



Clockwise from top:

Soay sheep.

The albatross.

Archaea can live in the most inhospitable places such as this hot geyser.  
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British and Ethiopian scientists checking a seismic station in Afdera, Ethiopia.

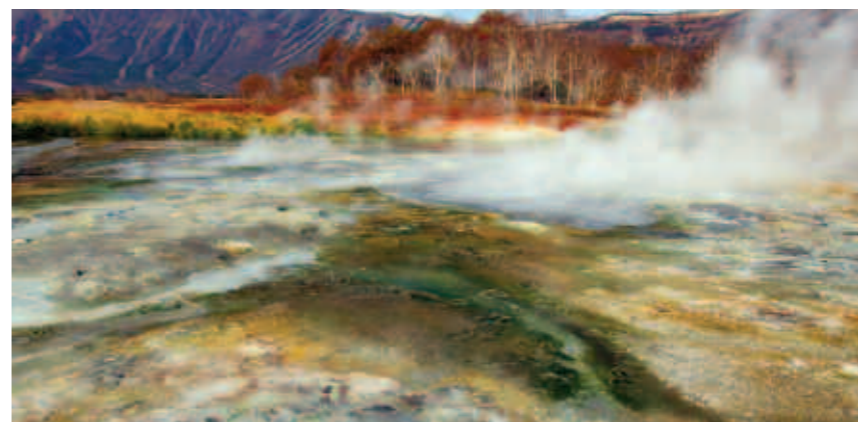
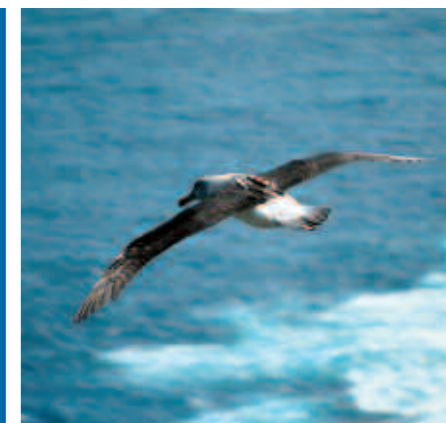
View of the Earth's magnetic field. © NASA



From witnessing the birth of an ocean to helping rebuild Afghanistan's ruined economy, this has been a challenging year for environmental science in the UK.

## Earth's life-support systems

A year of discoveries: from a virus that causes coral bleaching to the origin of Earth's wobble. These and our other achievements are increasing knowledge of how life on this planet thrives.



**This year we invested £102 million, or 28 percent of our budget, in projects investigating the complex interactions that make this planet habitable.**

### Bacteria demoted as a key player in the nitrogen cycle

Microscopic life forms known as archaea, thought to exist mainly in extreme environments, have been discovered to outnumber bacteria in an important step in the cycling of nitrogen in soils.

Scientists have found that a group of archaea – crenarchaea – living in soils and seawater can oxidise ammonia, a chemical produced when animal and plant material decomposes, to nitrite.

'Although we knew crenarchaea existed, we did not know what they did or how important they might be,' said Jim Prosser from the University of Aberdeen.

Before this work, researchers thought bacteria were the major players in ammonia oxidation.

The team, with colleagues from Norway, found evidence that these ammonia-oxidising archaea outnumber their bacterial counterparts.

'This is a key step in the nitrogen cycle and leads to production of the greenhouse gas nitrous oxide,' said Jim.

Professor James Prosser  
j.prosser@abdn.ac.uk

Archaea predominate among ammonia-oxidizing prokaryotes in soils. *Nature* 17 August 2006

### Towards a unified theory of Southern Ocean ecology

The Antarctic Circumpolar Current, the world's largest ocean current, is the dominating force in the Southern Ocean, mixing nutrients that fertilise huge algal blooms across the Atlantic region and bringing vital food supplies to penguins

and seals. The current also plays a key role in bringing the effects of El Niño to the Antarctic region.

These are some of the key findings of two decades of detailed research of components of the Southern Ocean ecosystem by British Antarctic Survey scientists. The work, brought together

and published in *Philosophical Transactions of the Royal Society B: Biological Sciences*, provides new insights into how this whole system works.

Lead author Eugene Murphy said, 'As the climate changes, our analyses indicate that we can expect potentially rapid shifts – over a few decades – in entire biological communities. So, for example, a reduction in the amount of Antarctic krill available to predators may lead to a greater dependence on fish, which will fundamentally change the way the whole marine ecosystem functions.'

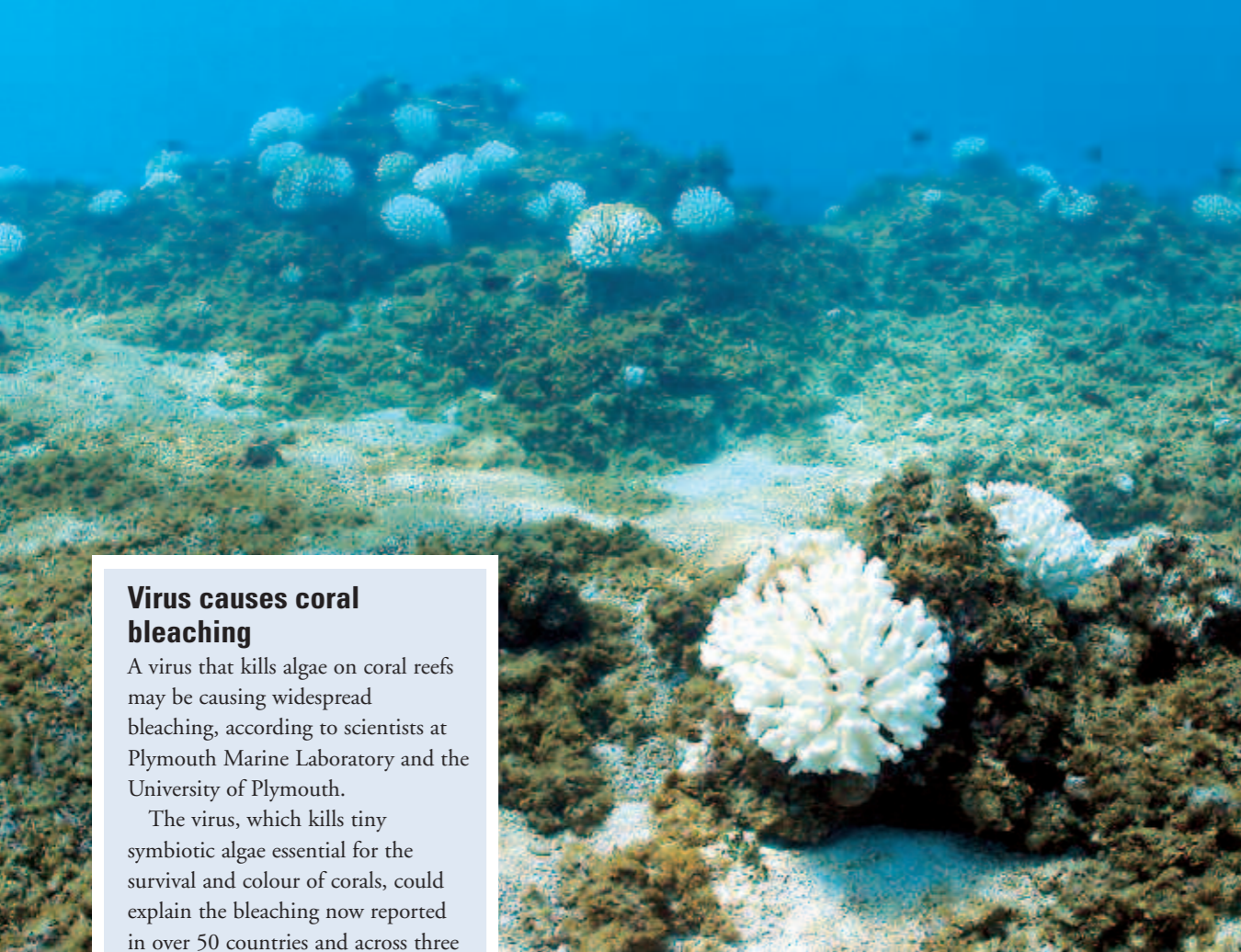
Professor Eugene Murphy  
e.murphy@bas.ac.uk

