Issue number 25 — October 2007

ISSN 1725-6658

CORDIS focus

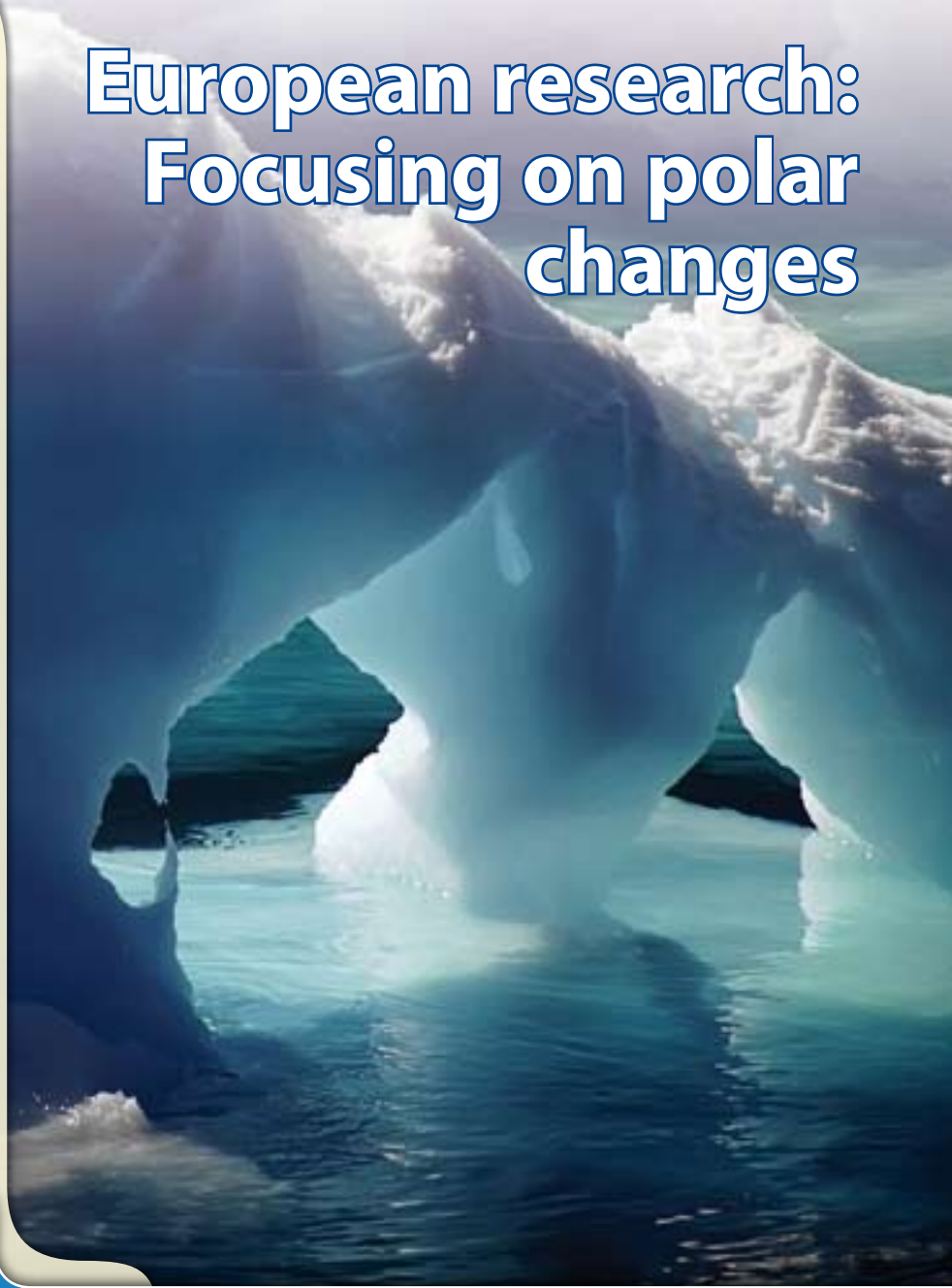
http://cordis.europa.eu

Thematic Supplement

European research: Focusing on polar changes

The International Polar Year 2007/08 is the largest internationally coordinated research programme in 50 years. This issue illustrates the key European contributions to research in the polar regions, especially in the field of climate change.

© Leif G. Anderson, University of Gothenburg, Sweden, 2007



CORDIS

EN

Publications Office
Publications.europa.eu

Published by:
Office for Official Publications
of the European Communities
2, rue Mercier
L-2985 Luxembourg
Fax (352) 29 29-44090
E-mail: cordis-focus@publications.europa.eu

CORDIS: Community Research
and Development Information Service

CORDIS *focus* is also available at:
http://cordis.europa.eu/news/focus

CORDIS *focus* is published by the Office for Official Publications of the European Communities as part of the EU-funded research programmes. It presents the most important developments in European research and covers news, calls for proposals, events, projects and their results.

This CORDIS *focus* Thematic Supplement is based on information from CORDIS. Additional contents have been mainly provided by the European Commission's Environment Directorate of Research DG and also by Environment DG, External Relations DG and scientists involved in the research projects described. Damien Cardinal and Elisabeth Lipiatou, Unit Climate Change and Environmental Risks of Research DG, were the guest scientific editors of this issue.

This Thematic Supplement presents project news and updates recently published. While the aim was to showcase a representative range of projects, the coverage makes no claim to completeness, nor is a relative ranking of the presented information implied or intended.

Subscriptions and orders
CORDIS *focus*
OPOCE
B.P. 2201
L-1022 Luxembourg
E-mail: cordis-focus@publications.europa.eu
Online subscription at:
http://cordis.europa.eu/news/focus/subscribe_en.html

50th Anniversary of the Treaty of Rome
http://europa.eu/50

Welcome message


© European Community, 2007

Janez Potočnik

Polar regions faced the largest warming on the planet in the past two decades. Even if the North and South Poles are often evocative of another world, we should not forget that these unique environments are amongst the most fragile and important for the whole planet. They are key components of the climate system and any major change there will impact our daily life in ways that still need to be accurately assessed. The polar regions are fascinating environments which constantly challenge our technical and thinking abilities.

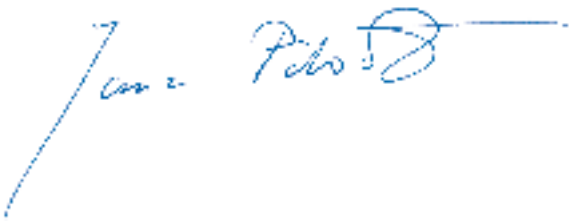
This explains why research in the polar regions is particularly important today. The International Polar Year (IPY) 2007/08, the largest international coordinated scientific effort in the last 50 years, brings us the opportunity to have an overview of European research activities in the polar regions. Europeans have been at the forefront of polar research cooperation since the early days of the polar adventure. The European Union has a rich polar history and numerous leading European polar research teams and organisations are active in these regions.

During my visit to Svalbard, Norway in the Arctic, in July 2007, I could see that these polar regions are indeed endangered. When you see the evidence with your own eyes, it becomes difficult to avoid the conclusion that something more than just natural change is going on. This trip not only confirmed that climate change is a reality and one we need to deal with sooner rather than later, it also showed that science really does reach across national and political borders and brings people together.

Major science achievements have been obtained by European collaborative projects in the polar regions. The examples presented in this issue show us that regional and discipline barriers are fading away: the Poles are no longer seen as isolated from the rest of the world and multidisciplinarity has become the common rule for research. This is a result of an improved understanding of the functioning of our planet and of the increasing complexity of research tools that have been developed in recent years.

This CORDIS focus *Thematic Supplement on* European research: focusing on polar change *highlights the diversity of these research actions and their close relation with European policies. They vary from the stratospheric ozone (O_3) hole to the deep-ocean biodiversity, from human health to research infrastructures, from past to future climate, and from ice to policies. I hope that while reading this issue you will sense, just like I did in Svalbard, the passion of the researchers active in these regions, working hard to raise the awareness of the urgent need for protecting and understanding them.*

Janez Potočnik
European Commissioner for Science and Research



Frequent acronyms

FP5/6/7	Fifth/Sixth/Seventh Framework Programme of the European Community for research, technological development and demonstration activities
CORDIS	Community Research and Development Information Service
IPY	International Polar Year
SSA	specific support action

TABLE OF CONTENTS

EU polar research

For most of us, the North and South Poles are like another world. Although it seems that they have been the same for centuries, they are certainly changing. The poles are very dynamic environments and play a fundamental role in the health and climate of our planet. But now, these regions are experiencing major change due to the effects of global warming.

However, we still know remarkably little about how polar climate operates and its interaction with polar environments, ecosystems and societies. The three fastest warming regions on the planet in the last two decades have been Alaska, Siberia and parts of the Antarctic Peninsula. The polar regions are highly sensitive to climate change and this raises great concern for the future of polar ecosystems and Arctic human society.

The Antarctic Peninsula has the largest annual warming seen anywhere in the world, with increases of over 2.5 °C in the last 50 years. The cause of this continental Antarctica warming is not clear and could be linked to increases in greenhouse gases in the atmosphere or natural variations in Antarctica's climate system. In the north region, if the current warming trends continue, the Arctic Ocean will be ice-free in summer by 2060. The disappearance of Arctic sea ice is likely to have dramatic effects on the world climate, and more specifically on European climate.

