

# Polar meltdown: climate change in your lifetime

Selected for the Royal Society's  
**SUMMER SCIENCE** EXHIBITION 07

**Shrinking ice-sheets, rising sea-levels, greenhouse gases and a warmer world**

Mankind stands on the brink of an uncharted journey into climate change and is facing many urgent challenges; none more so than identifying the processes which could accelerate climate change.

The environment is changing rapidly. Last year many skiers had trouble finding enough snow in Scotland and Cornish fishermen noticed more exotic, warm-water fish in their catches. Around the world even more dramatic changes are occurring that we don't get to see. The Arctic and parts of Antarctica are the fastest warming regions on this planet and scientists, funded by the Natural Environment Research Council (NERC), are working in these inhospitable and remote regions to find out exactly what is happening and why.

## International Polar Year

This year saw the launch of International Polar Year (IPY) which is a massive international effort to understand more about the poles. But why should we worry about the polar regions heating up? Firstly, melting ice will contribute significantly to sea-level rise; secondly, we will lose valuable habitats for wildlife and thirdly, the poles control some critical systems governing the Earth's entire climate.

## Have we lit the fuse?

The Earth has an intricate and finely-tuned climate system. Although global temperatures fluctuate naturally, scientists think there is a threshold above which an increase in temperature could push the system out of kilter, accelerating temperature rises — a scenario known as a 'tipping point'.

We need to assess just how close we are to reaching that 'tipping point' and find out exactly what will cause accelerated warming. These advances in science are vital to guide future decisions on how to respond and adapt in a changing world.

## Antarctic melt

If you leave the freezer door open, the ice melts — and so it is with Earth's shrinking ice sheets. Ice sheets in Antarctica and Greenland contain enough ice and snow to raise global sea levels by around 64 metres if it were all to melt. But how much can we expect to melt in the coming centuries? The greatest uncertainty in our predictions of future sea level rise is how much Antarctic ice will contribute.

### Exhibitors:

**Dr Christian Bernt**, *National Oceanography Centre, Southampton*; **Dr Mathias Disney**, *University College London*; **Dr Stephen Matthiesen and Dr Mathew Williams**, *University of Edinburgh*; **Dr David Vaughan**, *British Antarctic Survey*

David Vaughan from the British Antarctic Survey is working with an experienced team of oceanographers, geologists, geophysicists and numerical modelers to study the processes linking ice with the environment. Almost 30 years ago, scientists predicted that climate change could cause the rapid deglaciation of the West Antarctic Ice Sheet — raising the world's sea level by five metres. But until recently, there has been a lack of evidence. Now, satellite instruments show clear signs that the ice sheet is retreating. Although they do not point to an imminent collapse, there is strong evidence that an area of this sheet called the Amundsen Sea is changing very rapidly. This could lead to a potential sea rise of about 1.5 metres. Scientists think that if a significant retreat occurs around the margins of this ice sheet, it could become unstable, leading to rapid deglaciation. Looking to the future, the single most important piece of data which would advance our understanding of the potential for this ice sheet to collapse, is buried underneath the sheet itself. Sediments beneath the ice could reveal how the glacier previously responded to warming.



## Further information

Natural Environment Research Council

[www.nerc.ac.uk](http://www.nerc.ac.uk)

British Antarctic Survey

[www.antarctica.ac.uk](http://www.antarctica.ac.uk)

National Oceanography Centre

[www.noc.soton.ac.uk](http://www.noc.soton.ac.uk)

National Centre for Atmospheric Science

[www.ncas.ac.uk](http://www.ncas.ac.uk)

## How stable is Greenland?

Each summer, considerable amounts of ice melts around Greenland's low-lying margins. As the climate warms, this area of melting could grow and the resultant thinning of the ice sheet might make it more vulnerable to further melting. Sea levels would rise by seven metres if the Greenland ice sheet melted completely, a process that could take a thousand years or more.

Jonathan Gregory at the National Centre for Atmospheric Science in Reading and Philippe Huybrechts of the Free University of Brussels have developed improved methods to simulate the influence of future climate change on the Greenland ice sheet and hence, its likely effect on sea-level rise. The climate models — which combine ocean and atmospheric effects — suggest that the Greenland ice sheet will survive a temperature rise up to 4.5°C\*. But this warming is likely to be exceeded in the 21st century, according to many current predictions.

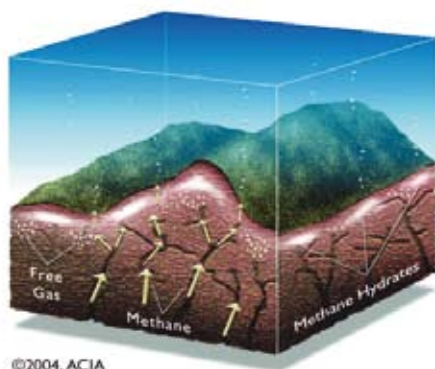
\* Annual average in Greenland relative to pre-industrial times (error margin +/-1.9°C).

## Hidden danger

The Arctic 'freezer' doesn't only contain ice; scientists have discovered vast stores of frozen methane hydrates in the Arctic's deep-sea sediments and beneath the permafrost (frozen ground). Methane is a very potent greenhouse gas, much more so than carbon dioxide. Scientists suspect that past periods of warming caused the crystals to melt, suddenly releasing massive amounts of methane. The question is, has the current change in climate begun to trigger a release?



Figure 1: Burning methane hydrate  
CREDIT: courtesy of USGS



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Figure 2:  
Subsea methane hydrates  
CREDIT: ACIA Overview  
report 'Impacts of a  
Warming Arctic'

These gas hydrate reservoirs (and the free gas that lies beneath them) store almost half of the Earth's organic carbon and are kept stable by the Arctic's cool temperatures. The trouble is that this region is warming rapidly — twice as fast as the global average. Christian Berndt and his team from the National Oceanography Centre, Southampton will travel to the Arctic to calculate exactly how much methane will reach the atmosphere if the Arctic's seas continue to warm and to find out how this might accelerate climate warming.

## Carbon stores beneath our feet

Frozen soils in the high arctic lock carbon away from the atmosphere for thousands of years. But these soils are thawing and we need to know how much carbon will be released. Mathew Williams and Phil Ineson are part of a large team of scientists working together to explore the ways in which carbon moves through Arctic ecosystems. The team will quantify the present state of the Arctic environment, particularly stocks of soil carbon and vegetation patterns. They will compare the amounts of carbon taken up by different types of vegetation to try to build accurate models of how intake or release will change as the climate alters. We need to know how this varies in different Arctic systems and how long carbon typically stays in the soil. The methods used are as varied as the questions asked. They range from following the carbon uptake of individual plants through to using a specially equipped light aircraft to measure the flow of airborne carbon, and satellites to map the seasonal cycles of plant growth. This vital work requires the skills of ecologists, meteorologists, soil scientists and physicists working at sites where the facilities are limited, where equipment has to be powered by solar radiation and wind generators, and where getting to work in the morning starts with a two hour walk across an Arctic landscape!



Figure 3: The movement of carbon will be studied in Sweden's tundra