### Walking with dinosaurs?

A 'tree of life' tracing the history of all 4500 mammal species on Earth shows that today's mammal diversity was not caused by the extinction of the dinosaurs 65 million years ago.

The research, reported in *Nature*, contradicts the previously accepted theory that the mass extinction of the dinosaurs prompted a rise in mammal species.

The team from the Zoological Society of London, Imperial College London and



### Virus causes coral bleaching

A virus that kills algae on coral reefs may be causing widespread bleaching, according to scientists at Plymouth Marine Laboratory and the University of Plymouth.

The virus, which kills tiny symbiotic algae essential for the survival and colour of corals, could explain the bleaching now reported in over 50 countries and across three oceans.

Coral bleaching is usually triggered by warmer waters. But the underlying cause of coral bleaching and the mechanisms involved remained largely unknown until now.

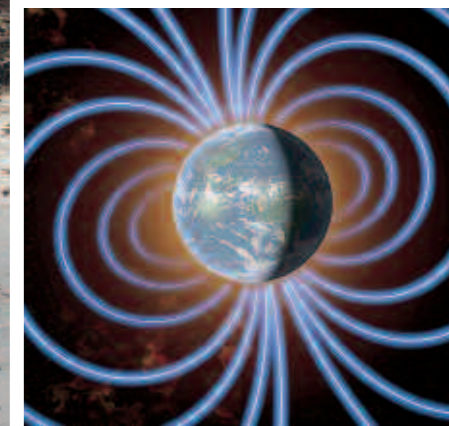
Willie Wilson said, 'The virus is latent in the algae. It starts to infect the symbiotic algae only when the coral is stressed by temperature or UV light. It provides a plausible explanation for some of the rapid bleaching we see in coral reefs.'

The work shows that viruses play an important role in coral reef dynamics.

In a separate study scientists at the Tyndall Centre for Climate Change Research and the University of East Anglia have shown that recent volcanic eruptions, which throw large quantities of small particles into the atmosphere, have protected Caribbean coral reefs from bleaching.

Dr Willie Wilson  
whw@pml.ac.uk

*Characterisation of a Latent Virus-like Infection of Symbiotic Zooxanthellae.* Applied and Environmental Microbiology, May 2007.



From left to right:

Low volcanic activity equals more bleached coral.  
© James D. Watt/imagequestmarine.com

This volcanic vent in Ethiopia opened in one day.

Do changes in the Earth's magnetic field explain its wobble?  
© Roger Harris/Science Photo Library

the Centre for Population Biology found that modern mammals such as primates, rodents and hoofed animals did not diversify until at least 10 to 15 million years after the mass extinction.

Andy Purvis from Imperial College London explained, 'Our research has shown that, after the dinosaurs were wiped out, present-day mammals kept a very low profile, while other mammals ran the show. It looks like a later bout of global warming may have kick-started today's diversity – not the death of the dinosaurs.'

Professor Andy Purvis  
a.purvis@imperial.ac.uk

*The delayed rise of present-day mammals.* Nature, 29 March 2007.

### Changing length of day explained

Changes in flows in the Earth's core cause irregular features in the Earth's magnetic field to switch from drifting westward to drifting eastward, say scientists from the University of Leeds. Westward drift was thought to be the default direction. These flow changes can also explain subtle

variations in the speed of rotation of the planet and so why the length of the day varies by a few milliseconds every 24 hours.

Mathieu Dumberry and Christopher Finlay say the findings also help explain sharp changes in the direction of the Earth's magnetic field that occur every 500-800 years over Europe.

In a separate study Mathieu also found an explanation for the Earth's mysterious wobble. At the poles the planet's rotational axis wobbles around the geographical axis. Scientists can detect a movement of about one metre every 30 years.

'Slight changes over time of the tilt of the inner core with respect to the mantle can cause a large enough change in angular momentum to create this wobble,' said Mathieu.

Dr Mathieu Dumberry  
dumberry@earth.leeds.ac.uk

*Eastward and westward drift of the Earth's magnetic field in the last three millennia.* Earth and Planetary Science Letters, 15 February 2007.

### Birth of an Ocean

A series of violent earthquakes and volcanic eruptions in the Afar Depression, Ethiopia could mark the birth of a new ocean. At the invitation of Ethiopian scientists, and with the aid of two NERC urgency grants, Cindy Ebinger from the University of Rochester, Tim Wright from the University of Leeds and colleagues used remote sensing and field studies to show that huge volumes of magma were injected along a 60-km-long section of the plate boundary during the seismic activity, forming a vertical 'dyke' at a depth of 2-9km, and allowing the plates to move apart by up to 8m.

The results, reported in *Nature*, suggest that the tectonic processes in the Depression are the same as those that formed the Atlantic Ocean.

Tim said, 'This was a genuine once-in-a-lifetime opportunity to observe these processes directly. They are rare and usually occur under several kilometres of water.'

Professor Cindy Ebinger ebinger@earth.rochester.edu  
Dr Tim Wright t.wright@see.leeds.ac.uk

*Magma-maintained rift segmentation at continental rupture in the 2005 Afar dyking episode.* Nature, 20 July 2006.

### Ocean-wide modelling of zooplankton

Researchers on the Marine Productivity programme have for the first time developed a mathematical model of the abundance on an ocean-wide scale of zooplankton – tiny floating marine creatures. The model takes account of a single species' unique function and behaviour, and also the ocean currents

that can move individuals hundreds or even thousands of kilometres over their lifetimes.