Much research has been done to learn to understand and protect our icecaps. Thanks to the Antarctic Treaty, signed in 1959, the environment, fauna, flora and mineral resources of the Antarctic continent and Sub-Antarctic Islands benefit from almost complete international protection.

Since the polar regions are part of the global Earth system, many European researchers and EU-funded research projects are carrying out very important work in this field. The shared enthusiasm and sense of urgency in the face of global warming is leading to an increasing number of European programmes and to a more coordinated approach to European polar research as a whole.

© ShutterStock, 2007

The European Commissioner for Science and Research, Janez Potočnik, pointed out that polar research is particularly well suited to international collaboration, not only because the challenging environment of the poles makes working there extremely expensive, but because what happens there will have an impact far beyond the polar regions.

The poles are also a vital source of information on what the climate was like in the past. Commissioner Potočnik linked them to an environmental library, providing information on changes in climate, ecosystems and societies. 'They give us a clue as to what will happen in the next stage of climate change, from previous examples,' he said.

'Developing Arctic modelling and observing capabilities for long-term environmental studies' (DAMOCLES) is currently the main EU-funded research project. This project tries to observe, understand and quantify climate change in the Arctic by looking at the impact on humans and the environment resulting from the reduction of sea ice. The 'European project for ice coring in Antarctica' (EPICA), another project funded by the EU, has extracted ice cores from more than 3 000 m depth. When analysing these ice cores, the carbon dioxide (CO_2) atmospheric content can be reconstructed for the last 900 000 years. EPICA has shown that levels of CO_2 are at their highest for 650 000 years, raising concerns about the intensity of global warming in the future. These results were used in Al Gore's book and film *An Inconvenient Truth*.

The Commission is also financing the 'International Polar Year — climate of the Arctic and its role for Europe' (IPY-CARE) project, which aims to better inform about Arctic climate change and develop education and training programmes on Arctic research for young scientists in Europe.

For further information, please visit:
http://ec.europa.eu/commission_barroso/potocnik/dossier/polar_research_en.htm

EU research highlights importance of polar regions for the global climate

The European Commission recently released a report highlighting the advances in understanding the role of polar regions in climate change and the environment that have been made thanks to the EU's research Framework Programmes. The report came as the international scientific community launched the IPY, an important scientific campaign with over 200 projects, involving scientists from more than 60 countries, to focus international attention on the importance of polar regions to our climate. As an EU contribution to IPY, the EU hosted an international symposium entitled 'Polar environment and climate: the challenges' on 5 and 6 March 2007 in Brussels, Belgium, which brought together high-level European and international scientists to discuss future perspectives and research priorities for the polar regions.

'The polar regions may seem remote to us, but environmental changes there have global impact' said EU Commissioner for Science and Research, Janez Potočnik, who delivered the keynote speech at the symposium. 'Since the early days of polar exploration, Europeans have been at the forefront of polar research. Our new research Framework Programme [FP7] will continue in this tradition. As we look forward to IPY and determine what we can do in the future, it is a perfect moment to take stock of our many achievements to date.'

Polar changes occur in the daily living environment of more than 4 million people in the Arctic. The reductions in extent and mass of sea ice have immediate local consequences for terrestrial and marine ecosystems. Changes in snowfall and shrinkage of glaciers will influence millions of people whose daily use of water for personal consumption or for agriculture depends on snow pack and glacial sources. But more than that,

continued on page 5

continued from page 4 **'EU research highlights importance of polar regions for the global climate'**

scientists know that polar regions play an important role in controlling and regulating the climate of the entire planet. However, there are still many questions to be answered about the consequences of human activities and the challenges that polar regions are now facing. IPY responds precisely to this need for more and better knowledge. Projects undertaken within its scope will cover polar atmosphere, ice, land, oceans and space.

Professor David Carlson, Director of the IPY's Programme Office, was enthusiastic about European involvement in IPY projects; of over 200 projects officially registered to IPY, just 16 do not have European involvement. For Professor Carlson, one of the biggest challenges of IPY will be managing the vast amounts of data collected during the year. Meeting this challenge will require a shared, flexible, accessible catalogue, with a clear data citation system to ensure that data providers get credit for their work. Professor Carlson also called for universal and affordable access to the relevant literature.

Dr Elisabeth Lipiatou, Head of the Climate Change and Environmental Risks Unit at the Commission's Research DG, highlighted the opportunities for polar researchers under the Seventh Framework Programme (FP7). 'Many of the first call topics under the subactivity "Pressures on environment and climate" will contribute to research in the polar regions,' she said. These include the stability of the thermohaline circulation, studies of the carbon cycle and climate change impacts on biodiversity and ecosystems. Dr Lipiatou also presented the publication outlining current projects funded by the Commission in the field of polar environmental and climate research.

© ShutterStock, 2007

The urgency of the situation at the poles and the need for IPY was clear to all participants. 'Climate research can make a difference and make that difference soon,' said Commissioner Potočnik, adding that just as humankind was responsible for climate change, it was also up to humankind to solve the problem. 'Failing is not an option,' he warned.

Based on a press release from the European Commission, IP/07/271, and a CORDIS News article, RCN 27253.

For further information on environmental research under FP7, please visit:
http://cordis.europa.eu/fp7/cooperation/environment_en.html

For further information on the report:
http://ec.europa.eu/research/environment/pdf/Polar_catalogue_final.pdf

For further information on the polar symposium:
http://cordis.europa.eu/sustdev/environment/ev20061023.htm

For further information on IPY:
http://www.ipy.org

Success measures of IPY: European and international opportunities and challenges

IPY 2007/08 has drawn extraordinary interest from scientists of many specialties and many nationalities. A cautious assessment prior to IPY start shows more than 200 international projects, addressing a wide range of physical, biological and social research topics in polar regions. With thousands of scientists as well as students, engineers, technicians and other support staff so essential to polar research, IPY will involve some 50 000 people from at least 60 countries. IPY will represent the largest coordinated international scientific effort in 50 years.

IPY research will focus on urgent polar and global issues, including ice melt and sea level rise, changes in global ocean circulation and polar oceanic ecosystems, polar sources and sinks in the global carbon cycle, and human well-being and community vulnerability in polar populations. We can and should expect excellent research and startling discoveries in every area of IPY science. But, does this accumulation of IPY research products ensure IPY's success, or does IPY face additional requirements and challenges?

IPY will stimulate cooperation and collaboration across a broad range of scientific specialties, from geneticists to glaciologists and from anthropologists to astronomers. What new tools, new journals, new meetings, new data conventions, new funding sources and processes, new mechanisms for collaboration will develop during IPY and how will the science community sustain successful interdisciplinary interactions after it? IPY will offer unprecedented data management and communication challenges and opportunities, internally among so broad a range of scientific specialties and externally to science education systems at all levels and to the general public. How will free and open data access work during IPY and how and where will it continue after it? Will data publication become a recognised international standard and will IPY free and open data policy extend to open and free access to scientific literature? In its total science and outreach effort, and in an age of geobrowsers, webcasts and increasing public discussion of climate change, IPY will represent a unique opportunity for a big step forward in making science available and accessible to the general public.

continued on page 6

continued from page 5 **'Success measures of IPY: European and international opportunities and challenges'**

Will IPY succeed and if so, what impact will that attention and success have on the future conduct of science?

European researchers and European countries play key leadership roles in IPY science. European researchers, operating through the multinational science programmes of the EU, have an opportunity and responsibility to also lead on these international and interdisciplinary collaboration, data exchange and public impact issues.

Based on a foreword by Dr David Carlson, Director of IPY International Programme Office during the international symposium 'Polar environment and climate: The challenges — European research in the context of the International Polar Year'.

For further information on IPY, please visit: http://www.ipy.org

For further information on the international polar symposium: http://cordis.europa.eu/sustdev/environment/ev20061023.htm

Study links Larsen ice shelf break-up to human activity

For the first time, a team of researchers has linked the recent dramatic collapse of Antarctic ice shelves to human activity.

Temperatures in the Antarctic's central western Peninsula have risen by almost 3 °C over the last 50 years, far higher than the global average rise of 0.52 °C and possibly higher than anywhere else on Earth.

The most visible consequence of this temperature increase is the break-up of the region's ice shelves; in the last 30 years over 13 500 km² of ice has disintegrated.

© ShutterStock, 2007

In 1995 and 2002, the world's attention was drawn to the issue by the sudden collapse of immense chunks of the northern part of the Larsen ice shelf. In the 2002 event, 3 250 km² of ice shelf disintegrated. At the time, questions were raised as to whether these dramatic events were the result of human activity.

Now, a team of researchers from the Centre for Polar Observation and Modelling(CPOM), University College London (UCL), United Kingdom, and the Katholieke Universiteit (KU) Leuven, Belgium, led by Dr Gareth Marshall of the British Antarctic Survey (BAS), have found evidence that this is indeed the case.

The hole in the ozone (O_3) layer and global warming have altered the Antarctic's weather patterns. Stronger westerly winds now regularly push warmer air eastward over the 2 000 m high mountains on the Antarctic Peninsula. When this happens, as it did in 1995 and 2002, the temperature over the north-east Peninsula rises by around 5 °C. This in turn creates the conditions which allow melt water on the surface of the ice sheets to drain down into crevasses, a process which is implicated in the break-up of ice shelves.

