Global Change at Edinburgh

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School of GeoSciences

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NATURAL ENVIRONMENT RESEARCH COUNCIL

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The Global Change Group

Human impacts on our planet are changing the atmosphere, climate, ice cover, global biogeochemistry, biodiversity, soils, and even ocean circulation. This puts **Global Change** at the centre of the international scientific agenda.

A key aim of the Global Change Group is to forecast the nature of change in the Earth System. This relies on understanding the building blocks of the system, represented by the Group's programmes: **Atmosphere, Biosphere, Cryosphere, Lithosphere, and Oceans**. These programmes involve fieldwork, monitoring, experimentation, theory and simulation, designed to determine how the earth's systems work, how they operated in the past and where they are going in the future.

Atmosphere: Physics & chemistry of the atmosphere. Air-sea interactions. Modelling of climate/ chemistry, air quality. Remote sensing of the atmosphere. Climate change monitoring. FRAME programme. 8 researchers.

Biosphere: Terrestrial carbon and water cycles, trace gas emissions, bio- & hydro-geochemistry, eco-physiology, -processes & -dynamics, land-atmosphere interactions. Linked to the NERC Centre for Terrestrial Carbon Dynamics and to the CarboEurope programme. 31 researchers.

Cryosphere: field & remote observations & experiments on glacial erosion/deposition & hydrology. Modelling past, present and future ice sheet dynamics. GLIMMER network. CRYOSAT. 8 researchers.

Lithosphere Programme: Response to climate and tectonic forcing in river, glacier and hillslope systems, and anthropogenic responses, primarily in mountain and polar regions, and using cosmogenic techniques. 10 researchers.

Ocean Programme: Marine biogeochemistry, palaeo-oceanography, paleoclimatology, pollutants, plankton genetics, remote sensing. Linked to SUERC, RCL NERC facility, SAMS-Dunstaffnage marine lab., Europe's PROPER network. 17 researchers.

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News

Dr Mat Williams is leading ABACUS, an International Polar Year Project, to investigate Arctic-Biosphere Atmosphere Coupling, as a £1.65 Million NERC Consortium project.

Dr Chris Merchant leads a consortium with Leicester University, the Southampton Oceanography Centre, the Met Office and the Rutherford-Appleton Lab, with funding from NERC/MoD/Defra amounting to £740,000 to determine the temperature of the Global Oceans.

Dr Tibor Dunai is heading up Cronus, a 3.4 Million Euro EU project that seeks to determine the rate at which Cosmic Rays bombard the earth's surface at different latitudes. This will significantly improve the accuracy of dates gained using cosmogenic exposure age methods.

Professor Sandy Tudhope's Oceans group has gained £600,000 from a NERC equipment grant to establish a microanalysis lab. This will be used to measure the bio-chemical properties of sediments that provide an indication of past climates.

The School of GeoSciences has taken delivery of its Dimona Eco aircraft, a remote sensing platform for measuring gas fluxes between the land surface and the atmosphere.

atmosphere

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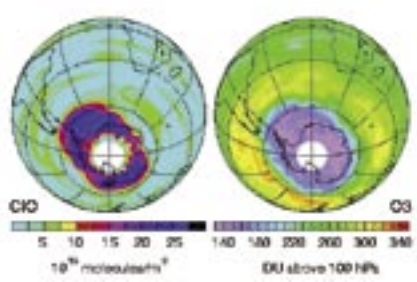
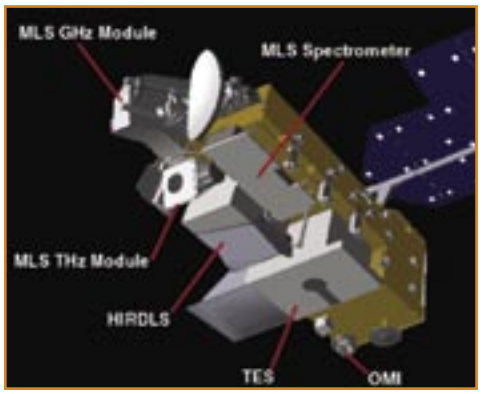
Atmospheric Health Check

We are constantly being made aware of the effects of climate change: soaring temperatures, flash floods, forest fires, desertification of the rainforests, record numbers of hurricanes, the pole-ward spread of malaria. Distinguishing anthropogenically generated climate change from natural variability requires sophisticated measuring techniques and state-of-the-art computer simulation.