Phil Williamson said, 'Holistic can be an over-used expression. However, the Marine Productivity programme fully merits that description – by successfully bringing together expertise in universities, fishery research laboratories and NERC centres, to work out how

biology and physics interact in the North Atlantic. Research problems don't get much bigger than that.'

Dr Phil Williamson  
p.williamson@uea.ac.uk

### Discovery of global patterns in insect diversity

Insect communities across the globe share many similarities in terms of abundance, body-size distribution and species-area relationships – as area increases, the number of species also increases.

Scientists from the Centre for Ecology & Hydrology analysed more than 600,000 insect species on scales from small islands to the entire land surface of planet Earth. The findings, published in *Proceedings of the Royal Society*, provide a useful tool for monitoring the status of insect communities in the face of human disturbance.

Report author Bland Finlay said, 'We can demonstrate that insect diversity reveals patterns which repeat at scales from local to global. Deviations from general patterns, such as unusual distributions of body sizes in an insect community, could provide useful



Left to right:

A young kittiwake surrounded by inedible pipefish.

Measuring the size of Soay sheep on St. Kilda.

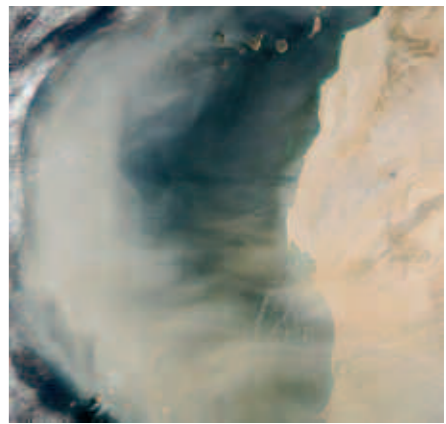
Solar panels to power atmospheric research equipment in Africa.

Saharan dust sweeping out over the Atlantic.  
© NASA



# Climate change

This year saw the publication of two major reports, the Intergovernmental Panel on Climate Change Fourth Assessment and the Stern Review on the economics of climate change. NERC-funded scientists made major contributions to both documents.



**In 2006-07 we invested £106 million, or 29 percent of our budget, in climate change research.**



indicators of local extinctions.'

*Professor Bland Finlay FRS, bjf@ceb.ac.uk*

*Self-similar patterns of nature: insect diversity at local to global scales. Proceedings Royal Society, 2006.*

### Snake pipefish explosion

An unexplained population explosion of snake pipefish in seas around northern Britain was reported in the journal *Marine Biology* by a European team led by Centre for Ecology & Hydrology scientists.

Pipefish, once rarely seen in British waters, now often end up in trawler nets. Numbers have risen a hundredfold since 2002 and their range has expanded.

Although eaten by marine predators, the rigid, bony structure makes pipefish poor food for seabirds. Reasons for the population explosion are unclear.

*Professor Mike Harris and colleagues mph@ceb.ac.uk*

*A major increase in snake pipefish in northern European seas since 2003: potential implications for seabird breeding success. Marine Biology, 2007*

### Evidence of climate driving evolution and ecology

Relatively minor environmental influences such as one harsh winter can force evolution in animal populations and rapidly change population sizes.

Scientists studying Soay sheep in the Outer Hebrides noticed that in years with long, cold winters the sheep population grew fastest when there were many large individuals within the population.

Tim Coulson from Imperial College London explained, 'Data shows that in the 1980s big sheep were genetically favoured in this population because big sheep had more chance of surviving the harsh winters. But as the climate changes and the Soay sheep are not subject to such tough winters, there will be reduced natural selection for larger animals. This could significantly affect the population dynamics of the Soay sheep overall.'

The research, reported in *Science*, has shown that population change is affected by body size, and that body size, in turn, is affected by various factors including genetics, climate, and the availability of food. The scientists have for the first time, linked the big ecological picture with the genetic make-up of individual animals.

*Dr Tim Coulson t.coulson@imperial.ac.uk*

*The evolutionary demography of ecological change: linking trait variation and population growth. Science, 16 March 2007.*

### Plant growth and death simulated in climate models

Scientists can now include the growth and death of plants in climate models. The new generation of models can even simulate fires and harvesting.

Researchers from the Quantifying and Understanding the Earth System programme (QUEST) and colleagues at the Met Office and other NERC centres (the Centre for Ecology & Hydrology and the Climate Land Surface Interaction Centre) are working together on the land ecosystem model called JULES (Joint UK Land Environment Simulator). JULES can link atmospheric conditions, for example cloud formation and rainfall, to plant growth, transpiration, vegetation structure and forest fires.

*Dr Sarah Cornell sarah.cornell@bristol.ac.uk*

### African Monsoon Multidisciplinary Analysis

A massive international project, the African Monsoon Multidisciplinary Analysis (AMMA), got under way during the summer of 2006 with a huge field campaign in sub-Saharan Africa. Over 1000 people from 60 research institutes and 28 countries joined forces to improve weather forecasting and climate model representations of the region.

AMMA-UK manager Doug Parker from the National Centre for Atmospheric Science said, 'Weather and climate models have systematic errors in representing the climate of West Africa. If we can improve our understanding of this region, this will improve global models.'

The team has already produced significant results. The strength of the link between ground conditions and atmospheric conditions is critical to the African climate. Chris Taylor from the Centre for Ecology & Hydrology and colleagues have shown how moist soils near dry areas can initiate storms. The air over wet soils builds up considerable humidity, while the air over dry soils gets hot and rises. When wet and dry surfaces are close together you have the ingredients for a large thunderstorm. AMMA continues until 2009.

*Dr Doug Parker doug@env.leeds.ac.uk  
www.env.leeds.ac.uk/research/ias/dynamics/amma  
http://classic.nerc.ac.uk/*

### Quantifying the effect of sand storms on climate

Saharan dust storms can block around one third of sunlight from reaching the surface of the planet in affected regions, according to scientists at NERC's Environmental System Science Centre.

An international team saw visibilities drop from 10 kilometres to 1 kilometre and felt daytime temperatures fall ten degrees Celsius in Niamey, the capital of Niger, during a large Saharan dust storm.

Lead author Tony Slingo said, 'The key point is just how large the effects of the

dust storms are – this study is the first time that's been shown so clearly.'

The effect on climate of small particles in the atmosphere is still a major uncertainty in climate change research.

Tony, who is deputy director of the centre added, 'Our models do quite well in simulating the effects of the dust on sunlight. This provides crucial information for reducing uncertainties in our predictions of future climate.'

This work contributed to the African Monsoon Multidisciplinary Analysis.

*Professor Tony Slingo as@mail.nerc-esc.ac.uk*

*Observations of the impact of a major Saharan dust storm on the atmospheric radiation balance. Geophysical Research Letters 30 December 2006.*

### North Sea temperatures not linked to Atlantic Ocean

The Atlantic Ocean does not play as big a role in temperature regulation of the shallow North Sea as previously thought.