'This is the first time that anyone has been able to demonstrate a physical process directly linking the break-up of the Larsen ice shelf to human activity,' explained Dr Marshall. 'Climate change does not impact our planet evenly — it changes weather patterns in a complex way that takes detailed research and computer modelling techniques to unravel. What we've observed at one of the planet's more remote regions is a regional amplifying mechanism that led to the dramatic climate change we see over the Antarctic Peninsula.'

The researchers' findings were reported in the 'Journal of Climate'. Based on a CORDIS News article and a BAS press release, PR No. 17/2006.

For further information, please visit: http://www.antarctica.ac.uk

Scientists and policy-makers pledge support for international polar research

Scientists and policy-makers from 45 countries have pledged their political and financial support to IPY 2007/08, the biggest internationally coordinated research effort for 50 years. The declaration was made at the annual 'Antarctic Treaty consultative meeting' in Edinburgh, United Kingdom.

IPY 2007/08 involves thousands of scientists from many countries in an internationally coordinated campaign of research that aims to provide the most thorough and comprehensive record of the changing state of the polar regions ever obtained. The overall objective of IPY is to provide better observation and understanding of the Earth's polar regions, and focus the world's attention on their importance.

In the 'Edinburgh declaration', the Antarctic Treaty parties state: 'We believe that the scientific research undertaken during IPY will increase knowledge of the Antarctic and will yield a better understanding of the major terrestrial, ocean and atmospheric systems that control the planet.'

The declaration goes on to highlight the importance of research in the polar regions to improving our understanding of the impacts of climate change, and urges more states to sign up to the 'Antarctic Treaty', and its accompanying 'Environmental protocol'.

The 'Antarctic Treaty', which came into force in 1961, was the result of negotiations started during the 'International Geophysical Year' 1957/58. The treaty stipulates that Antarctica should be used exclusively for peaceful purposes; guarantees continued freedom to conduct scientific research; promotes international scientific cooperation, including the exchange of research plans and personnel; and requires that results of research be made freely available. It currently has 45 signatories.

Based on a CORDIS News article, RCN 25865.

For further information, please visit: http://www.atcm2006.gov.uk

The ozone layer

The ozone layer performs the essential task of filtering out most of the Sun's biologically harmful ultraviolet (UV) radiation. Although ozone (O_3) is present in small concentrations throughout the atmosphere, most O_3 (about 90 %) exists in the stratosphere, in a layer between 10 and 50 km above the surface of the Earth.

Concentrations of O_3 in the atmosphere vary naturally according to temperature, weather, latitude and altitude. Furthermore, aerosols and other particles ejected by natural events such as volcanic eruptions can have measurable impacts on O_3 levels.

In 1985, scientists identified a thinning of the O_3 layer over the Antarctic during the spring months which became known as the 'ozone hole'.

Scientific evidence showed that human-made chemicals are responsible for the creation of the Antarctic ozone hole and are also likely to play a role in global O_3 losses. O_3-depleting substances (ODS) have been used in many products which take advantage of their physical properties (e.g. chlorofluorocarbons [CFCs] have been used as aerosol propellants and refrigerants).

© ShutterStock, 2007

CFCs are broken down by sunlight in the stratosphere, producing halogen (e.g. chlorine) atoms, which subsequently destroy O_3 through a complex catalytic cycle. O_3 destruction is greatest at the South Pole where very low stratospheric temperatures in winter create polar stratospheric clouds (PSCs). Ice crystals formed in PSCs provide a large surface area for chemical reactions, accelerating catalytic cycles. The destruction of O_3 also involves sunlight, so the process intensifies during spring time, when the levels of solar radiation at the Pole are highest, and PSCs are continually present.

Although O_3 levels vary seasonally, stratospheric O_3 levels have been observed to be decreasing annually since the 1970s. Mid-latitudes have experienced greater losses than equatorial regions. In 1997 the Antarctic ozone hole covered 24 million km² in October, with an average of 40 % O_3-depletion, and O_3 levels in Greenland, Scandinavia and Siberia reached an unprecedented 45 % depletion in 1996.

The amount of UV reaching the Earth's surface has been shown to correlate with the extent of O_3-depletion. In 1997 UV levels continued to rise at a rate of 2 % per annum. Increased UV levels at the Earth's surface are damaging to human health, air quality, biological life, and certain materials such as plastics.

Human health effects include increases in the incidence of certain types of skin cancers, cataracts and immune deficiency disorders. Increased penetration of UV results in additional production of ground level O_3, which causes respiratory illnesses. Biologically, UV affects terrestrial and aquatic ecosystems, altering growth, food chains and biochemical cycles. In particular, aquatic life occurring just below the surface of the water, where plant species forming the basis of the food chain are most abundant, are adversely affected by elevated levels of UV radiation. The tensile properties of certain plastics can be affected by exposure to UV radiation. Depletion of stratospheric O_3 also alters the temperature distribution in the atmosphere, resulting in indeterminate environmental and climatic impacts.

The 'Montreal protocol', signed in 1997, is recognised as one of the most successful multilateral environment agreement. The consumption of O_3-depletion substances has decreased globally by about 95 % from its baseline levels. The concentrations of man-made chlorine-containing chemicals in the troposphere is now decreasing. However, as the system has a relatively slow response time, there continues to be severe O_3-depletion and the ozone layer is expected to return to its pre-1980 levels in mid-latitudes by 2050 only and 15 years later in high latitudes. Additional measures are currently being discussed in the context of the 'Montreal protocol', *inter alia,* to accelerate the phase-out of some ODS in the refrigeration and air conditioning sectors in some developing countries, where the consumption increased rapidly over the recent years. The implementation of accelerated phase-out measures would provide needed additional protection for the ozone layer and avoid undermining progress made over the last 20 years.

For further information, please visit:
http://ec.europa.eu/environment/ozone/ozone_layer.htm

Limiting global climate change to 2 °C

Climate change is among the gravest environmental, social and economic challenges facing humankind, and it has been happening for a considerable time now. Urgent action is therefore needed to keep climate change at a manageable level and prevent serious physical and economic damage.

The European Commission's Communication *Limiting Global Climate Change to 2 degrees Celsius*, addressed to the Spring European Council on 8 to 9 March 2007 in Brussels, Belgium, is a key element of the Commission's new 'Energy and climate change strategy' to set out proposals for action by the EU and the rest of the international community. This summit of EU leaders led to a positive outcome, with the development of a comprehesive approach to the EU's energy and climate policies, targeted to preventing global climate change from irrevocable consequences.

Although the Kyoto protocol was an important first step towards cutting greenhouse gas emissions, its targets expire in 2012. This means that further international action needs to be agreed on for the period that follows.

According to the Commission, when an international agreement is reached on the post-2012 framework, a 30 % cut in emissions from developed countries by 2020 will result. To further underline its commitment, the Commission proposes that the EU cut its greenhouse gas emissions by at least 20 % by then, in particular through energy measures.

European Commission President José Manuel Barroso said at the summit: 'Today marks a step change for the EU. Energy policy was a core area at the start of the European project. We must now return it to centre stage. The challenges of climate change, increasing import dependence and higher energy prices are faced by all EU members.

continued on page 8

continued from page 7 **'Limiting global climate change to 2 °C'**

A common European response is necessary to deliver sustainable, secure and competitive energy. The proposals put forward by the Commission today demonstrate our commitment to leadership and a long-term vision for a new energy policy for Europe that responds to climate change. We must act now, to shape tomorrow's world.'

The key elements proposals were detailed in depth.

- Limiting global warming to 2 °C is both technically feasible and economically affordable if the international community acts swiftly. As reaffirmed by the recent *Stern Review on the Economics of Climate Change*, the benefits of taking action to limit global warming far outweigh the costs of reducing greenhouse gases. Delaying action will only increase economic costs and physical damage from climate change in the long run.
- Developed countries should continue to shoulder most of the global effort to reduce emissions over the next decade or so, as they are already doing under the Kyoto protocol. However, keeping global temperatures within the 2 °C temperature limit will also require action by developing countries. They should start slowing down the rate of growth in emissions as soon as possible, and then reduce their emissions in absolute terms from 2020-25 onwards. Many options are available for cutting emissions in developing countries that would deliver immediate economic and social benefits and would not affect their pursuit of economic growth and poverty reduction.
- To control climate change effectively, it will also be essential to halt tropical deforestation completely within the next two decades and then reverse it through afforestation or reforestation schemes. Deforestation currently contributes around 20 % of global greenhouse emissions, more than transport. Discussions are taking place under the UN Framework Convention on Climate Change (UNFCCC) aimed at creating appropriate incentives for reducing deforestation.


© ShutterStock, 2007

- Company-level emissions trading schemes such as the EU emissions trading scheme (EU ETS) will be a key tool to ensure that developed countries can reach their future targets cost-effectively. The international framework for combating climate change after 2012 should enable comparable trading schemes in different regions to be linked together. In this way the EU ETS would be the pillar of a global carbon trading network. The scope of the Kyoto protocol's 'Clean development mechanism' should be expanded after 2012, for instance to cover entire national sectors rather than individual projects.

The proposals were grouped under three main pillars for proposed action.