Chlorine Monoxide and the Ozone Hole





A group led by Robert Harwood is using a satellite radiotelescope built by NASA to monitor climate change and the expected recovery of the ozone-layer in response to pollution control. Valuable new information about the effects of burning forests on the upper atmosphere is emerging.

The measurements are complemented by computer simulations undertaken by David Stevenson and others. In these experiments the chemical changes in the atmosphere are calculated and used by bodies like the Intergovernmental Panel on Climate Change.

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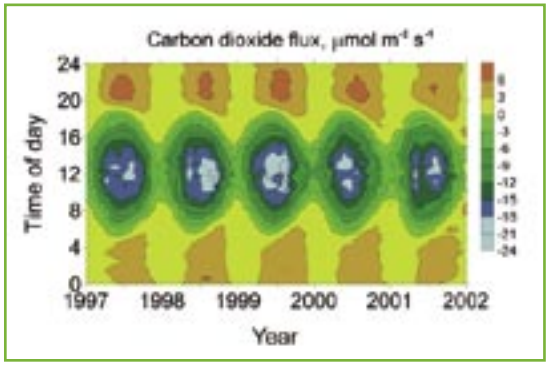
Plants and Greenhouse Gases

Climate change is one of the greatest challenges of the 21st century. We want to improve our understanding of the greenhouse gases that cause global warming; where they come from (the sources), where they go to (the sinks), and how we affect the balance between the sources and sinks.

Our research on greenhouse gases ranges from studying the exchange of carbon dioxide in forests and methane in peatlands, to nitrous oxide emissions from drainage waters, and involves predicting the effects of land use and land use change on the fluxes of all these gases.



Global warming and the climate change it causes are big news. A vital part of our work is to make sure that everyone is kept informed about our research and its implications.

biosphere

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Carbon Uptake in Old Forests

A team led by Jordi Martinez-Vilalta and Maurizio Mencuccini has been investigating what happens to trees as they age in a Scots Pine forest in West Lothian. Investigation involves measuring the uptake of carbon by the tree's leaf canopy. This is done by measuring carbon uptake of whole branches using a method called the 'branch bag' technique.

It is not yet known whether substantial declines in tree growth with age are due to genetic changes, or to physical changes caused by increasing size, such as shading of lower branches, and increased difficulty in supplying water to leaves.

Improvements in our understanding of the physiology of tree aging have applications in commercial forestry. They also help in predicting the ability of forests to reduce current increases in levels of atmospheric carbon dioxide.

Professor John Farmer
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Contamination and Remediation

The Environmental Geochemistry Group is investigating the sources, form, behaviour, transport, fate and impact of various potentially harmful chemical elements in a range of terrestrial and freshwater environments in Scotland.

Research has helped identify critical controls on the release of toxic and carcinogenic chromium from ore processing residue to groundwater. The work is aiding remediation strategies at contaminated land sites in urban Glasgow.

In rural areas the atmospheric deposition in upland catchments, of former industrial and traffic related lead, is tested for mobility and bioavailability. Depleted uranium at military firing ranges is also under investigation.

Professor Sandy Tudhope
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Corals and Climate

Corals can tell us a lot about past climates because the marine environments in which they live affect the way their carbonate skeletons grow. A team led by Sandy Tudhope and Colin Chilcott measures oxygen isotopes in present and fossil corals to gain an annual record of seawater composition and temperature.