Scientists at Proudman Oceanographic Laboratory have shown that sea



### Spring advances across Europe

Spring arrives six to eight days earlier across Europe on average.

Scientists led by Tim Sparks from the Centre for Ecology & Hydrology and Annette Menzel from the Technical University of Munich examined 125,000 datasets across 27 European countries. The team discovered that 30 percent of leafing, flowering and fruiting had happened significantly earlier while only 3 percent had happened significantly later. Rising temperatures had both advanced spring and delayed autumn.

Tim said, 'We clearly demonstrate change in the timing of seasons, and also show that change is much stronger in countries that have experienced more warming.'

The findings, the first comprehensive analyses on a continental scale, made headlines across the UK and Europe.

*Dr Tim Sparks  
ths@ceh.ac.uk*

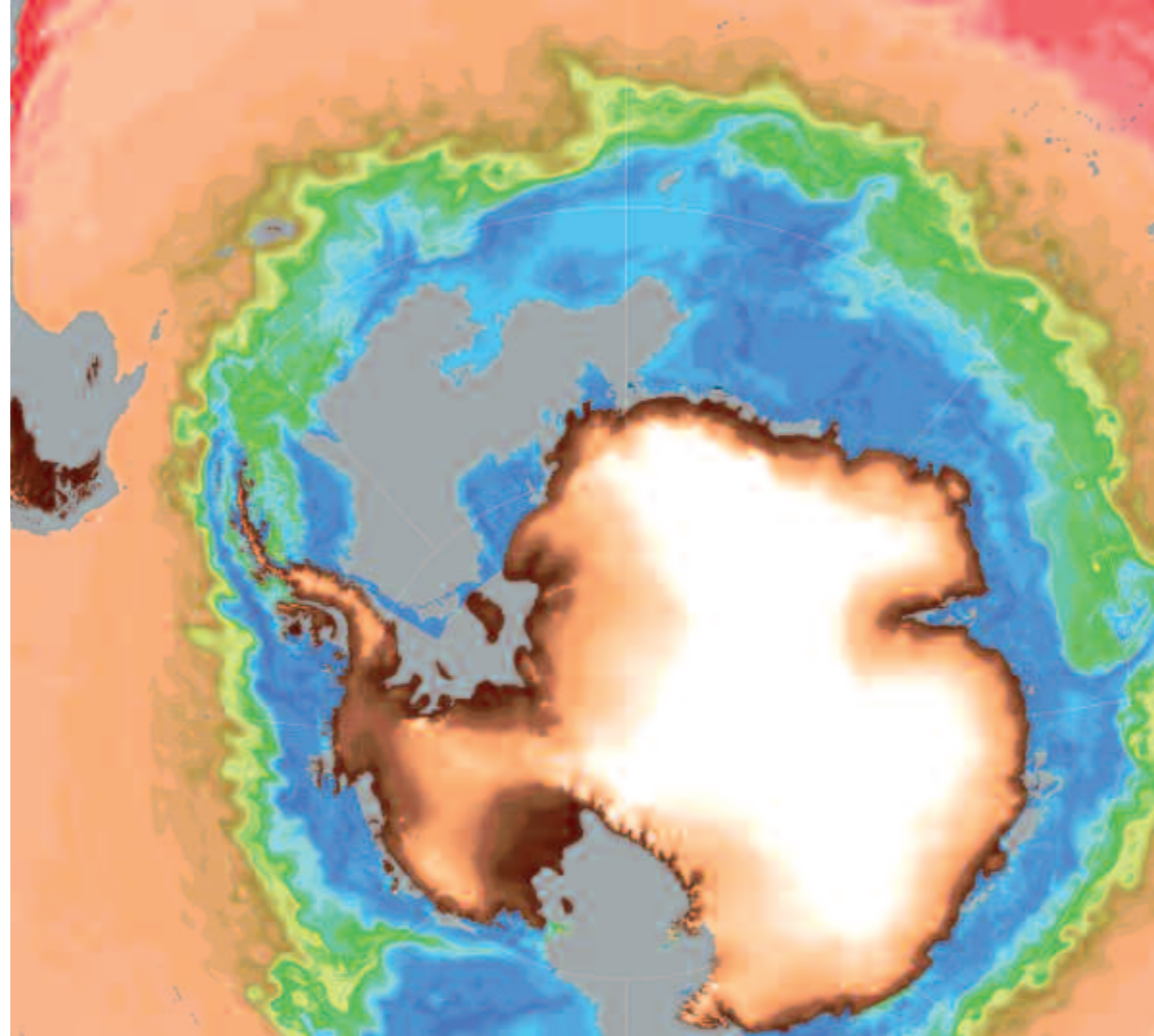
*'European phenological response to climate change matches the warming pattern'.  
Global Change Biology, 2006.*

temperatures in the north-western North Sea are mainly driven by local weather, not changes in the inflow of North Atlantic water.

Report author Jonathan Sharples said, 'This is an important result for marine biologists and ecologists who need to understand the mechanisms behind the gradual warming of the North Sea.'

*Dr Jonathan Sharples  
j.sharples@pol.ac.uk*

*Inter-annual variability in the timing of stratification and the spring bloom in the north-western North Sea. Continental Shelf Research, 2006.*



Left to right.

Spring now arrives six to eight days earlier.  
© Elliott Neep/OSF

Ocean temperatures around Antarctica.

The Mount Pinatubo eruption in 1991.

### Chemical equator discovered

A chemical equator separates polluted air in the northern hemisphere from cleaner air in the southern hemisphere.

Scientists flew north from Darwin, Australia measuring carbon monoxide, ozone and aerosols to test how much chemical mixing occurs between the northern and southern hemispheres: current thinking says very little. Despite being north of the Intertropical Convergence Zone, a band of cloud that circles the globe in the tropics marking where the trade winds meet, the air still showed little sign of pollution.

Geraint Vaughan from the National Centre for Atmospheric Science said, 'Eventually we did fly into distinctly polluted air. What surprised us was that the transition occurred in clear air with no relation to convection, showing that the chemical and meteorological boundaries are not necessarily related.'

The work is part of the ACTIVE consortium (Aerosol and chemical transport in tropical convection).

*Professor Geraint Vaughan,  
University of Manchester  
geraint.vaughan@manchester.ac.uk*

### Do stronger winds drive more heat toward Antarctica?

Stronger westerly winds around Antarctica are increasing eddy activity in the Southern Ocean and consequently may be driving more heat southward across the Antarctic Circumpolar Current – the world's largest current.