Firstly, there is a definite need to create a truly internal energy market. One main challenge will be to give EU energy users, both citizens and businesses, more choices for energy, in order to trigger high investment. This can be achieved through a clearer separation of energy production from energy distribution. Identified key bottlenecks and appointed coordinators, stronger independent regulatory control, as well as national measures, need to be in place if the 10 % minimum interconnection levels are to be met.


© ShutterStock, 2007

As Commissioner for Energy Policy, Andris Piebalgs, said at the summit: 'Our ambition to create a working internal market, to promote a clean and efficient energy mix and to make the right choices in research and development (R & D) will determine whether we lead this new scenario or we follow others.'

Next, accelerating the shift towards low carbon energy is a number one priority. The Commission stresses the objective of saving 20 % of total primary energy consumption by 2020, with a minimum of 10 % from biofuels, calling for massive growth in the electricity, biofuels and heating and cooling sectors. In addition, specific measures to facilitate market penetration of both biofuels and heating and cooling are outlined. If successful, this would mean that by then, approximately 13 % less energy would be consumed in the EU than today, saving EUR 100 billion and around 780 t of carbon dioxide (CO_2) each year.

'If we take the right decisions now, Europe can lead the world to a new industrial revolution: the development of a low carbon economy', he stated.

At present, nuclear electricity makes up 14 % of EU energy consumption and 30 % of EU electricity. The proposals underline that it is for each EU Member State to decide whether or not to rely on nuclear electricity. The Commission recommends that where there are nuclear energy reductions in the EU, this must be offset by the introduction of other low-carbon energy sources. Otherwise the objective of cutting greenhouse gas emissions will become even more challenging.

continued on page 9

continued from page 8 **'Limiting global climate change to 2 °C'**

However, changing energy sources alone is not enough. The third pillar emphasises solutions that need to be adopted for improving energy efficiency of existing sources.

Some of the ideas suggested by the Commission are: the utilisation increase of fuel efficient vehicles for transport; tougher standards and better labelling on appliances; improved energy performance of the EU's existing buildings and improved efficiency of heat and electricity generation, transmission and distribution; as well as a new international agreement on energy efficiency.

Annual spending on energy research — a crucial element in lowering clean energy costs — will also increase by at least 50 % for the next seven years and include a strategic 'European energy technology plan'.

The proposals centred on these three pillars will need to be underpinned by a coherent and credible external policy.

Stavros Dimas, the European Commissioner for Environment, confirmed that climate change is one of the gravest threats to our planet. Acting against climate change is imperative. Today, we have agreed on a set of ambitious, but realistic targets which will support our global efforts to contain climate change and its most dire consequences. I urge the rest of the developed world to follow our lead, match our reductions and accelerate progress towards an international agreement on the global emission reductions.'

To conclude, it is evident that the EU cannot achieve its energy and climate change objectives on its own. It needs to work with both developed and developing countries, energy consumers and producers. For these reasons, the EU will continue to actively develop: effective solidarity mechanisms to deal with any energy supply crisis; a common external energy policy to increasingly 'speak with one voice' with third countries; and real energy partnerships with suppliers based on transparency, predictability and reciprocity.

© ShutterStock, 2007

Based on a press release from the European Commission, IP/07/29, and MEMO/07/16.

For further information on the Environment DG, please visit: http://ec.europa.eu/environment/index_en.htm

For further information on the EU's policy on climate change: http://ec.europa.eu/environment/climat/future_action.htm

Humankind responsible for global warming, says IPCC

'This day marks the end of the debate over whether human action has anything to do with climate change,' said Dr Achim Steiner, Director of the United Nations Environment Programme (UNEP), as the latest report by the Intergovernmental Panel on Climate Change (IPCC) was released.

The report, released in February 2007, not only pins the blame for climate change on humankind, but states with new certainty what further changes the globe should expect to witness over the coming decades.

'Policy-makers have asked for scientific proof, and that proof is now on the table,' said Dr Steiner. He appealed for the launch of the report to be remembered as the moment that marks a shift from doubt to action, and claimed that anyone who still delays this shift 'will be considered as irresponsible in history books'.

The IPCC's main findings were presented by Dr Susan Solomon of the National Oceanic and Atmospheric Administration (NOAA) in the United States. 'Warming in the climate is now unequivocal,' she said. Palaeoclimatic work has shown that the last half century has been 'unusually warm', and that the last time the polar regions were significantly warmer than they are now was 125 000 years ago, due to a change in the Earth's rotation.

Perhaps the biggest change since the last IPCC report in 2001 is the certainty with which scientists can now say that human beings are implicated in climate change. In 2001 it was 'likely' that human activities were to blame, meaning a probability of between 66 and 90 %. Now, in 2007, the IPCC says that it is 'very likely' that humans are to blame, meaning the probability has increased to above 90 %.

European Environment Commissioner Stavros Dimas said the report provides further backing for the EU's objective of limiting global warming to no more than 2 °C above the preindustrial temperature. The temperature today is already almost 0.8 °C above this level.

More than 2 °C above current levels would result in widespread loss of biodiversity, decreasing global agricultural productivity, and a commitment to widespread melting of the Greenland ice sheets, which would eventually raise sea levels by 4 to 6 m.

Recent climate change is already having widespread effects on people, ecosystems and water resources, at a faster rate than previously anticipated, the report stated. Humans are also being directly affected through, for example, increased water stress, excess mortality during heatwaves, changes in the distribution of vector-borne diseases, limitations to mountain sports, threats to indigenous livelihoods and increased risk of forest fires.

The report predicts that temperatures will rise by between 1.8 and 4 °C, but suggests that they could rise by as much as 6.4 °C. Report co-author Michael Manning suggested that a world with temperatures of 6.4 °C warmer than today would have an ice-free Arctic, more extreme and frequent heatwaves, and more tropical cyclones. 'We'd see what we've seen through the second half

continued on page 10

continued from page 9 **'Humankind responsible for global warming, says IPCC'**

of the 20th century, but everything would be much more severe,' he said.

According to the authors of the report, future climate change will magnify existing regional differences in Europe's natural resources, with winter floods and coastal floods in maritime regions, snowmelt floods in central and eastern Europe flash floods throughout Europe, and forest fires in southern Europe predicted to be significantly on the increase.

Demands on dwindling water supplies, coupled with climate-related health risks from heatwaves and flooding, will have adverse effects on biodiversity, particularly in central and southern regions. These changes will pose major challenges to many economic sectors in Europe, including agriculture, forestry, tourism and energy production.

The IPCC's findings have been summarised in a document for policy-makers. 'We are looking for unequivocal commitment from policy-makers, business leaders and civil society,' said Dr Steiner.

Dr Solomon was less willing to get involved in dictating which policy approaches should now be taken, or how urgently action is needed. 'Science can best serve society by not going beyond its expertise. There are people out there who have this role [...]. The report is not policy-prescriptive, but policy-relevant, and I think that's how it should be', said Dr Solomon.

The report *Climate Change 2007: The Physical Science Basis* was written by some 600 scientists from 40 countries. Over 620 expert reviewers and a large number of government reviewers also participated.

The full report will be released later in 2007, along with other IPCC chapters on the probable impacts of climate change, options for adapting to these impacts, and possible ways to reducing the emission of greenhouse gases.

Based on a CORDIS News article, RCN: 27065.

For further information, please visit:
http://www.ipcc.ch

Climate report urges mix of mitigation and adaptation policies

The second in a series of four international reports on climate change was released on 6 April 2007, warning that billions of people around the world face food and water shortages and an increased risk of flooding.

The report from the Intergovernmental Panel on Climate Change (IPCC) is based on more than 29 000 pieces of data on observed changes to physical and biological aspects of the environment. Scientists on the IPCC believe that 89 % of the data are consistent with a warming planet.

'For the first time, we are no longer armwaving with models; this is empirical data, we can actually measure it,' said Professor Martin Parry, Co-chair of the IPCC Working Group II.

The report recommends a portfolio of adaptation and mitigation measures to diminish the risks associated with climate change. 'Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts. [...] this suggests the value of a portfolio or mix of strategies that includes mitigation, adaptation, technological development (to enhance both adaptation and mitigation) and research (on climate science, impacts, adaptation and mitigation),' reads the summary for policy-makers.

The report lists a number of observed changes, along with the degree of certainty that these are being caused by global warming. There is a 'high confidence' that there are now more and larger glacial lakes, more rock avalanches in mountain regions and changes in some Arctic and Antarctic ecosystems, affecting predators high in the food chain.

There is 'high' confidence that lakes and rivers are getting warmer, which in turn is affecting thermal structure and water quality, and there is high confidence that we are seeing changes to algal, plankton and fish abundance in high-latitude oceans, an increase in algal and zooplankton abundance, and earlier migration by fish in rivers.

Certainty over the effects on terrestrial biological systems is even higher. There is 'very high confidence' that spring events such as leaf-unfolding, bird migration and egg-laying are happening earlier, and that there have been poleward and upward shifts in the ranges of plant and animal species.

EU Environment Commissioner Stavros Dimas said that the impact and importance of the work carried out by the IPCC could not be overestimated. He pointed out that just a few weeks after Working Group I published its report, the EU's Heads of State or Government committed the EU to an ambitious package of energy and climate change policies and targets.

'The EU is not waiting for others to take action. Even before negotiations on a global agreement start, the EU leaders have agreed that the EU should make a firm, independent commitment to reduce our emissions by at least 20 %,' said Mr Dimas. 'In the current climate discussions, countries are waiting for others to move first. Only EU leadership can break this impasse.'