Mary Elliot and Kevin Welsh study brightly coloured giant clams in the Indo-Pacific ocean. These secrete annual layers of calcium carbonate, their shells recording the water properties in which they grew. The idea is to see if living specimens preserve the historic record of sea water temperature, salinity and productivity.

The next step is to collect fossil specimens which can be used to study how different our climate was up to 100,000 years ago. Fossil specimens of corals and giant clams have been recovered from the uplifted beaches of Papua New Guinea.

Dr. Gregory L. Cowie
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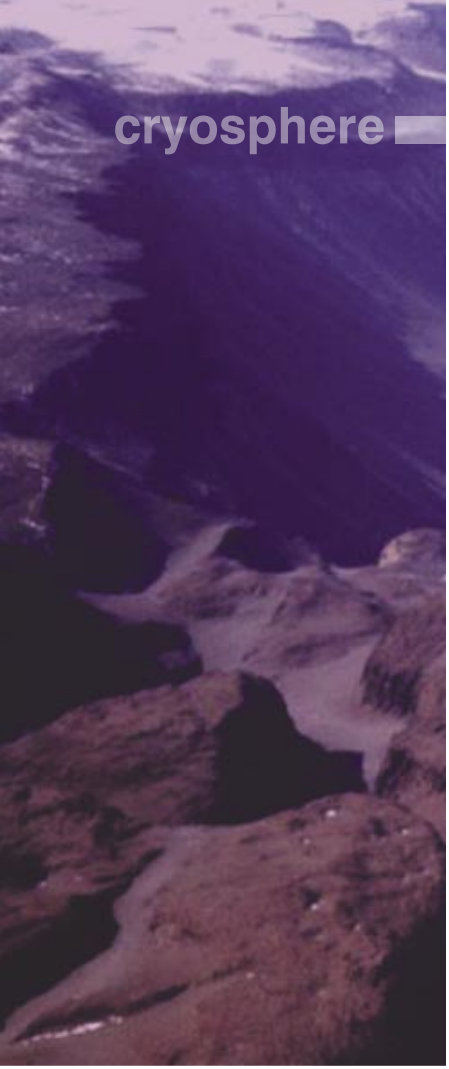
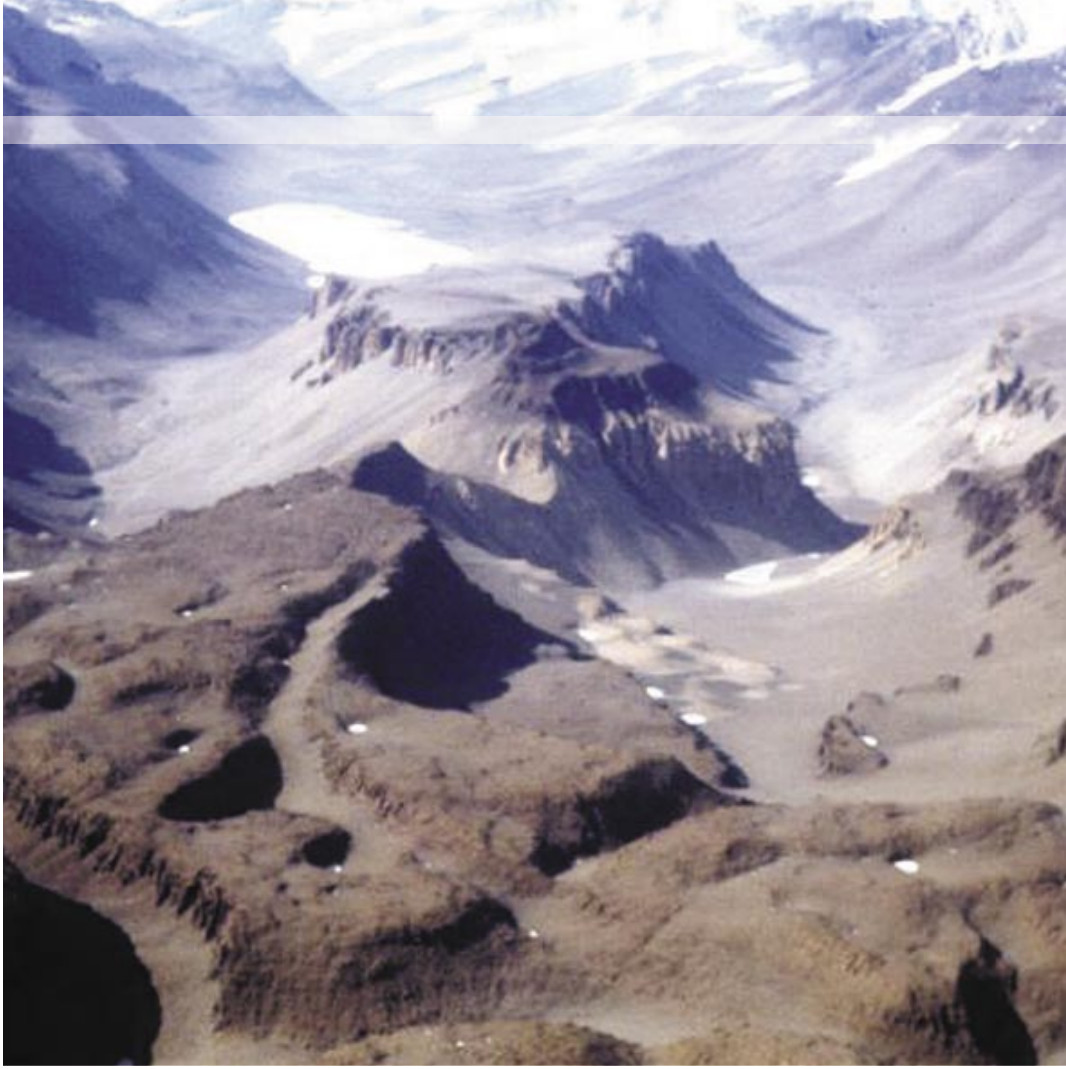
The Monsoon and Ocean Oyxgen