Winds over the Southern Ocean are strengthening, due at least in part to human-induced change such as ozone depletion and greenhouse gas emissions. Scientists have found that the Antarctic Circumpolar Current only shows a slight acceleration when these winds blow stronger, but that there is a large increase in ocean eddy activity. Eddies are the ocean equivalent of atmospheric weather systems, and in the Southern Ocean they play a key role in moving heat southward toward the Antarctic continent.

Researchers already know that the Southern Ocean is warming rapidly. The findings from the British Antarctic Survey suggest that ocean eddies could be responsible.

*Dr Michael Meredith  
m.meredith@bas.ac.uk*

*Circumpolar response of Southern Ocean eddy*

*activity to changes in the Southern Annular Mode. Geophysical Research Letters, 19 August 2006.*

### Greenland had ice 34 million years ago

Continental ice existed on Greenland in a world with much higher temperatures and atmospheric carbon dioxide levels than today, scientists from the National Oceanography Centre, Southampton reported in *Nature*.

Sediment retrieved from beneath the Norwegian-Greenland Sea indicated that ice at least partly covered Greenland 20 million years earlier than previously thought.

Co-author Ian Harding explained, 'We have good information on southern hemisphere ice sheets, but essentially we didn't have any information concerning the presence of ice in the northern hemisphere, so this is really the first indication as to exactly what was going on.'

*Dr Ian Harding  
ich@noc.soton.ac.uk*

*Continental ice in Greenland during the Eocene and Oligocene. Nature, 8 January 2007.*

### Volcanic eruption sheds light on climate uncertainties

The Mount Pinatubo volcanic eruption in 1991 is now providing vital clues as to how water vapour and clouds, two major remaining climate change uncertainties, respond when the climate system is disturbed.

John Harries from Imperial College, London and Joanna Futyan from Columbia University, New York found that the atmosphere reacted quickly to the eruption, which threw large quantities of sulphur dioxide into the sky. These small particles blocked sunlight, so cooling the planet. This cooling rose to a maximum within four months and consequently global humidity dropped – a cooler atmosphere holds less water vapour. Eighteen months later the climate had settled back to equilibrium.

John Harries said, 'This will be a valuable extra test to ensure that climate models predict the correct rates of change of such processes.'

The research also provides a snapshot of how the Earth's radiation balance fluctuates once perturbed.

*Professor John Harries  
j.harries@imperial.ac.uk*

*On the stability of the Earth's radiative energy balance: response to the Mt. Pinatubo eruption. Geophysical Research Letters, 15 December 2006.*



Left to right:

Part of the array of instruments deployed across the Atlantic Ocean.

Scientists use sedimentary cores such as these to build pictures of past climates.

The Amazon rainforest.

### Air quality set to worsen

An international study suggests that current emission control measures for low-level ozone will fail to stem a global increase of up to six percent above 2000 levels by 2030.

Ground-level ozone is detrimental to human health and agriculture. Legislation to reduce levels of near-surface ozone exists in most countries.

The research, led by NERC Advanced Fellow David Stevenson from the University of Edinburgh, was the largest coordinated study to date of atmospheric chemistry models. The team also analysed another more optimistic future scenario and demonstrated that applying stringent emission controls, feasible with current technologies, improved global air quality and significantly reduced the effects of ozone and methane on climate.

Dr David Stevenson  
dstevens@staffmail.ed.ac.uk

*Multimodel ensemble simulations of present-day and near-future tropospheric ozone.*  
Journal of Geophysical Research,  
26 April 2006.

### Rapid Climate Change – first results from Atlantic array

For the first time scientists have continuously measured the magnitude and variability of the ocean circulation largely responsible for Europe's temperate climate, the Atlantic Meridional Overturning Circulation. Researchers demonstrated at NERC's Rapid Climate Change international science conference that the array of instruments deployed across the Atlantic Ocean accurately measures all components of the overturning circulation.

The pilot scheme could pave the way for a permanent monitoring system that will help improve predictions of the effect of changes in the ocean on European climate.

The monitoring array has already produced one unexpected result. In November 2004 part of the overturning circulation, the flow of lower North Atlantic deep water, at depths below three kilometres, slowed abruptly and halted for a few days, before starting up again. This flow anomaly remains unexplained.

Dr Meric Srokosz  
M.Srokosz@noc.soton.ac.uk

### Forest growth from space

A new way of measuring forest growth from space has been developed by researchers at the Centre for Terrestrial Carbon Dynamics. Until now, relating an image from space to key ecological processes on the ground, for example tree growth or leaf expansion, has proved difficult.

Tristan Quaife and Mathew Williams

are using a combination of methods to derive information. Mathew said, 'We are adapting techniques developed for tracking rockets to solve the problem. The technique uses a trajectory model, for example for rocket flight, or in our case for forest growth, that we can update using satellite data.'

The key development has been to model how a forest ought to look from

space, and compare that with what the satellite sees.

'We can then correct the forest model trajectory accordingly, and get a better estimate of how it is growing and taking up carbon,' added Mathew.

Dr Mathew Williams  
mat.williams@ed.ac.uk

*Assimilating canopy reflectance data into an ecosystem model with an ensemble kalman filter.* Remote Sensing of the Environment, in press.

### Orbit changes led to ice ages

The most conclusive proof yet that between 23 and 34 million years ago variations in the Earth's orbit around the sun caused ice sheets to wax and wane was reported by scientists working on the Integrated Ocean Drilling Program. The team also linked these variations to ocean acidity.

Lead author Heiko Pälike said, 'We assembled the first detailed record from this period by analysing marine microfossil carbonate shells. Our records show a clear link between ocean acidity and climatic cycles, both driven

substantially by orbital variations, and most likely influencing the global carbon cycle.'

The Earth moves from an elliptical to a circular orbit every 405,000 and 110,000 years.

The scientist from the National Oceanography Centre, Southampton and colleagues from Cardiff, Cambridge and the US used ocean sediment to build a picture of climate conditions during this period, known as the Oligocene.

The team also demonstrated correlations between solar forcing, the global carbon cycle, deep ocean acidity and the production and burial of biomass.

Dr Heiko Pälike  
heiko@noc.soton.ac.uk  
*The heartbeat of the oligocene climate system.*  
Science, 22 December 2006.

### Atmospheric 'bridge' tells tropical Pacific what is happening in Atlantic

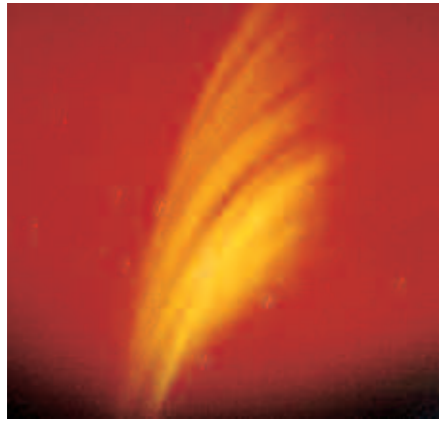
Ocean circulation in the North Atlantic can influence weather in the tropical Pacific in a matter of days or weeks, not decades as previously thought.

