice biomes, and also predators high in the food chain" (WGII SPM, pg8); "In both polar regions, specific ecosystem and habitats are projected to be vulnerable, as climate barriers to species invasions are lowered" (WGI SPM, pg 15).
- Of the papers cited by the WGII Chapter 15 (Polar Regions, 8% included a BAS author. Similarly, of the

papers cited by the WGI Chapter 4 (Observations: changes in snow, ice and frozen ground), 4% included a BAS author.

- During the preparation of IPCC AR4, 10 BAS Scientists contributed as reviewers of WGI chapters, 3 contributed to WGII chapters.
- A review of eight regional chapters in IPCC AR4 WGII, was specifically commissioned by the Netherlands government to assess the quality and traceability of statements, and conducted by Netherlands Environmental Assessment Agency (PBL) in 2007. (see, <http://www.pbl.nl/sites/default/files/cms/publicaties/500216002.pdf>). In this review, Chapter 15, Polar Regions (Arctic and Antarctic) for which DGVaughan served as Coordinating Lead Author, was the only chapter for which no errors (“major” or “minor”) were highlighted, and the only chapter for which no errata were requested.

#### **5. Contacts for further information**

*Prof. David G. Vaughan, Science Leader, [dgv@bas.ac.uk](mailto:dgv@bas.ac.uk), 01223 221643.*

*Dr Gareth Marshall, Science Programme Coordinator, [gjma@bas.ac.uk](mailto:gjma@bas.ac.uk), 01223 221400*

## BAS 4 Polar View: Operational sea ice information serves science and business users

### 1. Summary of the impact (100)

Sea ice affects polar shipping operations. **Polar View** – developed in the Antarctic by an international consortium of ice charting experts led by BAS – provides a near-real-time sea ice information service for ship operators to help them minimise delays, improve efficiency, and take action to avoid life-threatening safety hazards, damage to vessels and potentially severe consequences for the environment. **Polar View** is a service delivering information products from BAS and its international collaborators based on satellite data. It is widely used by commercial and tourist shipping, and by national polar research programmes. Services have been extended recently to cover the Arctic.

### 2. Nature of the impact

The **Polar View** service enhances safety of ship operations in hazardous polar waters, has led to industry efficiency and cost savings, and has attracted around £1million of external R&D funding to BAS since 2005. The web-based sea-ice monitoring service created and led by BAS sea ice and informatics specialists, delivers mapped data direct to ships. Information products include radar satellite images with 100 m pixel spacing delivered in less than four hours from acquisition. Working in partnership with Polar View partners (<http://www.polarview.aq/team.php>) and drawing on expertise from the BAS Climate programme, the service is delivered in two parts:

1. Publically available free-to-use sea ice information service;
2. On-demand, paid for, services customised to user's location and information requirements.

A key part of this delivery is through the Polar View Antarctic website ([www.polarview.aq](http://www.polarview.aq)) which expanded to cover the Arctic in 2009. Since November 2011, the Polar View Antarctic website has recorded almost 20,000 visits, two-thirds of which are repeat visits. In the same period there have been over 6000 unique visitors.

The Polar View service is used by a range of different sectors including:

- Science community:
- Tourism:
- Commerce:
- Defence:
- Rescue and marine safety organisations:

### Context

In recent years the polar oceans have seen an increase in maritime activity resulting from:

- use of northern sea routes by commercial shipping operators<sup>1,7</sup>
- an expansion of natural resource exploration driven by changes in Arctic sea ice extent<sup>1</sup>
- growth of commercial fishing activity in the Arctic and Antarctic
- increasing tourism and yacht racing in both polar regions
- Arctic and Antarctic scientific research cruises

Today more ocean-going vessels are transiting through hazardous ice infested waters than in previous decades. This raises concerns about safety, especially in areas remote from search and rescue (SAR) facilities, and about potential damage to the environment from oil spills or accidents.

The International Maritime Organisation (IMO) has developed an international code of safety for ships operating in polar waters<sup>2</sup> which recommends that voyage planning takes into account ice and icebergs given the risk they pose

to vessels, and the SOLAS convention<sup>8</sup> already requires the use of meteorological services, including ice information. To comply with the IMO Code ship operators are required to use meteorological services, including ice information. **Polar View** service is used and valued by commercial and scientific ship operators as well as by coast guard and rescue coordination organisations. In addition the service is accessed by onshore users including scientific research groups and indigenous Arctic populations.

### **Benefits to Polar View users**

**Efficient ship operations.** Evidence and feedback from the user community, plus willingness to pay for customised services, indicates that the up-to-date and detailed sea ice information in both Antarctic and Arctic waters provided by **Polar View** is enabling ships' captains to make efficient navigational decisions. Operating in ice-infested areas frequently results in costly delays because of the need to travel through ice at slower speeds which significantly increases fuel burn due to the resistance of sea ice. Less time spent moving through ice also reduces the amount of damage to a ship hull and minimises maintenance costs. Two users of the **Polar View** Antarctic service indicated significant cost savings due to availability of sea ice information.

**Safety** - Sea ice and icebergs are significant hazards to shipping as highlighted by the recent sinking of the MS Explorer<sup>3</sup> in 2007. The Polar View service allows ship operators to avoid areas which pose greater risk. Search and rescue (SAR) assets for the polar regions are very remote and rescue coordination centres require good information to plan SAR efforts. The BAS **Polar View** service has been used on several occasions to assist with rescue efforts.

**Environmental protection** - The Arctic Marine Shipping Assessment<sup>1</sup> states "The most significant threat from ships to the Arctic marine environment is the release of oil through accidental or illegal discharge". **Polar View** provides better knowledge of sea ice conditions which leads to safer operations, reducing the risk of accidents and resulting environmental damage.