The Commissioner also underlined the role that FP7 will play in tackling climate change. He pointed to its significantly increased budget for research on mitigation and adaptation to climate change, as well as for energy and transport technologies. The Commission also intends to have 12 large-scale carbon capture and storage demonstration projects in operation by 2015.

© Shutterstock, 2007

The first IPCC report this year, published in February 2007, concluded that it is at least 90 % likely that human activities are principally responsible for the warming observed since 1950. The third report, published in May 2007, focused on ways of curbing the rise in greenhouse gas concentrations and temperature, while the fourth report, due in November 2007, will sum up all of the findings.

For further information, please visit:
http://www.ipcc.ch

For further information on environmental research under FP7:
http://cordis.europa.eu/fp7/cooperation/environment_en.html

For further information on the EU's policy on climate change:
http://ec.europa.eu/environment/climat/future_action.htm

Leading polar scientists come together for international symposium organised by the European Commission's Research DG

The European Commission celebrated the launch of IPY with a symposium on the 'Polar environment and climate: The challenges' in early March 2007. The symposium brought together around 160 participants from 21 countries.

The symposium was organised by the Commission's Climate Change and Environmental Risks Unit from the Research DG. The Commission was able to highlight its contributions to polar research, while the event proved a useful forum for exchanging ideas between leading specialists in the field.

'Climate change has been caused by us human beings. It is up to us to sort it out.' With those words, EU Commissioner for Science and Research Janez Potočnik set the tone for the symposium from the start — climate change, its effects on the polar regions and the impact on global climate patterns.

Climate change is also a key issue for IPY, organised by the International Council for Science (ICSU) and the World Meteorological Office (WMO), and running over a two-year period from March 2007 to March 2009. Thousands of scientists from over 60 countries are involved in more than 200 research projects. IPY offers opportunities for enhanced collaboration in regions that remain underexplored and aims to raise awareness amongst the broader public. As Dr Dave Carlson, IPY Programme Director, said, the event is 'a chance to bring science back to the public'.

The polar regions are suffering disproportionately from global warming. The effects on local communities and wildlife in the Arctic could be devastating and are also likely to be felt globally. For example, ice melting could disrupt the thermohaline circulation (the global circulation of sea water that links the world's oceans together), with effects that remain to be discovered. Indeed, the Commission is calling for a large research project on thermohaline circulation stability as part of the recently launched FP7.

Polar research faces three basic challenges: the first is cost — expenses incurred in doing fieldwork can be prohibitive; the second is its interdisciplinary nature — polar research brings together scientists from many fields, and a more holistic approach offers strong potential in new discoveries; the third is the information itself — despite decades of polar research — there are still large gaps in our understanding of the polar regions. Big collaborative fieldwork as embodied by IPY should go some way to addressing this.

The first day's sessions looked at climate systems — the historical record of past climate change, present observations, and future polar climate change modelling. A recurring theme was the lack of data. Polar research has a long and illustrious history behind it (stretching back to the 1830s), but the regions' remoteness and size makes getting comprehensive information a big challenge. In addition, the very subject of climate change incorporates a number of variables that are not easily brought together. The Arctic was the main focus of attention, with the threat of summer Arctic sea ice disappearing altogether in the near future a main cause for concern.

Past climate data is based on both historical records and techniques like ice core drilling. In the latter case, ice samples are taken from great depths, and air bubbles trapped within the snow and ice can be analysed to show how the past climate was (the level of atmospheric carbon dioxide [CO_2] for example). Such samples are useful to look at natural climate variability which plays an important role. Sudden shorter-term climate events like the Pacific *El Niño* southern oscillation need to be differentiated from longer-term climate trends.

© Qwentest, 2007

Speech of Janez Potočnik, Commissioner for Science and Research at the opening session of the polar symposium chaired by Manuela Soares, Director of the Environment Programme and Jean-Claude Gascard, coordinator of DAMOCLES.

Research in the polar regions and climate change also bring together a number of different scientific disciplines — from biologists studying plankton to scientists tracking ozone (O_3) depletion in the atmosphere. Creating common terminology and finding data that can be mutually exploitable are fascinating challenges.

The quality and quantity of data are essential for climate prediction models. Increased confidence has been expressed in these, but additional data sources are still needed. For example, little data exists on polar cloud formations and their climatic impact. Modelling climate change is very complex, and the larger the scale the more the variability.

The second day was devoted to crosscutting issues. Two sessions looked at the human and biological side of polar research: health; and the natural and socioeconomic impacts of climate change. The Arctic is inhabited by around 4 million people. It is also home to a surprisingly large biodiversity: thousands of species, many still unrecorded and many others facing extinction. The health session focused on disease and pollution threats, and the benefits of integrated methods were illustrated, for example those exploring the dynamics between climate change and the appearance of new diseases and parasites. The session on natural and socioeconomic impacts of climate change stressed that long-term (100-year timespan) data was very limited, lamenting that most data had only been collected over recent years, after rapid climate change had been set in motion.

Further crosscutting subjects highlighted the importance of adequate research infrastructure. Polar research is an expensive venture, entailing high logistics and capital. The need to create sustainable observation networks was stressed, as well as the advantages of pooling resources and research data. Participants pointed out that IPY offers the potential for unparalleled sharing of infrastructure and funding.

The last panel discussion focused on public outreach and education. The need to make science accessible to the public is a subject exercising minds across the scientific community, and IPY is a great opportunity to highlight polar research — new discoveries and impressive research efforts should create headlines. The link with climate change, a core preoccupation, is also a way of showing the relevance of the polar regions to the rest of the world. A film trailer was shown about polar research and other initiatives were highlighted, with participants responding warmly.

The need to encourage young researchers was also stressed, through the creation and sup-

continued on page 12

continued from page 11 **'Leading polar scientists come together for international symposium organised by the European Commission's Research DG'**

port of associations like the Association of of Polar Early Career Scientists (APECS). Like other scientific disciplines, polar research runs the risk of finding too few young scientists to ensure a new generation of research. Young researchers at the symposium also raised concerns about academic support as older generations of polar scientists retire. Certainly, with the depth and breadth of polar research increasing — as new scientific techniques are perfected, as collaborative fieldwork gathers pace, and as public awareness increases about the importance of these regions — it will be up to these young researchers to build up knowledge of these cold, distant and beautiful regions.

For further information on the polar symposium, please visit: http://cordis.europa.eu/sustdev/environment/ev20061023.htm

The proceedings of this international symposium are available free of charge upon request and freely downloadable. They reflect our current understanding of the polar regions in the fields of environment and climate. The Director-General for Research, José Manuel Silva Rodríguez, says, in his foreword to the publication, 'the polar regions are especially vulnerable to climate change. Much of the research shown on these pages paints a grim picture. […] this makes research in the polar regions all the more necessary and urgent. A glance through the titles of the proceedings shows what a multidisciplinary effort polar research is — from climatologists to biologists, and from engineers to economists'. Adding that 'climate change now more than ever in the public eye, with IPY now underway, we hope that these proceedings will contribute to the engagement of scientists, policy-makers and the general public, and encourage the next generation of polar researchers'. 'They should also provide a useful basis to build the future European research policies in the polar regions,' he then concluded by reminding that 'this still-pristine environment needs to be understood before it is altered forever'.

'Polar environment and climate: The challenges — European research in the context of the International Polar Year conference proceedings' edited by Damien Cardinal and Elisabeth Lipiatou, European Commission, Climate Change and Natural Hazards Series #11, ISBN 92-79-06278, 197pp, 2007.

Publication available on: http://ec.europa.eu/research/environment/pdf/polar_env_and_climate_proceedings.pdf

Global change and ecosystems: how FP6 projects are tackling sustainable development

The Sixth Framework Programme (FP6) contributed to our growing understanding of environmental change and sustainable development. Its thematic subpriority 'Global change and ecosystems' (GCE) brings together international partners from around the world in some 280 projects. Research focuses on the mechanisms and impacts of global environmental change as well as practical strategies and tools for sustainable development.

FP6 research teams study, for example, the impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone (O_3) depletion and carbon sinks (oceans and inland waters, forests and soil). They do research to understand the mechanisms and assess the impact of global change on the water cycle, water quality and availability, as well as soil functions and quality to provide the bases for management tools for sustainable water systems. Biodiversity and ecosystems are analysed to understand and minimise the negative impacts of human activities. The mechanisms of desertification and natural hazards, such as earthquakes, tsunamis and volcanic activity, are being elucidated to improve risk assessment, forecasting, prevention and mitigation. Efforts are also deployed to improve, integrate and use Earth observation systems which are ground-based, airborne and space observing systems, crucial for example in monitoring climate change or for enabling early warning of natural hazards. In addition, strategies and tools for the sustainable use of land — with emphasis on coastal zones, agricultural lands and forests — are developed to ensure sustainable development at economic, social and environmental levels. A dozen of FP6 projects — please see the projects section from page 19 — have a direct or indirect link with environment in the polar regions. They include the largest IPY project, DAMOCLES, on Arctic modelling and observing capabilities, but also projects on global scale climate modelling (ENSEMBLES), palaeoclimatology (MILLENNIUM, EPICA-MIS), carbon budget (CARBOOCEAN, CARBO-NORTH), natural resources (HERMES, EUR-OCEANS), environment and health (EDEN), stratosphere (SCOUT-O3).