Researchers at the National Centre for Atmospheric Science wanted to know how changes in the North Atlantic circulation affected El Niño, a disruptive climate phenomenon occurring every three to eight years in the Pacific. They showed that a weakened Atlantic circulation leads to cooler sea-surface temperatures in the North Atlantic and, shortly afterwards, more El Niño activity in the Pacific.

Their research contradicts earlier studies that suggested these kinds of connections happened on a timescale of decades not days. The research offers an explanation for why El Niño was more frequent and intense at the height of the Little Ice Age in the 17th century, a cold period over the North Atlantic caused by a weakened ocean circulation.

Dr Buwen Dong and Dr Rowan Sutton  
B.Dong@reading.ac.uk  
R.Sutton@rdg.ac.uk

*Enhancement of ENSO variability by a weakened Atlantic thermohaline circulation in a coupled GCM.* Journal of Climate, in press.



# Sustainable economies

The UK and global economies rely on environmental science to sustain a growing population.

**This year we invested £69 million, or 19 percent of our budget, in projects investigating sustainable economies.**



## US satellite protection scheme could cause global communication blackouts

A proposed US system to protect satellites from solar storms or high-altitude nuclear detonations could cause side-effects that lead to radio communication blackouts, according to British Antarctic Survey scientists and colleagues from New Zealand and Finland.

The US solution involves launching a constellation of ten satellites that would emit VLF (very low frequency) waves in a time of crisis. These waves would flush out harmful electrons injected into the upper atmosphere by solar activity or a nuclear explosion.

British Antarctic Survey scientists say the proposed system would significantly alter the upper atmosphere causing unusually intense high-frequency radio-wave blackouts around most of the world.

Mark Clilverd said, 'Some planes and ships that rely on high frequency communications could lose radio contact, and some remote communities could be isolated for as long as six to seven days. It would also disrupt GPS signals.'

## Restoring wild flowers increases hay yield

Growing hay meadows with many wild-flower species boost yields by 40 percent compared with growing just a few types of agricultural grasses.

The research by scientists at the Centre for Ecology & Hydrology shows there need not be conflict between increasing crop yield and attracting more animal and plant species.

James Bullock said, 'We took arable fields and re-created hay meadows with many wild-flower species. We contrasted their agricultural output with plots where we had sown only a few types of grasses. These grasses were those often selected by farmers to increase yields.'

The team found that, as well as increasing hay yield, the wild flowers made the hay more nutritious as cattle fodder than hay from the grass plots, and the effects went on increasing over eight years.

'This suggests that biodiversity has an important economic role for humans and that maintaining and restoring biodiversity can help rural livelihoods,' added James.

*Dr James Bullock  
jmbul@ceh.ac.uk*

*Long-term enhancement of agricultural production by restoration of biodiversity. Journal of Applied Ecology, February 2007.*

*Dr Mark Clilverd  
macl@bas.ac.uk*

*Atmospheric implications of radiation belt remediation. Annales Geophysicae, August 2006.*

## City slickers – tracking urban pollution

The complex way exhaust fumes emitted at the bottom of built-up city streets, known as street canyons, make their way to the atmosphere above cities is being unravelled by researchers at the



Left to right:

Solar storms can cause scientific and communication satellites to short-circuit. © TRACE/NASA

Wild-flower species boost hay yields. ©Robin Bush/OSF

Scientists can now model how street canyons funnel pollution. ©Eric Nathan/Alamy

University of Birmingham and the National Centre for Atmospheric Science (NCAS).

Birmingham academic Jennifer Salmond and colleagues from Meteo France found the layout and daytime heating of streets played a crucial role in how much pollution from particulates (airborne particles of dust and chemicals) from the street canyon reached the atmosphere above the city. Their findings help assess people's exposure to particulates and the effect of urban pollution downwind of cities.

In a separate development Stephen Belcher from NCAS, Ian Castro from the University of Southampton and colleagues have formed a business partnership with an engineering solutions company CD-adapco to develop urban-scale weather and air-quality computer models. The researchers found they could use software developed by CD-adapco in air quality models to include the shape and layout of streets and buildings in UK towns and cities, and to successfully simulate air and heat flow.

Stephen said, 'There is a growing need to be able to simulate flows in urban areas for applications ranging from dispersion of traffic pollutants to predicting the

## 60 percent emissions reductions not enough

Researchers at the Tyndall Centre for Climate Change Research announced that the UK's emissions target – a 60 percent reduction by 2050 – is unrealistic. The report, commissioned by Friends of the Earth and the Co-operative Bank, states that if the UK wants to help prevent global temperatures rising above 2°C, it needs to reduce emissions by 90 percent by 2050.

A major government report, the Stern Review on the economics of climate change, drew heavily on the Tyndall centre's pioneering approach to integrated assessments of climate change, and the Economic and Social Research Council (ESRC) funded a year-long secondment from Tyndall to the Treasury team responsible for the document.

Tyndall, with many other NERC-funded centres, also made a major contribution to the United Nations Intergovernmental Panel on Climate Change Fourth Assessment (IPCC). See page 25.

*Living within a carbon budget. Report for Friends of the Earth and the Co-operative Bank, July 2006.*

spread of terrorist gas releases. This new partnership promises the tools we need to tackle these issues.'

*Professor Stephen Belcher  
s.e.belcher@reading.ac.uk  
Dr Jennifer Salmond  
j.salmond@bham.ac.uk  
Professor Ian Castro  
i.castro@oton.ac.uk*

## UK Energy Atlas

The first comprehensive picture of energy research in the UK is now available online.

The UK Energy Research Centre has come up with the Energy Research Atlas which gives users a live view of research and development in this field. The Atlas incorporates a database of energy awards, a series of documents characterising



Left to right:  
 Training Afghan geologists.  
 Using peat bogs as carbon stores.  
 © Macana/Alamy  
 India needs more than just aquifers to manage its water resources.  
 Pandemic drugs could cause serious environmental pollution. ©Lourens Smak/Alamy



### Rebuilding Afghanistan's economy

Beneath an old al-Qaeda training camp close to the outskirts of Kabul, British Geological Survey (BGS) scientists and colleagues in Afghanistan have identified a vast copper deposit that could be worth \$30 billion to the war-torn country's shattered economy. The UK team of geologists has been assisting the Afghanistan Geological Survey over the past two years to interpret geological data. The group, funded by the Department for International Development, has created a detailed three-dimensional model of the deposit.

To help capitalise on this world-class resource, BGS and the World Bank worked with the Afghanistan Ministry of Mines to prepare a new minerals law to enable effective and efficient management of an emerging mining industry.

Decades of war had reduced the Afghanistan Geological Survey to a shadow of its former self. BGS has helped revitalise the organisation. This culminated in the opening of the refurbished building in August 2006.