### **Sustainability of this impact**

The **Polar View** service relies on many national ice centres, including national meteorological agencies. Collectively these agencies offer the opportunity to enhance the effectiveness of public services through **Polar View**. The commercial service development fits well with UK Government strategy for economic growth from the space sector<sup>4,5</sup> which encourages development of space-based technologies and applications to promote economic growth. This strategy is also aligned with that of the EC through its GMES (Global Monitoring for Environment and Security) programme and strategy for sustainable development of the Arctic<sup>6</sup>. UK industry can benefit from the technology, expertise and market knowledge developed at BAS through the **Polar View** programme. The international **Polar View** network is now incorporated in the UK as Polar View Earth Observation Ltd which will provide further opportunities for attracting R&D investment and for commercial exploitation.

### **3. How the Centre contributed to the impact**

**Andrew Fleming**, BAS, has led the development of a coordinated sea ice service for the Antarctic component of the Polar View project since 2005. Andrew Fleming and **Andreas Cziferszky** have developed the technology to collate and deliver information to ships. BAS also provides interpretation and products based on SAR (synthetic aperture radar) satellite imagery. The automated delivery of geospatial data is an important BAS development that allows customisation of services to users. In addition this development enables improvements in the transmission of large satellite images over low-bandwidth communications links.

BAS works with key user groups to ensure wide use of the service. Presentations at relevant conferences and user meetings, including the Council of Managers of National Antarctic Programs (COMNAP) and International Association of Antarctic Tour Operators annual meetings. Raising wider awareness through proactive media engagement resulted in articles highlighting the issues and technology (<http://goo.gl/9nhiA> & <http://goo.gl/g4xfd>). BAS has also become a signatory member of the International Ice Charting Working Group (IICWG - <http://nsidc.org/noaa/iicwg/>) which promotes cooperation between the world's ice centres. **Andrew Fleming** is now the UK representative on the IICWG Data and Applied Science standing committees and is working on

establishing an Antarctic working group within IICWG. BAS hosted the IICWG 2011 annual meeting in Cambridge.

#### **Funding**

Since 2005 the BAS effort has been funded to further develop these technologies and applications by the **European Space Agency** with contributions from the **UK Foreign and Commonwealth Office, European Commission** (EC MyOcean and ICEMAR), BAS Core funding and associated commercial income from certain users. External income to BAS for these developments is currently in excess of £1million.

#### **4. Evidence and sources to corroborate the impact**

The Polar View Antarctic service maintains service level agreements with a small group of representative users. These are available to corroborate the impact. Feedback from users include:

*“The images we receive from Polar View are far superior to images from any other system available to us. The safety of the vessel and persons onboard is greatly increased if we can keep out of the heavy concentrations of pack ice. The more good information we have about the ice, the safer our work becomes.”*

*“The program's shipping capability is a significant expense and the ability to undertake safe and efficient ice navigation is an important component of its cost management. The Polar View consortium is a key component of the suite of tools that improves the safety of our operations in the Southern Ocean and as such its continuance is actively supported*

*“Polar View provides a valuable tool to for the many member-companies of our association who operate passenger vessels in Antarctic waters. Good, near real-time sea ice information is extremely useful for safety as well as environmentally responsible and economically sound vessel operations.”*

#### **Key sources of supporting information referenced in the text are:**

1. Arctic Marine Shipping Assessment - <http://goo.gl/6e0Gg>
2. IMO Ships operating in Polar Regions - <http://goo.gl/eml5F>
3. Guardian report on sinking of MS Explorer - <http://goo.gl/4GY11>
4. UK secures £1.2 billion package of space investment - <http://goo.gl/o7J3F>
5. Technology Strategy Board announces Satellite Applications Catapult centre - <http://goo.gl/f782G>
6. Developing a European Union Policy towards the Arctic Region - <http://goo.gl/sGqmB>
7. DNV Shipping across the Arctic position paper - <http://goo.gl/kskpl>
8. IMO International Convention for the Safety of Life at Sea (SOLAS) - <http://goo.gl/vWpKb>

#### **5. Contacts for further information**

The two staff most able to comment on the BAS contribution to Polar View are:

1. **Andrew Fleming**; Remote sensing manager; Tel: 01223 221451; ahf@bas.ac.uk
2. **Andreas Cziferszky**; Information systems developer; Tel: 01223 221420; ancz@bas.ac.uk

BAS 5 –Sea-level research leadership advises UK and EU policy and sea defence planning.

### 1. Summary of the impact (91)

BAS's leadership of UK, international and European sea-level research programmes is influencing UK and European sea defence policy and planning. BAS's core-funded *Ice Sheets* research programme and BAS leadership of the EU-Framework-7 programme *ice2sea* responds to the declared requirement of UK and overseas governments that the uncertainty in projections of future sea-level be reduced. Collaboration and dialogue with stakeholders from UK and European parliamentary bodies and agencies, and with the science community, provides a robust foundation for sea-defence planning, coastal adaptation, and to support negotiations on the mitigation of climate change.

### 2. Nature of the impact

BAS scientific knowledge and expertise generated by its *Ice Sheets* research programme, coupled with its leadership of a major international programme funded by the EU Framework-7 Programme (*ice2sea*), has led to the first development of projections of ice-sheet change that are tied to specific greenhouse gas emission scenarios and based solely on physically-based models. Interaction and engagement with stakeholders, including national and international agencies, governments and their advisors, has informed and continues to inform important sea-level policy and planning decisions. Examples include:

- BAS leadership of a major EU Framework-7 Programme (*ice2sea*) combines knowledge, expertise and data from the BAS core-funded Ice Sheets programme with that of European partner institutions. Direct engagement with EU stakeholders raises awareness at Government level of this important global issue. The scientific research outputs provide the **Intergovernmental Panel on Climate Change (IPCC)** with a definitive assessment of the current contributions of glaciers and ice sheets to sea-level rise
- Collaborative working with the **Environment Agency (EA)** and the provision of sea-level data, knowledge and expertise informs the implementation of the EA's Thames Estuary 2100 plan – the decision framework for maintaining acceptable levels of flood risk for the City of London and ongoing management of the Thames Barrier
- BAS sea-level data and expertise, and stakeholder engagement activity has informed the **Netherlands Government** initiative (Delta Commission) to develop "high-end" sea-level projections. The process has defined the Netherlands future requirements for sea-defences, and informed the investment plan to deliver these requirements.