In 2004, the GCE subpriority was oriented to also support the European Commission's action plans regarding 'Environmental technologies' and 'Environment and health'.

European research is thus delivering sustainable solutions to societal and industrial problems. The 'problem-solving' approach combines scientific expertise with industrial involvement to secure reliable and exploitable results with highly marketable potential. Green technologies create a real opportunity to combine long-term economic growth with a better environment. The development of technologies includes reducing the degree of pollution in soil, rivers, lakes and the atmosphere, as well as minimising waste.

Within the 280 projects of the GCE subpriority, a total of 79 projects carry out research directly linked to policy-making, assessing — for example — the impact of environmental issues on health. These projects are part of the 'Scientific support to policies' (SSP) activities, which aim to help politicians make effective policies based on sound evidence. Commission services outside Research DG with a clear interest in SSP activities (mainly from environment, enterprise, agriculture and regional policy areas) were consulted to

continued on page 13

continued from page 12 **'Global change and ecosystems: how FP6 projects are tackling sustainable development'**

establish a list of research topics high on the agenda of EU policy-making.

A wide consultation process initiated by the Commission, involving notably the scientific community, enterprises and EU Member States, helped in defining the research areas to be covered by this subpriority. On this basis, calls for proposals were published by the Commission in the *Official Journal of the European Union* and on the CORDIS website.

These calls have generated high interest within the scientific community of the EU and also from many third countries which were motivated to participate in the EU's environmental research.

To download the catalogue of projects, please visit: http://ec.europa.eu/research/environment/pdf/global_change_ecosystem.pdf

To download the FP5-FP6 polar projects' catalogue: http://ec.europa.eu/research/environment/pdf/Polar_catalogue_final.pdf

Researchers feed ideas to EU for future climate change research priorities

The Earth is warming because of human-induced climate change, but how to react? Should the international community inject light-reflecting sulfur gas into the atmosphere to cool things down? Or commercially remove carbon dioxide (CO_2) from it? Is the ocean's rising acidification undermining our food chain? What are the sociological implications for tomorrow's sustainable cities? And how to better predict extreme climate change-related hazards such as floods, drought or superstorms? These and many other research ideas were vigorously debated at the two-day 'International symposium on climate change' held in Brussels, Belgium, on 2 and 3 February 2006.

Participants heard plenty of bad news about the reality of climate change, but also heard plans for future research that should help to address some of the issues raised.

The symposium opened with an introduction from EU Science and Research Commissioner Janez Potočnik who stated: 'The latest figures suggest that 2005 was the warmest [year] on record, and there were increased instances of extreme events. The public is alarmed and wants answers. Central and southern Europe experienced a great deal of flooding. How are we to prevent and mitigate this? In 2003, the EU underwent a heat wave, causing thousands of casualties. Should we expect this to be the normal summer for us?'

He was quick to point out that global warming is no longer a possibility, but a certainty, and that research will now not only focus on minimising human impact on the environment, but also examine ways to deal with the effects of global warming when it arrives. 'A rise of 3 °C will have an impact on global society. How are we able to take responsible decisions? We will be exploring unanswered scientific questions and tackling adaptation strategies. Earth observation will continue under FP7 for early detection of climate change. We need to find the points of no return which humanity needs to know.'

© European Community, 2006

Session chairs: Janez Potočnik, Commissioner for Science and Research (centre), Pierre Valette, Acting Director of the Environment Programme (left) and Elisabeth Lipiatou, Head of Unit Climate Change and Environmental Risks (right)

The picture was not all gloom, however, as the Commissioner pointed out that the 'Montreal protocol' is functioning — chlorides are in decline in the atmosphere and the ozone hole should recover in the coming decades. Kyoto is the first step, but more is needed to achieve these ambitious goals — but warming is unavoidable and we all need to prepare for change. FP7 includes climate change, and we need further research excellence at the EU and international levels.'

Insisting that environmental policies must be built on sound scientific knowledge to minimise climate change's socioeconomic impact, he said FP7 will address 'major unanswered scientific questions and advance our understanding of the Earth system's functioning and changes.' The aim would be to include local, regional and global impacts of climate change, as well as optimum mitigation and adaptation strategies.

The event was split into three research-oriented work sessions and a final fourth one to summarise all the technical presentations. Scientists across the entire spectrum of climate change research in Europe were present: from chemical atmospheric specialists to oceanographers and hydrologists to polar icecap and desertification experts. Their diverse backgrounds enabled a broad spectrum of experiences, ideas and viewpoints to be shared.

The fundamental importance of climate studies was raised by Pierre Valette, acting Director in charge of the 'Environment research' programme at the European Commission's Research DG, who pointed out that climate change studies have driven many other research areas such as economic modelling since the early 1990s. 'There's been a revolution in this field. Cost-benefit analysis, emissions trading, the external costs of energy and transport: all these did not really exist 15 years ago and the EU has been largely responsible for the change,' he said. What is more, there is no scientific theory for adaptation, but we need one for scientific and economic planning. Climate change will drive this research. He went on to say that: 'The Commissioner has always pushed for climate change research, central to economic planning to minimise uncertainty. Climate change research also generates other advanced technology developments.'

For Dr André Berger of the Institute of Astronomy and Geophysics at the Université catholique de Louvain (UCL), Belgium, 'Reconstructions of past climates will not only help validate models used for predicting the 21st and 22nd centuries' climate, but will also provide the best analogue and description of what might happen in the next future.' He continued by saying: 'Just because we may be entering another glacial period is not a reason to continue pumping CO_2 into the atmosphere. But we need modelling and high-quality reconstructions of the past to determine the consequences.'

The complexity of climate change models has increased greatly in the last 30 years but they must be improved to handle yet more resolution, complexity and uncertainty, believes David Griggs, Director of the United Kingdom's meteorological office, the Hadley Centre. 'We need to incorporate atmospheric chemistry into them, as well as land surface and ocean carbon cycles,' he said. 'But to do so we need a sixfold increase in today's computing power.'

One way that predictive power could be used is to analyse Earth's 'switch elements' such as the marine carbon pump off the coast of Peru, which draws carbon out of the water/atmosphere and into organic matter that settles into the deep sea.

continued on page 14

continued from page 13 **'Researchers feed ideas to EU for future climate change research priorities'**

'We need to find out how all these switch elements really behave. Global warming could cause a greening of the Sahara, but would this decrease the dust that blows across the Atlantic to fertilise the Amazon's forests?', asked Professor Hans Joachim Schellnhuber, who works at the University of East Anglia (UEA), United Kingdom, and the Potsdam Institute for Climate Impact Research (PIK) Germany.

'Society has the choice between a low- and high-carbon future. Reducing greenhouse gas emissions does not have to be costly if you induce technological change through top-down measures: incentives. But if you leave that to market forces, change will come too late. We need to aggressively improve climate change modelling to produce a cost-benefit approach as a guide to climate change management and, just as important, to predict social adaptation to sustainability.'

Professor Pavel Kabat, a fellow session participant, agreed. Professor at the Wageningen University and Research Centre (Wageningen UR), Netherlands, he said research that reinforces the hard economic impact of policy choice would be the most effective in combating climate change. Pointing to *El Niño*-induced flooding and droughts that cut a quarter of Kenya's gross domestic product (GDP) in the late 1990s, Professor Kabat said 'it is much easier to argue for investment in water management technology and projects when you show economists and policy-makers this kind of data.'

Changes in atmospheric composition and ozone (O_3) depletion led discussions during session II, where the discussion of possible solutions to mitigate global warming included some spectacular ideas.

Professor Paul Crutzen of the Max Planck Institute (MPI) for Chemistry (Otto Hahn Institute), Germany, and a 1995 'Chemistry Nobel prize' winner, speculated about the potential of sulphur 'dust' to reverse the effects of atmospheric warming. 'I'm very intrigued with the idea of using sulphur gas,' he said, adding that only a small amount of the material would have to be injected into the stratosphere to create a small 'volcanic eruption'-type cooling of the lower atmosphere.

But possible side effects could be the O_3 destruction and disruption of the stratosphere's dynamics. Thus Professor Crutzen called for a moratorium on the idea but with a proviso to unfreeze it if temperatures rise too quickly. 'The situation should be reviewed every six years. That is my position,' he said.

Turning to marine carbon sinks, Dr Christoph Heinze of the University of Bergen (UiB), Norway, said research should focus on integrated land-ocean carbon budgets as a function of time, and whether genetics are changing with the ocean's increasing acidification. 'This has implications for the entire food chain,' he said, adding that other research objectives should include more sustained prediction systems 'beyond classical operational oceanography' and a systematic data assimilation of the palaeo record.

'None of these things can be done in a single country: they must form a joint international and worldwide effort,' said Dr Heinze. 'It would be a good way to achieve European added-value.'

Many climate change modelling and prediction techniques also apply to natural hazards, whose prevention, risk management, mitigation and forecasting aspects were the focus of presentations during session III.

Dr Joachim Hill of the University of Trier, Germany, drew listeners' attention to the fact that people are abandoning Europe's so-called marginal areas. 'Trees are reforesting the land and thus biofuel is building up,' he said. 'This is negatively affecting biohydrological patterns. As a result, ground water tables are dropping fast, particularly in southern Europe, which will affect drought conditions.' Dr Hill called for an interdisciplinary approach to desertification research 'which should carry strong socioeconomic relevance and rely on space-borne systems as useful research tools.'