Richard Ellison  
 rael@bgs.ac.uk

The cause of the release is the vast system of drainage ditches dug across the uplands during the 1950s. This was an unsuccessful attempt to increase land productivity. Scientists say that if these could be blocked then peat would form again.

Analysts at Defra suggest that the cost of blocking one hectare of peat drains is about £188. RELU researchers have hit on the idea of working with a carbon-offsetting company that would allow consumers to offset their carbon footprint by paying for upland regeneration.

Anne Liddon  
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the British Geological Survey, in collaboration with partners in India and Nepal, assessed the effectiveness of managed aquifer recharge.

Ian said, 'Findings confirmed that the techniques are not a panacea for overexploitation and by themselves will not halt or reverse the long-term loss of water resources. Managed aquifer recharge must be used with other water management strategies.'

In recent years massive investment has gone into creating millions of recharge structures, particularly in the Indian sub-continent, but until now little work had been done on understanding the effects on sustainable water use and hence rural economies.

Ian Gale  
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 www.iab.org/recharge/pdf/assessment.pdf

### Potential environmental risk of pandemic drug

More research is needed to assess the human and environmental risks of Tamiflu, the antiviral drug recommended worldwide for the prevention of avian flu in humans, according to a study in *Environmental Health Perspectives*.

Scientists from the Centre for Ecology & Hydrology modelled Tamiflu concentrations in river water in the UK and the US during a simulated influenza pandemic. Their computer simulations suggest there is a potential risk that an antiviral could cause pollution as well as encourage a new strain of virus to develop if widely used.

Lead researcher Andrew Singer said, 'An antiviral drug has never been widely used before so we need to work out what might happen. During a flu pandemic millions of people will take Tamiflu at the same time. Massive amounts of the drug will be expelled in sewage and find its way to rivers. It could have huge effects on fish and other wildlife.'

'Current evidence on the effects of widespread pharmaceutical releases, for example oestrogen in birth-control pills, supports a precautionary approach. It is imperative we make the most of the available time ahead of a pandemic to take those precautions.'

Dr Andrew C. Singer  
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Potential risks associated with the proposed widespread use of Tamiflu. *Environmental Health Perspectives*, January 2007.

research activities, and a set of roadmaps showing the sequence of research obstacles preventing new technologies from becoming commercially viable.

The Atlas is open to anyone and is intended to form a major part of the evidence base for prioritising and planning energy research activities. Plans are also underway to incorporate data from the private sector.

www.ukerc.ac.uk

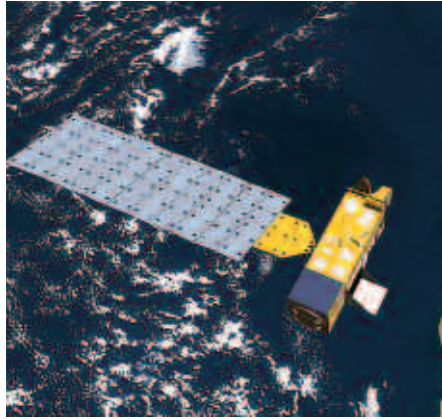
### Carbon offsetting could fund peatland regeneration

The peatlands of England and Wales could store up to 41,000 tonnes of carbon per year, if they were in pristine condition. But erosion and damage mean that the peat is actually releasing carbon into the atmosphere at a rate of 381,000 tonnes a year, according to researchers on the Rural Economy and Land Use (RELU) programme.

### Ancient water storage techniques re-examined

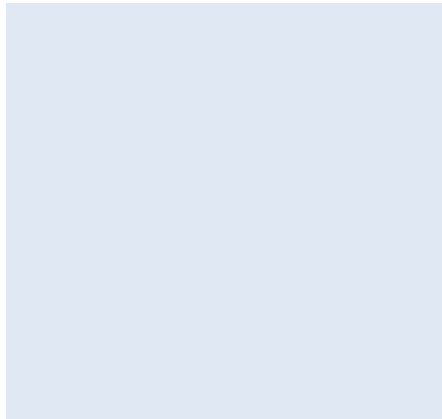
For thousands of years people living in semi-arid nations have used various techniques to recharge underground reservoirs to store precious monsoon water. Falling groundwater levels due to over pumping in countries like India and Nepal are forcing authorities to relearn and implement these ancient techniques.

A three-year study, led by Ian Gale of



# Technology

World-class research requires continual investment in new technology. Here are some of this year's achievements.



## Overcoming hurdles

Scientists working on a satellite instrument that was at one point almost given up as a lost cause have announced that they are now receiving high-quality data on atmospheric temperatures and chemical composition including ozone.

In July 2004, NASA successfully launched the Earth observation satellite Aura. The success was overshadowed in the UK by the silence from one of Aura's four instruments – the joint NERC/NASA-funded High Resolution Dynamics Limb Sounder (HIRDLS). The instrument was due to measure atmospheric temperatures and composition, including ozone and particulates.

During the launch a piece of protective plastic film tore free and lodged over the instrument's only optical beam, reducing visibility to just 20 percent.

Since the launch, scientists led by John Barnett from the University of Oxford and John Gille of the University of Colorado have painstakingly developed new algorithms to maximise the data retrieved from HIRDLS.

Now, even with 80 percent of the optical beam still blacked out, in one day

## Robotic sub returns from the freezer

The UK's deep-sea robotic vehicle, Isis, successfully completed its first Antarctic mission in February 2007. Scientists aboard the research ship *James Clark Ross* were thrilled to receive the first images from the craft as it sank like a polished stone 3.5 kilometres to the seafloor.

Julian Dowdeswell from the Scott Polar Research Institute, who led the expedition, said, 'When you are sitting there in the control room surrounded by monitors, you really feel you are on the seabed. You have to pinch yourself to remember you are not.'

The £4.5 million sub made 15 separate dives over three weeks to map shallow waters in Marguerite Bay, the continental shelf edge and the deep continental slope. This was the first time anyone has used a deep-water remotely operated vehicle in the Antarctic.

Peter Mason, the Isis project manager said, 'Isis has the capacity to carry a range of scientific tools, from simple sampling equipment to sophisticated sonar systems.'

*Peter Mason  
pjm@noc.soton.ac.uk*

the team can retrieve data from nearly all the world – a remarkable achievement.

NERC's British Atmospheric Data Centre will distribute data in the UK.

*Dr John Barnett  
j.barnett1@physics.ox.ac.uk*

## Heavy metal strikes hard rock

A new drill designed to retrieve marine cores in very deep water and extremely hot conditions has successfully completed its inaugural mission.

Scientists took the seabed rock drill, funded by the NERC Infrastructure Programme and designed, built and



## Still learning from Archimedes – underwater gliders

Graceful, simple, underwater gliders are providing researchers with excellent data on deep convection in the Mediterranean Sea.