**Context:** The 2007 report of the IPCC highlighted that the contribution to sea-level rise from ice sheets was the largest remaining uncertainty in projections to 2100. This uncertainty limits the ability of people business and government in the effective planning for adaptation and/or mitigations of increasing flood risk.

Decades of experience in managing strategically-led science, and a strong profile in the international science community put BAS in a unique position to lead a coordinated response to governments concerns. Through science undertaken under NERC National Capability and grant funding, and through the leadership of a major international programme funded by the EU Framework-7 Programme (*ice2sea*), BAS has led the first development of projections of ice-sheet change tied to specific greenhouse gas emission scenarios and developed solely from physically-based models. These have been delivered to meet deadlines for potential inclusion in the upcoming Fifth Assessment Report (AR5) of the IPCC.

**Sustainability of the impact** – The IPCC AR5 is currently in draft, and will be published in 2013/14. It will include specific sea-level rise projections to 2100 that have the imprimatur of the IPCC consensus process, but will be based almost exclusively on the evidence provided in the peer-reviewed literature. More than 30 scientific papers authored by BAS and its *ice2sea* partners, were submitted specifically to meet the deadlines for inclusion in IPCC AR5 drafts (31/7/2013), and it is fully expected that many of these will be cited in the published version of that document.

**Future impact potential** – An outline proposal to continue the research begun in *ice2sea*, has been submitted for

consideration by the European Union FP7 programme. Scientists at BAS are currently developing a proposal for regional sea-level projection for the UK coastlines, which would involve NERC Centre/Surveys and UK HEIs.

### **3. How the Centre contributed to the impact**

Science background: The first development of a strategic science programme aimed at understanding the role of ice sheets in contributing to future sea-level rise began in the late-1990s and is ongoing (as *Ice Sheets*) within the BAS core programme, Polar Science for Planet Earth. The *ice2sea* programme was proposed by BAS in 2008, and after successful proposal, began in April, 2009. It will run until November, 2013.

Recent high-profile outputs from *IceSheets* include papers demonstrating: the impact of ocean change on ice-loss from Antarctica <sup>1</sup>, the importance of ice-sheet dynamics in transmitting coastal change into the ice sheets <sup>2</sup>, the potential for unstable collapse in marine ice sheets <sup>3</sup>.

**Professor David Vaughan** leads the BAS *Ice Sheets* Programme and the EU-funded *ice2sea* Programme Office (hosted by BAS). **Professor Vaughan** together with Communications and Engagement Manager **Heather Martin** and *ice2sea* Programme Manager **Elaina Ford** has coordinated a significant programme of dissemination and stakeholder engagement. A stakeholder review, identified lessons of best practice to be applied to communications on sea-level rise issues, and results of a survey of 146 respondents on their requirements for information. Target stakeholders have a role in policy making or sea defence planning, or the quantification of local flood-risk, the development of coastal adaptation strategies. Each has an interest or requirement to ensure that reducing uncertainty in sea-level projects is based on the best scientific evidence.

Carefully targeted and managed stakeholder engagement activities include:

#### **United Kingdom**

- UK parliamentary briefings include a briefing to The Commonwealth Parliamentary Association (06/07/2009, Houses of Parliament); and the provision of science evidence to inform answers to Parliamentary Questions (e.g., Lord Dykes, 6/12/09).
- BAS was requested to provide information and advice by the Parliamentary Office of Science and Technology, prior to writing of *Postnote Number 363, September, 2010: "Sea-level Rise"*, and to fact-check the draft version. <http://www.parliament.uk/documents/post/postpn363-sea-level-rise.pdf>

#### **Europe:**

- Reaching a mass European Audience via the media: four media releases, which produced 50 individual items of coverage across the European media.
- Engaging with the European Parliament by making contact with a UK MEP who would act as 'champion' and with the European Polar Board to assist in utilising effective channels for engagement. Outcomes include a high-level face-to-face briefing on sea-level rise with Anne Glover, Chief Scientific Advisor to the European Parliament (04/04/2012) and an event "Science Briefing for Policy-makers: Understanding Sea-level Rise" (27/06/2012, European Parliament)
- Briefing on Sea-level Rise at Department of Foreign Affairs, Netherlands (5/10/2012, The Hague)
- Briefing to the Danish Ministry of the Environment (February, 2013)
- Expert comment and advice and provided by the BAS *Ice Sheets* Programme leader Professor David Vaughan has informed the Netherlands Government's Delta Commission's initiative to develop "high-end" projections of sea-level to plan future requirements for sea-defences.
- Professor Vaughan was invited to join a scientific workshop in Utrecht (7-8/4/2008) to provide written advice and scientific evidence for inclusion in the official Government report as well as in the peer-reviewed paper that resulted from the workshop<sup>4</sup>.

#### **United Nations:**

- United Nations Framework Convention on Climate Change (COP 18, Nov 2012; Professor Vaughan was invited to present at Doha by the European Commission)



#### **Collaboration with the Environment Agency on sea defence planning.**

A decade-long working relationship between BAS's **Professor Vaughan** and the Environment Agency continues to inform the implementation of the EA's Thames Estuary 2100 plan. Data, knowledge and expertise from the BAS *IceSheets* Programme communicated through face-to-face meetings, written evidence, expert comment on EA draft reports ensures that the Environment Agency is up-to-date on sea-level science. A recent development from this collaboration is that Professor Vaughan has been invited by EA to join the iStorm Sea-level Rise initiative which will monitor scientific developments and update the sea defence community across Europe on the emerging science of sea-level projection. The aim of this international network is to share experiences and transfer of knowledge about operational and functional management of large movable storm surge barriers in order to optimize the management of barriers by innovative management. Similar activities have been undertaken with other areas of the EA.