The Arabian Sea is one of the world's most biologically productive ocean regions, due to intense upwelling caused by the seasonally reversing monsoon winds. This productivity also leads to reduced oxygen levels at intermediate depths. Where the sea floor at the continental margins intersects with this de-oxygenised water a "bathtub ring" of remarkable conditions is created on the seafloor.

RSS Charles Darwin: Research voyages in the Arabian Sea

A group led by Greg Cowie is part of an international collaboration of British, Dutch, American and Indian scientists who have used remotely deployed and automated research platforms to investigate the lower ocean and sea floor. This enables us to determine how gases, nutrients and trace metals in seawater interact with one another to affect seafloor communities.





Professor David Sugden
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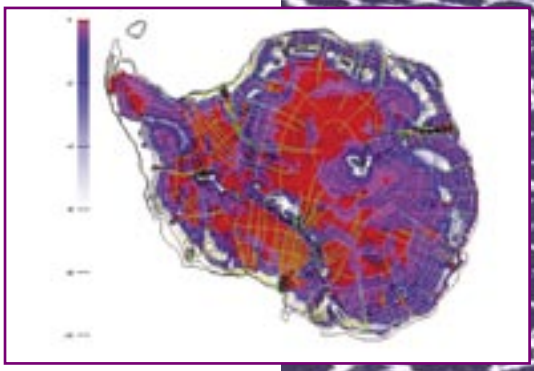
Landscapes Frozen in Time

Antarctica has some of the oldest surviving landscapes known on earth. Work undertaken by a team led by David Sugden alongside co-workers from the USA suggests that the East Antarctic Ice sheet has existed in a form similar to the present for 15 Million years and has been very resilient to global climate fluctuations over this time.



Argon-Argon dates on ancient ash falls and surfaces dated with cosmogenic age exposure methods point to some landscapes remaining essentially unaltered at the edge of the ice sheet since the early Oligocene (30 million years ago).