Underwater gliders combine high-tech design with buoyancy principles first put forward by Archimedes in 250BC. They sink slowly, but their shape forces them to slip forward through the water as they fall. A change in volume plus a tilt backwards and the machine travels upwards on a gentle incline through the water column. Sea gliders can use these simple manoeuvres to travel great distances, even crossing oceans.

In 2007, the team from the National Oceanography Centre, Southampton deployed three gliders in the Gulf of Lion. They used satellite communications during the three-month project to adapt the glider mission as conditions changed.

David Smeed said, 'We are combining measurements from the gliders with models of convection to gain a better understanding of mixing in the ocean.'

*Dr David Smeed  
das@noc.soton.ac.uk*

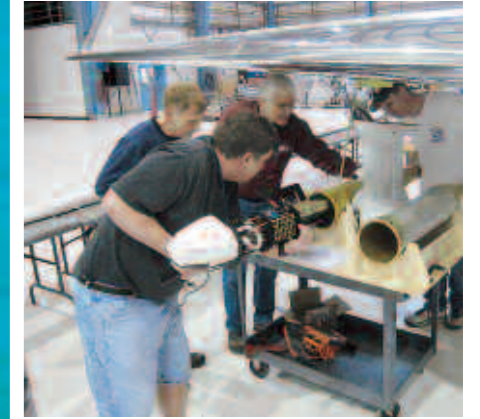
operated by engineers at the British Geological Survey, to the Mid-Atlantic Ridge in November 2006 to investigate the geology and microbiology below hydrothermal vents. These 'black smokers' fire steaming water and gases out of the seabed at 350°C.

The team used the drill to take seabed cores in water depths ranging from 2980 to 3050 metres, the first system of its kind to operate in such a deep-water

hydrothermally mineralised area. The results have already led to a new understanding of the geology of the Mid-Atlantic Ridge.

This lightweight (less than five tonnes), compact system provides scientists with a more cost-effective method of seabed coring than using a drill ship.

*Ali Skinner  
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Left to right:

NERC funded one of the instruments on board NASA's Aura satellite. © NASA

NERC's robotic sub returns from the icy depths.

These underwater gliders effortlessly cross the Mediterranean.

Scientists oversee the installation of the ice probe.

## Ice detectives

The Small Ice Detector Probe (SID2) does what it says on the tin: detects micron-sized ice crystals and super-cooled water droplets in clouds. Scientists working on NERC's Clouds, Water Vapour and Climate programme have developed this instrument to provide unique data on the sizes and distributions of these particles.

Paul Kaye from the University of Hertfordshire said, 'This information is vital to understanding cloud dynamics and their role in trapping or reflecting heat from the sun and so global climate.'

The instrument has caught the attention of several organisations around the globe and led to commissions for similar instruments from the US National Centre for Atmospheric Research, Colorado State University, Texas A&M University, the Institute for Meteorology and Climate Research in Karlsruhe, and the Institute for Tropospheric Research in Leipzig.

*Professor Paul Kaye  
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http://strc.herts.ac.uk/cair*

Left to right:

The Diamond Synchrotron Light Source facility which opened earlier this year.  
© Diamond Light Source Ltd

Part of the equipment used by scientists to measure cosmic rays in Antarctica.

Commercial planes could be used in atmospheric research. © BAA Aviation Photo Library/Anthony Charlton.



### Satellite instrument improves climate forecasts

A satellite instrument funded by NERC is now helping the Met Office's global forecast model as well as greatly benefiting researchers investigating clouds and dust in the climate system.

The Geostationary Earth Radiation Budget instrument (GERB) measures the Earth's energy balance from its orbit 36,000 km above Africa. This year it has helped reduce model uncertainties in: the greenhouse effect of small dust particles over the western Sahara; the brightness of marine stratocumulus clouds; and the daytime variation of African deep convective clouds. This is leading to improved climate forecasts.

The instrument, onboard satellites MSG-1 and MSG-2, was developed by Imperial College, Rutherford Appleton Laboratory and Leicester University with contributions from Belgium and Italy.

See also page 11, *Quantifying the effect of sand storms on climate.*

Professor John Harries  
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### Revolution in data analysis

Scientists have developed what is being described in the industry as a 'killer application' to automatically manage and evaluate hundreds of complex computer simulations at the same time. The system, developed by the NERC eMinerals Consortium, is set to revolutionise data analysis. It is now running on the Science and Technology Facility Council's Neutron and Laser Facilities as well as the Diamond Synchrotron Light Source, the largest UK-funded scientific facility to be built for over 40 years, which opened its doors earlier this year.

The system tracks hundreds of individual calculations on numerous systems where parameters such as temperature or magnetic field strength are constantly changing.

Although researchers designed the system for geologists, it is an equally powerful tool for particle physicists and climate scientists.

Professor Martin Dove  
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### Linking cosmic rays and electric currents to rain and snow

Extremely sensitive polished metal spheres suspended in mid-air above the Antarctic ice will this year begin measuring the weak electrical currents that flow through the atmosphere.

The instruments, designed by British Antarctic Survey engineers, aim to confirm or disprove the theory that cosmic rays, or other electrical interference in the atmosphere, influence cloud formation, rain and snowfall.

Joan Junyent said, 'The weakness of the currents make measuring them a challenge.'

Through a block of air one metre square flows a current one billionth of a millionth of that used to light a torch bulb.

'The best location in the world to measure them is in Antarctica, where it is high and dry, with no electrical interference,' he added.

The instruments will go into service during International Polar Year.

Joan Junyent  
jju@bas.ac.uk

### Commercial aircraft to help atmospheric researchers

Using commercial aircraft as atmospheric measuring platforms could soon be a reality if researchers on NERC's Upper Troposphere Lower Stratosphere Ozone programme are successful in their negotiations with the airline industry.

While aviation growth has an increasing impact on climate and local air quality, commercial aircraft also offer a unique opportunity to routinely monitor conditions in a critical region of the atmosphere.

Rod Jones at the University of Cambridge and Martin Gallagher at the University of Manchester are developing instruments for commercial aircraft to measure important gases and small particulates. They have already demonstrated that these lightweight instruments, which weigh just a few kilogrammes, are feasible for commercial aircraft use.

British Airways and Airbus are actively involved in the project. British Airways climate change manager Andy Kershaw said, 'BA see this research as an important step in improving the

understanding of the climate system to better quantify human impacts.'

Dr Helen Rogers  
helen.rogers@atm.ch.cam.ac.uk

### New data management system for meteorologists

The Met Office is adopting a new approach to data modelling and management pioneered by the NERC Data Grid. The Norwegian Met Office and the Tasmanian Partnership for Advanced Computing have also implemented software developed by the project.

The NERC Data Grid makes environmental information more easily available to scientists by allowing users to find out what data sets are available and where; explore what is known about the data sets including information about how the data was collected and what it has been used for; and access, manipulate and visualise the data.

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