**Funding** to support BAS's research on ice sheets and sea-level rise comes from NERC National Capability and grants, and the EU's Framework-7 Programme (grant 226375, ice2sea). Since 2009, ice2sea has funded scientists, programme managers/administrators, and part-time Communications Coordinator. The IceSheets programme has secured NERC grant funding to continue a significant programme of work.

#### **4. Evidence and sources to corroborate the impact**

Information on ice2sea <http://www.ice2sea.eu/>, and the ice2sea stakeholder review [http://www.ice2sea.eu/wp-content/uploads/2011/08/ice2sea\\_D1.2-1\\_report\\_stakeholders.pdf](http://www.ice2sea.eu/wp-content/uploads/2011/08/ice2sea_D1.2-1_report_stakeholders.pdf)

Information on TE2100 <http://www.environment-agency.gov.uk/homeandleisure/floods/125045.aspx>

Peer-reviewed sources include:

- <sup>1</sup> - Pritchard, H. D., R. J. Arthern, D. G. Vaughan, and L. A. Edwards (2009), Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets, *Nature*, 461(7266), 971-975.
- <sup>2</sup> - Pritchard, H. D., S. R. M. Ligtenberg, H. A. Fricker, D. G. Vaughan, M. van den Broeke, and L. Padman (2012), Antarctic ice loss driven by ice-shelf melt, *Nature*, 484, 502-505.
- <sup>3</sup> - Gudmundsson, G. H. (2012), Stable grounding lines on retrograde slopes, *The Cryosphere*.
- <sup>4</sup> - Netherlands Delta Commissie, 2008 - <http://www.deltacommissie.com/en/advies>; also peer-reviewed as, Katsman, C. R., et al. (2011), *High-end climate change scenarios for flood protection of a low-lying deltas*, Clim. Change, DOI: 10.1007/s10584-10011-10037-10585 (Co-author, D.G. Vaughan, BAS).

Since its launch in 2011 the ice2sea website ([www.ice2sea.eu](http://www.ice2sea.eu)) has attracted 4,573 unique visitors.

#### **Feedback from stakeholders:**

*"It was a very informative meeting with David. As the Fens work is really starting now, it is essential that we bring your organisations insights and outputs from the Ice2Sea programme, to our 'local' location. If nothing else, providing compelling evidence is crucial if we are to help communities, business and wildlife/habitats adapt."*

*"Dear David, Thank you for delivering such ground breaking work. I just saw the support of Michael Oppenheimer for the work..."*

*"...congratulations to all on the hard work and great outcomes of yesterday! I think it was a success and look forward to continue working with you on outreach..."* **European Commission Programme Officer**, commenting on ice2sea briefing to MEPs, 28/06/2012

*"Thanks for this latest information. I still have good memories of the presentation in The Hague, and appreciate keeping me informed about the latest developments!"*

#### **5. Contacts for further information**

Prof. David G. Vaughan, Science Leader and ice2sea Coordinator, [dgv@bas.ac.uk](mailto:dgv@bas.ac.uk), 01223 221643.

Dr Elaina Ford, ice2sea Programme Coordinator, [eakf@bas.ac.uk](mailto:eakf@bas.ac.uk), 01223 221453



BAS6 Antarctic Media Visits engage and inform a mass audience in polar research.

### 1. Summary of the impact (100 words)

In both 2007 and 2011 over 400 million viewers world-wide learned about BAS climate and ecosystems research programmes when they watched two flagship TV series that were made possible by the BAS Public Engagement in Research annual Antarctic Media Visits Programme. ITV *News at 10*, fronted by news anchor Mark Austin live from Antarctica, broadcast a week-long series from Rothera Research Station. BBC Natural History Unit's landmark TV series *Frozen Planet*, a 7-part series with online content, engaged viewers in BAS conservation biology at BAS Bird Island Research Station and in biological, climate and sea-level rise research at Rothera Station.

### 2. Nature of the impact

British Antarctic Survey runs an annual programme of Antarctic Media Visits as part of its wider Public Engagement in Research Programme. Journalists and broadcasters compete for places – each year around 12 strong proposals are received from broadcasters or journalists. Two of the best proposals are selected to promote, explain and engage a diverse range of audiences in BAS scientific research and operations. This case study focusses on two high-impact examples.

BAS climate science and conservation biology were focal points for two of the UK's leading broadcasters who competed for, and invested in, places on the BAS Antarctic Media Visits Programme. Each produced prime-time landmark series featuring BAS scientific research that contributed to policy debate about climate change and informed members of the public about the importance of understanding global environmental change by studying the polar regions.

The level of financial and resource investment by ITV News and BBC Natural History Unit (NHU) editors to compete for places on the BAS Antarctic Media Visits programme ran to many thousands of pounds. ITV News editors and BBC Commissioning Editors had to be convinced that there was a public appetite and a global 'market' for programmes focussed on BAS science. The TV series were:

1. **ITV News' 'The Big Melt' (2007)** a week-long series of special reports for *News at Ten*. Television history was made during the week of 15-19 January 2007 with the first live news programmes broadcast from Antarctica. Each 30 minute programme featured around 10 minutes about BAS research. ITN, one of the largest and most respected independent news organisations in the world, worked with the BAS Communications team to produce a news and factual series for national and international broadcasters. Over 8 million UK viewers watched three daily broadcast special reports from Rothera Research Station. In addition, selected reports shown also on CNN international reached 186 million homes and NBC Nightly News (USA) reached 9.3 million viewers. Australian and German TV network news programmes ran selected reports reaching over 6 million viewers. Many internet news sites ran stories from 'The Big Melt' series with several including video clips from the programmes.