Other natural hazard experts argued for European centres of research excellence to better predict landslides or movements or volcanic disruptions and their effects, for instance.

'We have not sufficiently mapped Europe for the risk of landslides and we are missing information about highly localised landslides and their effects,' said Claudio Margottini, who works at the Ente per le Nuove tecnologie, l'Energia e l'Ambiente (ENEA, the Italian agency for new technologies, energy and the environment). 'There is no laboratory in Europe for large-scale analysis of soil samples and movements. Japan and the United States have them, but not us.'

Professor Jean Virieux, a researcher with the Université de Nice Sophia Antipolis (UNSA) and the Centre national de la recherche scientifique (CNRS) at Sophia Antipolis, southern France, expressed a similar need in the field of multihazard research involving volcanoes, landslides and earthquake-generated tsunamis. 'If you're not recording small earthquakes, then you're missing information needed to predict ground motion. Dense monitoring networks are needed, as well as a large-scale earthquake simulation and analysis centre with supercomputing capabilities.'

Dr Hartmut Graßl, Director at the Max Planck Institut für Meteorologie (MPI-M) in Hamburg, Germany, said: 'Climate change is now visible to most people. Climate is the key resource. Palaeoclimatology is not enough — we need tested models. Has the tolerable window been reached?'

'Temperature is rising by 0.13 °C per decade. Some researchers believe this is already over the threshold. There are no accurate ocean/land/atmosphere models tested for the future. There is a lack of methodology to talk about the next 50 or 100 years. Will there be a way to prepare for future climate change in the absence of such a model?'

The following speaker, José Achach from the World Meteorological Organisation (WMO), referred to the 'Global Earth observing system of systems' (GEOSS) project, which aims to build a holistic model taking into account measurements from the land, sea and air to produce more meaningful models and accurate predictions of climate change, as suggested by Dr Graßl.

The project is highly ambitious and is not yet possible, as supercomputers are simply not powerful enough to deal with the necessary computations.

Dr Graßl pointed to a current climate model, known as A1B, which looks forward to 2100. The model predicts dry places becoming drier and wet areas becoming wetter. This would lead to significant migrations of people, although how many is yet to be determined.

'An Arctic polar summer without sea ice is possible. Research shows that in the past, Greenland's ice sheet has melted at temperatures that are 1.5 °C over the preindustrial revolution level, so we could already be in trouble,' explained Dr Graßl.

Dr Elisabeth Lipiatou, Head of the Climate Change and Environmental Risks Unit at the European Commission's Research DG, outlined areas of targets for FP7 research, including: monitoring of the carbon cycle; adaptation and migration measures; Earth modelling on global, regional and local levels; assessing impacts and critical thresholds; changes in atmospheric composition; and natural disasters.

The symposium was dedicated to the memory of Dr Anver Ghazi, Head of the Global Change Unit at the Commission's Research DG, who died in 2005.

For further information, please visit:
http://ec.europa.eu/research/environment/index_en.htm

FP7 Environment including climate change

The main objective of environment research under FP7 is to manage both the man-made and natural environment and their resources. By increasing the knowledge on the interaction between the climate, biosphere, ecosystems and human activities, new environmentally friendly technologies should be developed.

As environmental problems extend beyond national frontiers and natural resources are under pressure, Europe needs a new sustainable relationship with the environment.

Since long, the European Commission is supporting research in the polar regions through the implementation of its Framework Programmes, following calls for proposals on priority themes. Almost 60 research projects under the Fifth Framework Programme (FP5) and FP6 related directly or indirectly to polar issues have been funded for the last decade. Most of these initiatives were related to climate research due to the changes the poles are currently facing and their importance for the Earth's climate.

In FP7, funded actions should focus on:
- predicting climate, ecological, Earth and ocean systems' changes;
- tools and technologies for monitoring, prevention and mitigation of environmental pressures and risks including on health;
- sustainability of the natural and man-made environment.

Funding in this area will also improve competitiveness and strengthen European industries' position in world markets for environmental technologies. Emphasis will be given to the following activities.

– Climate change, pollution and risks:
- pressures on the environment and climate;
- environment and health;
- natural hazards.

– Sustainable management of resources:
- conservation and sustainable management of natural and man-made resources and biodiversity;
- management of marine environments.

– Environmental technologies:
- environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environments;
- protection, conservation and enhancement of cultural heritage, including human habitat improved damage assessment on cultural heritage;
- technology assessment, verification and testing.

– Earth observation and assessment tools:
- Earth and ocean observation systems and monitoring methods for the environment and sustainable development;
- forecasting methods and assessment tools for sustainable development taking into account differing scales of observation.

More specifically, under the FP7 Environment theme and under subactivity 'Pressures on environment and climate', the following core areas have been underlined.

- Area 1: 'The Earth system and climate: functioning and abrupt changes';
- Area 2: 'Emissions and pressures: natural and anthropogenic';
- Area 3: 'The global carbon cycle: greenhouse gas budget';
- Area 4: 'Future climate';
- Area 5: 'Climate change: natural and socio-economic impacts';
- Area 6: 'Response strategies: adaptation, mitigation and policies'.

Research in the polar regions is potentially suitable in all of these areas and the priority themes of the Framework Programmes are based on results acquired during previous and ongoing programmes. For instance, in the first FP7 call for proposals published at the end of 2006, polar issues were included under two topics which are at the current science frontier: first, stability of the thermohaline circulation (which has a large impact on Europe's climate); second, investigating life in extreme environments. The thermohaline circulation call builds heavily on past and current multidisciplinary projects on the interactions between ocean, cryosphere and climate. There will also be relevant topics to the research in polar regions that are scheduled for the future FP7 calls: palaeo-environment; sea level rise and ice sheets; ultraviolet (UV) radiation; carbon budget and cycle; future climate; climate change impacts on biodiversity and ecosystems; and human health issues.

For further information on FP7, please visit:
http://cordis.europa.eu/fp7/home_en.html

To download the FP5-FP6 polar projects' catalogue:
http://ec.europa.eu/research/environment/pdf/Polar_catalogue_final.pdf

Published FP7 calls with direct links to polar regions

ENV.2007.1.1.1.1. Stability of the thermohaline circulation

Integrated observation and process studies in key regions (e.g. the Arctic and sub Arctic), modelling and palaeo-studies to assess the risk of the breakdown or sudden reduction of the thermohaline circulation (THC). Feedback with stability of ice sheets in polar regions, changes and variability in atmospheric circulation and the hydrological cycle should be included. The participation of international cooperation partner countries (e.g. Russia) is encouraged. This topic is also a contribution to IPY.

Funding scheme: collaborative projects (large-scale integrating projects; Community contribution from EUR 4 million up to EUR 10 million).

Expected impact: much improved quantification of the risk, time horizon and possible scenarios for THC breakdown and related abrupt/rapid climatic change; understanding the influence of ice sheets melting on THC; predicting the THC in the future.

This call is closed and the evaluation of proposals received are in the final stage.

For further information on the FP7 Environment programme, please visit:
http://cordis.europa.eu/fp7/environment/home_en.html

INFRA-2008-1.1.2.24.

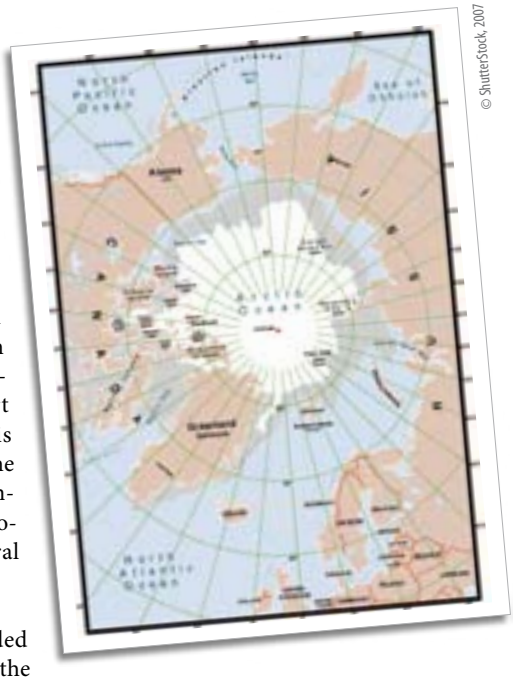
In the Capacities programme of FP7, research intrastructures part, the work programme 2008 has been published and an environment-specific objective relates to 'Integrating, for efficient polar research, existing observation and monitoring stations in both Arctic and Antarctic regions'.

This call will be open at the end of 2007.

For further information on the FP7 'Research infrastructures' programme,please visit:
http://cordis.europa.eu/fp7/capacities/research-infrastructures_en.html

The Northern dimension

The 'Northern dimension' concept covers a broad and diverse geographic area, stretching from the Arctic and sub Arctic to the southern shores of the Baltic, and from north-west Russia in the east to Iceland and Greenland in the west.



Originally launched in 1999, a new 'Northern dimension' policy was adopted at a summit of the leaders of the EU, Iceland, Norway and Russia in November 2006. The new policy is a shared policy with common ownership of the four partners and continuous involvement of the other main stakeholders (the four northern regional councils and the international financing institutions). Canada and the United States are observers.