In other areas the team have uncovered evidence for catastrophic 'mega-floods' resulting from the build-up and outburst of lakes under the Antarctic Ice Sheet. Flood discharges many times larger than the present day Amazon remain a possibility in future climates.

Dr Tibor Dunai
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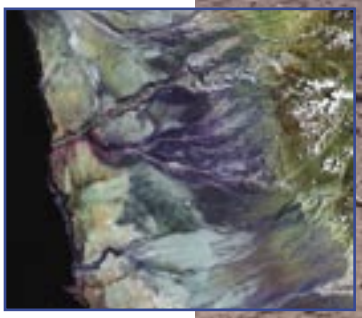
Mars on Earth

Space agencies test their Mars probes in the Atacama desert, the driest place on earth. It is the best analogue for conditions on the Martian surface. Recent work by Tibor Dunai and co-workers in Chile and the Netherlands has shown that wide areas of the Atacama show little or no trace of running water, since at least 20 million years ago.



Exposure dating with cosmogenic nuclides shows that the landscape is mummified in an ancient state; since water last flowed over the ground. In vast areas gypsum is deposited from the air when distant sea-spray and airborne nitrates 'dust' the landscape and are left unmodified by rainfall.

Only major global climatic fluctuations during the last 20 million years have been able to disturb the regional climate and have brought a little, localized precipitation. The few ephemeral rivers crossing the desert receive their water from rainfall in the distant Andes.

Post Graduate Opportunities	Collaborating with Industry	Links with Government & Society
PhD Opportunities www.geos.ed.ac.uk/postgraduate	Sponsored research	Knowledge resources and transfer
MSc Geoscience for Subsurface Exploration, Appraisal & Development (GeoSEAD)	Consultancy	Sponsored research
MSc by Research in GeoSciences	Training and Continuing Professional Development	Consultancy
MSc Geo Information Science	Knowledge Transfer Partnerships	Climate Change
MSc Geoinformatics	Materials and Micro-Analysis	Policy and Science
MSc Remote Sensing and Image Processing	Joint ventures	Expert opinion
MSc Environmental Protection and Management	Licensing	Industry networks
MSc Global Environmental Change	Insurance/Risk Management	Key technology assets
MSc Management of Natural Resources		Media Links

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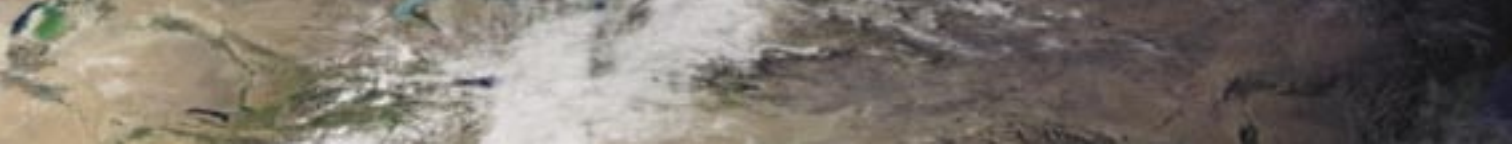

In the School of GeoSciences, we explore the factors and forces that shape our world and environments in which we live. As a leading interdisciplinary group, we aim to understand the interaction between the Earth's geology, atmosphere, oceans, biosphere and human responses and roles in this complex interplay. With over 100 academic specialists and some of the best scientific infrastructure in the UK, we deliver new insights into the dynamics of the Earth system and its relationship with society. This interdisciplinarity enhances our ability to model and predict global responses to environmental change, and to serve the needs of society, government and industry through meaningful knowledge transfer.

Five integrated and interdependent research groups:

- **Subsurface Geoscience Research Group**
- **Global Change Research Group**
- **Edinburgh Earth Observatory**
- **Human Geography Research Group**
- **(CECS) Centre for the study of Environmental Change and Sustainability**

Further information on MSc & PhD opportunities found at: **www.geos.ed.ac.uk**