The week-long series, fronted by news anchor Mark Austin, investigated climate change science and presented it in the political and global context. Special reports featured interviews with BAS scientists **Professor Chris Rapley, Dr Robert Mulvaney, Professor Andy Clarke, Dr Simon Morley** as well as University of Durham's **Dr Mike Bentley**. ITN brought leading figures to comment on climate change including **Prime Minister Tony Blair, HRH the Princess Royal** (who was visiting Rothera at the time), **Sir Nicholas Stern, Professor Stephen Hawking, Bjorn Blomberg** and **Sir Ranulph Fiennes**. BAS won two PR industry awards for its work with ITV News to produce 'The Big Melt'. (see below)

2. The BBC's highly acclaimed seven-part series **Frozen Planet (Nov-Dec 2011)** involved four years of planning to facilitate two visits by BBC Natural History Unit film crews to Bird Island Research Station, on the subantarctic island of South Georgia, and to Rothera Research Station on the Antarctic Peninsula. The primary focus for these two locations was BAS long-term research into albatross populations at South

Georgia, and glaciology research into the stability of the West Antarctic Ice Sheet. The latter topic featured also in the seventh episode - a 1-hour special on climate change written, produced and narrated by **Sir David Attenborough** and featuring BAS glaciologist **Dr Andy Smith** working from Rothera to deploy ice-monitoring instruments on the recently collapsed Wilkins Ice Shelf.

Each of the seven programmes was watched by between 6.8 and 7.9 million UK viewers. The TV series was seen also by a BBC World global audience (approx. 180 million viewers) and sold to other international broadcasters. Extensive additional content was broadcast on BBC online and featured behind the scenes interviews with science teams at Bird Island and Rothera research stations. The series is sold also by BBC Enterprises as a DVD boxed set.

### 3. How the Centre contributed to the impact

The two examples from the Antarctic Media Visits Programme outlined in this case study – **ITV's The Big Melt**, and **BBC's Frozen Planet** grew from long-standing productive relationships between BAS and broadcasters who have acquired in-depth knowledge about polar science.

Journalists and broadcasters compete for places on the Media Visits Programme by submitting proposals to the Head of Communications, **Linda Capper**. These are assessed against criteria that determine the 'fit' for meeting strategic objectives for science communication and public engagement, as well as for potential impact on logistics and operational planning. The BAS Communications team meet with journalists and broadcasters to assist them in preparing credible proposals that are ranked in order of priority and submitted to the BAS Board for final approval in May each year. Two media visits are facilitated most years.

From the point of acceptance up until the Antarctic visit the Communications team worked with the ITV and BBC producers to develop the 'Reporting Plans'. Pre-visit preparation involved members of staff from the Communications, Operations and Science teams. For ITV News the pre-deployment dialogue took approximately 7 months from acceptance of their proposal to on-location filming. For BBC Frozen Planet pre-deployment dialogue and planning was undertaken over four years. **Linda Capper** managed both visits on-location. A Memorandum of Understanding was agreed between BAS and each of the media visitors.

The BAS Press Office provided media coaching for scientists; organised science and logistics briefings for journalists; and 'translated' complex and complicated and topical science into plain-language engaging copy. Scientists from the BAS Conservation Biology research and Climate Science programmes gave detailed briefings to producers and researchers. **Drs Phil Trathan, Richard Phillips, Jaume Focarda** and **Iain Staniland**, worked with BBC NHU to develop scientific narratives for filming Bird Island, for fact-checking and for working on location with the camera crew. **Drs Andy Smith, John King, Melody Clark, Mellissa Langridge** and **Professors David Vaughan** and **John Turner** worked with BBC NHU to develop science narrative, fact-checking and provide interviews for online.

For on-location and flight filming both visits required a high level of planning to get specialised equipment operational. For ITV this was a large amount of kit for live satellite broadcasting; for BBC a special cineflex camera system had to be tested and approved by BAS Chief Pilot **Alan Meredith** before the BBC could film the break-up of the Wilkins Ice Shelf from a BAS Twin Otter aircraft.

For BBC Frozen Planet an additional component was the production of supplementary online content and a map poster that was co-ordinated by BBC Partner the Open University. **Dr John Shears** was an expert assessor on the OU Science Short Module – the Frozen planet (S175). **Athena Dinar** from the BAS Communications Team collaborated with the Open University and BAS science teams to create online content, and with **Adrian Fox** and **Peter Fretwell** from the BAS mapping team to supply data for a 'viewer offer' free-on-demand poster. The map exceeded all expectations for demand. After the initial print run of 100,000 copies 'sold out' a second 100,000 print run was produced. A link to BAS's educational resource [www.discoveringantarctica.org.uk](http://www.discoveringantarctica.org.uk) generated the highest ever number of monthly visits (227,760) in November 2011

ITV and BBC funded their own staff and travel costs from UK to Punta Arenas where they joined the BAS operation. BAS funded transit from/to Punta Arenas and Antarctic accommodation & food.

#### **4. Evidence and sources to corroborate the impact**

Full Evaluation Reports, submitted annually to the BAS Board, are available for scrutiny if required. During broadcasts in January 2007 and December 2011 the number of unique visitors to the BAS website increased by around 20,000 in each month. Both programmes stimulated dozens of requests for media interviews with scientists.

#### Recognition – Awards for ‘The Big Melt’

2007 **CorpComms Winner** for Best use of Broadcast

*“Described by judges as ‘in a class of its own’ the British Antarctic Survey succeeded in its objective to engage a mass UK and international audience in the science behind climate change when it granted ITV permission to visit Rothera Research Station and broadcast the first live news programmes from the Antarctic.”*

2007 **CIPR Excellence Awards Finalist** in Broadcast Category.

#### **5. Contacts for further information**

**Linda Capper**, Head of Communications British Antarctic Survey, email: [LMCA@bas.ac.uk](mailto:LMCA@bas.ac.uk)

**Mike Dinn**, Operations Manager, British Antarctic Survey, email: [medi@bas.ac.uk](mailto:medi@bas.ac.uk)

BAS 7 Science in the classroom – award-winning curriculum-relevant resource influences teaching in schools and national exams

## 1. Summary of the impact

Polar environmental science, including climate science and marine ecology, is at the heart of an award-winning<sup>1</sup> online GCSE and A-level teaching resource created by British Antarctic Survey (BAS), the Royal Geographical Society (RGS-IBG) and the Foreign and Commonwealth Office (FCO) Polar Regions Department. Teachers and students from around 7000 UK schools, polar educators from around the world, and a leading UK examining board regularly utilise this resource to create lesson plans, classroom projects and exam questions. Since its launch in 2006 Discovering Antarctica has contributed to the delivery of UK Government and NERC-BAS aspirations for enthusing young people in science.

## 2. Nature of the impact

The next generation of citizens and scientists is learning about importance of the polar regions for understanding global environmental change by using an award-winning, innovative, curriculum-relevant, interactive teaching and learning resource developed using BAS science data and the knowledge of its staff.

### Impact and benefits for UK Geography and Science curriculum delivery

Polar science has featured in UK GCSE and A-Level Geography curricula modules including 'wilderness places' and 'weather patterns'. Exam questions based on BAS science data were included by Edexcel in Geography papers in 2007. In addition, an accompanying exam teaching booklet published by Edexcel called "Making Decisions" featured polar environmental science data, maps and written content contributed by BAS. The continued recognition of BAS science as a valued source of exam content was emphasised more recently in 2012 when AQA Education, the largest of the three English Exam boards, credited British Antarctic Survey on the back of each GCSE Geography exam paper after three data charts were selected by them from the Discovering Antarctica website.

Since its launch in 2006 there have been over 1.2 million visits to [www.discoveringantarctica.org.uk](http://www.discoveringantarctica.org.uk). The highest ever number of monthly visits (227,760) was in November 2011 when a map, produced by Open University and BAS to compliment the BBC's Frozen Planet series featured a link to the teaching resource. Significant peaks in the number of visits around school exam time are recorded suggesting that the educational community find the resource useful for revision. The resource is free-of-charge.

### Impact and benefits for polar educators

The wider international polar community shares the BAS commitment to improving scientific literacy and for enthusing young people in polar science. Several leading organisations have embedded links in their websites to extend their own educational outreach programmes. For example, in 2011 the UK Antarctic Heritage Trust made links on its website <http://www.ukaht.org/what-we-do/education>; as did the Scientific Committee on Antarctic Research <http://www.scar.org/about/capacitybuilding/antarcticeducation/> and the US National Science Foundation <http://www.teachersdomain.org/resource/ipy07.sci.life.eco.discant/>

### Benefits for other organisations

- In 2010 the Arctic research community obtained an opportunity to engage young people in Arctic science when Discovering Antarctica spawned a sister site [www.discoveringthearctic.org.uk](http://www.discoveringthearctic.org.uk), created by a similar partnership arrangement between BAS, RGS-IBG and FCO and others.
- In 2012 the British Library enriched its collections when it requested permission to archive a copy of the site on the UK Web Archive which "contains specially selected websites that represent different aspect of online

in the UK”

- In 2012 the Galapagos Conservation Trust commissioned an educational resource inspired by and based on the structure and approach of [www.discoveringantarctica.org.uk](http://www.discoveringantarctica.org.uk)

### Benefits for the partners who created Discovering Antarctica

This resource, created from an original BAS School Pack, helps the three organisations deliver shared strategic goals for engaging young people and the wider public in polar environmental science. In addition, it delivers UK Government and NERC aspirations for enthusing the next generation in science. By pooling distinct areas of scientific data, knowledge, expertise and networks this partnership achieves more than any one partner could do individually.

### **3. How the Centre contributed to the impact**

This resource was developed from an original and highly successful printed Schools Pack created by BAS with funding from the Foreign and Commonwealth Office Polar Regions Department in 2000. A pre-existing working relationship between BAS and RGS involved regular collaborations and activities to engage young people in polar research. In 2004 negotiations between BAS Head of Communications, **Linda Capper**, BAS Head of Environment Office **Dr John Shears**, RGS and the FCO Polar Regions Department led to the formation of a new partnership to develop the BAS Schools Pack into an up-to-date, cutting edge, online interactive and in-depth learning resource.

As part of its long-running public engagement in research programme BAS invests staff resource time for the creation and writing of environmental science content, maps and datasets, as well as the capture of video and stills assets that are used for communicating science to many different sectors. BAS takes a proactive and leading role to develop educational resources and to exploit its assets to provide the ‘in-kind’ contribution to Discovering Antarctica which includes:

- The creation and coordination of the production of original content and data on a wide range of topics including climate and environmental change; ecosystems; marine, terrestrial and atmospheric scientific data; and living and working in the polar regions
- The creation and provision of video, stills, graphics by BAS’s **Pete Bucktrout** and **Jamie Oliver**, and mapping image assets produced by Adrian Fox and the mapping and geographical information team
- The development of interactive modules by **Jamie Oliver** in association with RGS and software developers WAVE
- Commissioning and coordination of expert content from BAS scientists
- Promotion through media, online, the STEM Ambassadors Scheme and other classroom activity and through networks with other national polar operators
- Liaison with examining boards; hosting teacher Continuous Professional Development and evaluation days

Funding is provided by FCO Polar Regions Department as part of its own public engagement in the polar regions. Finances are paid to and managed by RGS-IBG. Initial FCO funding of around £50k was used to employ an educational expert to update and re-version the Schools Pack for online delivery, to commission and manage a software house to develop the resource, and for marketing to the RGS national network of teachers. Each year FCO invests to fund the development of new modules within the resource and for marketing activity mostly through schools poster campaigns. Funding is currently awarded in 3 year blocks.

Since 2005 the development has been led by the BAS Communications and the RGS-IBG Education teams.

Publishing and Education manager **Jamie Oliver** leads from BAS; Head of Education leads from RGS-IBG; the FCO oversees the management of funding and provides expert- content relating to geopolitical issues. Each year around 4-10 BAS scientists provide their expertise, data and other assets for inclusion in the resource.

#### **4. Evidence and sources to corroborate the impact**

Analysis of web statistics reveals that the top 10 countries using the online resource are: UK, Australia, USA, Canada, India, Switzerland, Poland, Singapore, Ireland and New Zealand. Year-on-year the number of visitors continues to grow. Forty percent of visitors access the site directly using its URL suggesting that poster campaigns generate a good level of awareness. The remainder of visits come from search engines and direct referral from BAS, RGS and Scott Polar Research Institute.

In 2007-08 Edexcel featured BAS environmental science data, maps and written resources in its GCE A-level Geography exam “Synoptic Assessment Issues Analysis – Antarctica” in 2007. The success at A-level led to take up in GCSE Geography Resource booklet “Making decisions – the future of Antarctica”, which was released to schools nationwide in September 2008.

Exam papers: AQA GCSE Geography (Specification B) Unit 2 - Foundation and Higher Tier papers

Data used: Average air temperature at Faraday/Vernadsky, average sea surface temperature west of the Antarctic Peninsula (see [http://www.discoveringantarctica.org.uk/12\\_using\\_data.html](http://www.discoveringantarctica.org.uk/12_using_data.html)), and a map of territorial claims ([http://www.discoveringantarctica.org.uk/9\\_claims.php](http://www.discoveringantarctica.org.uk/9_claims.php)).

<sup>1</sup>Recognition through prestigious awards and teacher resources listings including:

- **2006** Children’s BAFTA Award nomination for Secondary Learning
- **2006** Webby Award nomination for Education (the ‘Internet Oscars’ - the prestigious Webbys, presented by The International Academy of Digital Arts & Sciences (IADAS))
- **2007** Geographical Association, Highly Commended Award for Secondary Learning
- **2007** Scottish Association of Geography Teachers Gold Award
- **2008** – present. Discovering Antarctica achieves an annual listing in the Govt’s STEM directory
- **2009** Best Website Award, GeoScience Information Society (GSIS) in the US
- **2012** Listing on the Guardian Teacher Network

#### Extracts from external evaluation by teachers

*“What I like about the resource is that it does not have to be used by a pupil in a secondary school. It could be used by anybody with an interest in Antarctica and they would be able to discover a range of information which they could utilize in a variety of contexts.”*

*“I think that the most powerful resources on this site are the interactive activities - they are engaging and give pupils specific knowledge about Antarctica in a dynamic way. The Wilderness quiz is very good as it gives the user feedback to reinforce their knowledge. The video resources are also powerful in the sense that they bring Antarctica alive to students who sometimes have difficulty visualising environments outside their own.”*

#### **5. Contacts for further information**

**Linda Capper**, Head of Communications, email: [LMCA@bas.ac.uk](mailto:LMCA@bas.ac.uk); tel: 01223 221448

**Jamie Oliver**, Publishing and Education Manager, email [jaol@bas.ac.uk](mailto:jaol@bas.ac.uk); tel: 01223 221413

BAS8: Bespoke events engage international business leaders on sustainability and climate change and its impacts

### **1. Summary of the impact**

A series of bespoke lectures for business executives, created in partnership between British Antarctic Survey (BAS) and the University of Cambridge sparks a deeper understanding of the present and likely future impacts of global climate change. The exchange of knowledge between BAS scientists and executives who are actively looking to embed sustainability principles into their operations and future strategies generates new insights for both communities into how science can underpin business. The exchange provides a catalyst for businesses and their clients to explore ways to become more resilient to climate risks and to recognise potential new opportunities and commercial advantage.

### **2. Nature of the impact**

Since 2005 BAS has organised events for senior executive education programmes and leadership groups in collaboration with two internationally renowned institutions within the University of Cambridge. These events inform and influence the thinking of industry leaders, strengthen relations with Cambridge University and generate income for BAS. The business leadership programmes are:

- (1) the Cambridge Programme for Sustainability Leadership (CPSL) – formerly Cambridge Programme for Industry, and
- (2) the Cambridge Judge Business School (JBS).

The programmes, designed for organisations and business leader (often at Board level), include bespoke lectures and dialogue sessions that address critical global challenges, such as climate change, economic disparity, resource depletion and energy security. These sessions, created by BAS scientists, provide the scientific context for climate change related components of the programmes. The BAS programme is expected to continue for at least the next three years.

Some 1,800 business leaders from more than 300 organisations have visited BAS during one of CPSL's or JBS's executive programmes or leadership initiatives. (Details given below). The sessions hosted at BAS are funded by mutually agreed fees and have generated income for BAS-NERC.

There are a number of benefits and beneficiaries of this activity including:

1. Access to some of BAS's leading researchers and facilities provides Cambridge University with a rich, relevant and valued component to their business leadership programmes
2. Creation of opportunities to engage in discussion and two-way dialogue about globally important environmental issues that have mutual value for business and the BAS science communities
3. Working jointly with Cambridge University generates engagement with international business leaders that would otherwise be difficult to achieve for BAS
4. Programme visits have led to around 10 follow-up activities between BAS and companies to develop interactions to extend the messages more widely and deeper into their organisation. Example companies include KPMG, Unilever, ARUP and Kent National Health Service
5. Positive feedback has been received from Cambridge University and business delegates

The following groups visited BAS:

CPSL Programmes, Leadership Groups and Visits:

- The Prince of Wales's Business & Environment Programme (BEP) Corporate Leaders Group on Climate Change – 90 delegates (19 Nov 2007 & 27 May 2008)
- The Prince of Wales's BEP Senior Executives Seminar – 61 delegates (15 Apr 2008)
- Climate Leadership Programme – 329 delegates (1 Oct 2007, 19 May 2008, 10 Nov 2008, 18 May 2009, 25

Jan 2010, 7 Jun 2010, 10 Oct 2011 & 29 May 2012)

- The FCO's Chevening Fellowship Programme: Economics of Climate Change – 82 delegates (30 Jan 2008, 23 Mar 2009, 12 Jan 2010 & 24 Jan 2011)
- China Advanced Leadership Development Programme – 31 delegates (16 Nov 2007)
- PwC Forward Thinking Programme – 60 delegates (4 Mar 2008)
- World Bank Sustainable Development Leadership – 562 delegates (3 Nov 2008, 24 Feb 2009, 5 May 2009, 21 Sep 2009, 8 Dec 2009, 29 Mar 2010, 13 Jul 2010, 31 Aug 2010 & 12 Dec 2011)
- Aviva Staff Development Course – 17 delegates (30 Sep 2010)
- Asian Development Bank Sustainable Development Leadership Programme – 125 delegates (18 Jul 2011, 31 Oct 2011 & 27 Feb 2012)
- TATA Group – 25 delegates (9 May 2012)
- African Development Bank – 12 delegates (20 Nov 2012)

#### JBS Programmes and Visits

- Shell eXpLore Global Exploration Leadership Programme – 120 delegates (16 Nov 2005, 24 Jan 2006, 10 Oct 2006 & 9 Oct 2007)
- IBM Science Innovation Workshop – 25 delegates (1 May 2008)
- IBM Staff Development Course – 18 delegates (6 Oct 2009)
- IBM Executive Education Programme – 24 delegates (7 Oct 2010)
- Investcorp – 25 delegates (20 Oct 2008)
- Executive Education for Lawyers – 60 delegates (10 Mar 2010)
- Executive Education Programme for Taiwanese Government – 38 delegates (7 Jul 2010)
- Executive Education Programme for KPMG – 25 delegates (20 Apr 2011)
- Standard Chartered Bank – 50 delegates (21 Jul 2011)

### **3. How the Centre contributed to the impact**

Business leaders gain new knowledge and insight into global climate and environmental issues, BAS scientists utilise the insight into business needs to shape and develop relevant and engaging sessions; successful partnering with Cambridge University and the Judge Business School leads to new and valuable interactions with industry.

The programmes and groups bring together experts and leading thinkers from academia, policy and industry as well as delegate groups of between 10 and 60 business leaders. Periodic meetings between the Cambridge programmes and BAS review and refresh the content of the BAS programme. Typically, BAS hosts a half- or full-day session for delegate groups at BAS Cambridge. The BAS Director, Board Members and senior scientists give formal presentations and talk to delegates during panel sessions or guided tours of our marine aquarium and ice core facilities.

Scientists create events to showcase the latest climate science in a global, societal and business context.

Engagement with business leaders lead to informed robust discussions on the evidence and impacts of climate change, including the polar regions.

Since the joint programme began in 2005 over 50 different BAS members of staff have been involved. The principal contributors have been BAS Directors: Professor Chris Rapley (2005-2007), Professor Nick Owens (2007-2008), and Professor Alan Rodger (from 2008). The Directors give keynote presentations and lead the discussions on climate change issues. Senior BAS scientists that have made substantial contributions include Professor Eric Wolff and Dr Rob Mulvaney (past climate change/the evidence from ices cores), Professor Lloyd Peck and Dr Melody Clark (climate impacts on marine ecosystem/marine aquarium tour).

The most recent events hosted by BAS Oceanographer Dr Emily Shuckburgh, who is also Science Advisor seconded to DECC to enhance the communication of climate science to a number of different sectors, and Professor Alan Rodger, are tailored specifically to each business sector. The visits programme has been managed by Dr Timothy



Moffat (Nov 2005 to Apr 2009) and Audrey Stevens (from May 2009 to date).

#### **4. Evidence and sources to corroborate the impact**

CPSL and delegate written feedback - extracts:

“The authoritative presentation of the latest climate science combined with inspirational and insightful guided tours of BAS's aquarium and ice cores have had a tremendous resonance with senior leaders from around the world. BAS scientists have deepened and challenged their understanding of climate science and have provided an invaluable catalyst to explore the role of science in informing public policy and business decision-making.”

“My own experience of seeing the ice cores and hearing from the team who lead BAS's research was incredibly impactful.”

“I was fortunate to have visited BAS, listened to a very informative presentation that clearly represented the scientific rigour underpinning the conclusions, the aquarium and the ice cores. My knowledge, interest, and commitment to the global concerns of climate change and its impact on development and global poverty alleviation increased by an order of magnitude after that visit.”

“BAS is globally one of the most respected international climate science bodies, playing a particularly crucial role in informing a fact based climate change debate. Independence is crucial in this regard, given the sophisticated and highly resourced sceptical viewpoint which continues to be sponsored by vested interest groups. Its work is critical and relied upon by many commercial enterprises which are seeking to drive the low carbon economy and develop adaptation solutions for the already inevitable climate change that is locked in.”

“Visiting the BAS at Cambridge earlier this year as part of the Climate Leadership Programme was a personal highlight for me. Seeing, feeling and listening (!) to ice core samples and discussing with BAS scientists the evidence for climate change made it real for me and ‘beyond reasonable doubt’ in my mind: this has been a great motivator to me.”

#### **5. Contacts for further information**

Professor Alan Rodger, (Interim) Director, [asro@bas.ac.uk](mailto:asro@bas.ac.uk), 01223 221524

Dr Emily Shuckburgh, Oceanographer, [emsh@bas.ac.uk](mailto:emsh@bas.ac.uk), 01223 221544