The 'Northern dimension' is now the regional expression in the north of the four EU/Russia common spaces: the common economic space; the common space of freedom, security and justice; the common external space; and the common space of research, education and culture.

The 'Northern dimension' in the external and crossborder policies of the EU reflects the EU's relations with Russia (and particularly north-west Russia) in the Baltic and Arctic Sea regions. It addresses the specific challenges and opportunities arising in those regions and aims to strengthen dialogue and cooperation between the EU and its Member States, Iceland and Norway (the northern countries associated with the EU under the European Economic Area, EEA), and the Russian Federation within the framework of the 'Partnership and cooperation agreement' with Russia.

Several key priority themes for dialogue and cooperation under the 'Northern dimension' have been identified, including:
- economy, business and infrastructure;
- human resources, education, culture, scientific research and health;
- the environment, nuclear safety and natural resources;
- crossborder cooperation and regional development;
- justice and home affairs.

The 'Northern dimension' operates through the efforts of all stakeholders. Where financial support at the EU level is required, the 'Northern dimension' draws on existing EU financial instruments, notably until now the 'Technical aid to the Commonwealth of Independent States' (TACIS) and Interreg, and from now on the European 'Neighbourhood and partnership instrument' (ENPI) including its crossborder element, aiming to use these instruments for projects which provide significant added-value.

The 'Northern dimension' aims at addressing the special regional development challenges of northern Europe. These include cold climatic conditions, long distances, wide disparities in standards of living, environmental challenges including problems with nuclear waste and waste water management, and insufficient transport and border crossing facilities. It is also intended to take advantage of the rich potential of the region, for example in terms of natural resources, economic dynamism, and a rich cultural heritage.

The 'Northern dimension' is intended to promote security and stability in the region as well as helping build a safe, clean and accessible environment for all the people in the north. It also has the objectives of addressing the challenges arising from uneven regional development, and helping to avoid the emergence of new dividing lines in Europe following EU enlargement.

With the enlargement of the EU on 1 May 2004 to include Estonia, Latvia, Lithuania and Poland, the importance of the 'Northern dimension' has increased considerably: eight EU Member States (Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden) surround the Baltic Sea, and the EU's shared border with Russia has lengthened significantly.

The four partners, the European Union, Iceland, Norway and the Russian Federation, have defined a comprehensive and open list of 'Northern dimension' actors.

The participants:
- The regional councils in the north: The Barents Euro-Arctic Council (BEAC), the Council of the Baltic Sea States (CBSS), the Nordic Council of Ministers (NCM) and the Arctic Council (AC). All four northern regional councils, with their different memberships, identify needs for development and cooperation in their respective areas and support project implementation in different ways.
- The international financing institutions active in the north which contribute to supporting the policy, notably the European Bank for Reconstruction and Development (EBRD), the European Investment Bank (EIB), the Nordic Investment Bank (NIB) and the World Bank's International Bank for Reconstruction and Development (IBRD).
- European Union institutions, other than the Commission which participates as part of the EU delegation, and those of the other 'Northern dimension' partners.

Other actors: the regional and subregional organizations in the Baltic and Barents regions, the subnational (regional and local) authorities, non-governmental organisations and other civil society organisations (including notably indigenous peoples' organisations), universities and research centres, business and trade union communities, etc.

The 'Northern dimension' also provides a frame of reference for intensified transatlantic cooperation of its partners in matters concerning the northern regions of the world, through the observer status of Canada and the United States. Other interested countries may be invited to participate as observers.

Among the top priorities of the 'Northern dimension' framework we find:
- research, education and culture, including increased cooperation in research and education exchange programmes, youth policy, promotion of people-to-people contacts, links between cultural and economic life, visibility of regional and local cultural identity and heritage;
- environment, nuclear safety and natural resources, including reduction of the risk of nuclear and other pollution, maritime safety, protection of the marine environment in the Baltic and Barents Seas, biodiversity, forests, fish stocks and protection of the Arctic ecosystems, cooperation in the field of water policy, climate change, environmental legislation and administrative capacity building.

For further information on the 'Northern dimension', please visit:
http://ec.europa.eu/external_relations/north_dim/index.htm

EU research at the top of the world: Commissioner Potočnik visits the world's northernmost settlement

The European Science and Research Commissioner Janez Potočnik visited Svalbard in northern Norway from 4 to 6 July 2007 as part of IPY. During the visit which took place at the invitation of the Norwegian research minister the Commissioner participated in a discussion with students taking part in EU projects, visited Polish research vessel* Oceania*, radar facility studying the interaction between the Earth and the Sun and the European Centre for Arctic Environmental Research. The Commissioner was accompanied by members of his cabinet and Manuela Soares, Director of the Environment Programme.

The research going on there, by such dedicated and enthusiastic people from across the world, is fundamentally important for the rest of us. Svalbard really is a unique natural laboratory, not only in terms of the science being done there, but for the way in which it brings together scientists from across the world and connects them. The trip not only confirmed that climate change is a reality and one we need to deal with sooner rather than later, it also showed that science really does reach across national and political borders and bring people together.

– *Svalbard* consists of a group of islands and is the northernmost part of the Kingdom of Norway. The Svalbard Treaty recognises Norwegian sovereignty over Svalbard. With the 1925 Svalbard Act, Norway chose to make Svalbard a part of the kingdom, and it remains one of four special entities whose status is recognised by international treaty in the world today.

The Svalbard archipelago is a unique research platform in the European Arctic with its easy accessibility and well developed infrastructure, despite of its remote high latitude location. It is the best equipped Arctic research platform in the world with a very favourable geographical location for research within upper atmosphere and space physics, biology, geology and geophysics, in particular environmental research such as climate change, long-range transportation of pollutants, ecology and ocean-atmosphere interactions.

Global warming with increased climate variability, stratospheric change and the long-range transported contaminants represent multiple challenges to Arctic ecosystems that add to the harsh environments with large natural variability. This is due to the fact that these key environmental factors are amplified in the Arctic, forced by natural and anthropogenic variability.

Svalbard was used as a research platform already under the first IPY (1882/83) and during the 'International Geophysical Year' (1957/58).

– *Longyearbyen* is the administrative centre of Svalbard and has approximately 1 800 inhabitants. Research activities and tourism are growing steadily each year due to its excellent infrastructure. The research infrastructures include the following.

- One of the European Incoherent Scatter Scientific Association (EISCAT) radars to study the interaction between the Sun and the Earth as revealed by disturbances in the ionosphere and magnetosphere. EISCAT is funded and operated by the research councils of Finland, France, Germany, Japan, Norway, Sweden and the United Kingdom, and receives also support from FP6.
- The University Centre in Svalbard (UNIS) opened in 1993. It is a cooperation of all four Norwegian universities which provides lectures in geophysics, Arctic biology, geology and Arctic technology as well as Bachelor, Master and PhD positions. All in all it has about 300 students, but these numbers will increase with the opening of the new research centre.

European Science and Research Commissioner Janez Potočnik (right) and Norwegian Education and Research Minister Øystein Djupedal on board the '*Oceania*' research ship, part of the EU Damocles project, Svalbard

– *Ny-Ålesund* is the world's northernmost functional public settlement. Today, it is inhabited by a permanent population of approximately 30 to 35 persons all working for one of the research stations. The Norwegian stateowned company Kings Bay AS owns the land and most of the infrastructure in Ny-Ålesund. The main activities carried out are related to climate research and environmental monitoring.

Designated by the Norwegian authorities to be a green scientific station, where scientists should get access to a near pristine environment and where local pollution is kept at a minimum, Ny-Ålesund is also characterised as being a 'radio silent area', permitting the effective use of passive receiving equipment.

Today 12 research institutions are established in Ny-Ålesund representing nine different countries: China, France, Germany, Italy, Japan, the Netherlands, Norway, South Korea, Sweden and the United Kingdom. Four of the stations are manned all year round. The German institute for polar and marine research, Alfred-Wegener-Institut (AWI), and the French polar institute, Institut Paul Émile Victor (IPEV) act as a joint research platform for scientists from both countries, Awipev. The bulk of year-round observation is dedicated to the global Network for the Detection of Atmospheric Composition Change (NDACC). The platform is run as a comprehensive base for a large spectrum of polar research with many long-term projects, notably in atmospheric sciences.

An Arctic marine laboratory is run by Kings Bay AS. This experimental laboratory is ideal for researchers in marine ecology, physiology and biochemistry as well as some physical sciences like oceanography, marine geology and ice physics. Proper lab facilities are offered with system-control of experimental variables like temperature and salinity and good facilities for carrying out experiments under ambient conditions (e.g. ambient seawater and light). The marine lab contains some basic equipment and instruments.

The Norwegian Institute for Air Research (NILU) runs a year-round comprehensive atmospheric monitoring programme for pollutants and influences on climate from the Norwegian Polar Institute's (NPI) Zeppelin station situated at 473 m on the Zeppelin mountain. The monitoring programme

continued on page 18

continued from page 17 **'EU research at the top of the world: Commissioner Potočnik visits the world's northernmost settlement'**

is maintained in close collaboration with Stockholm University, Sweden.

The Norwegian Polar Institute's (NPI) Sverdrup station has a permanent staff of four engineers and technicians, increased during summertime. The staff is responsible for maintenance of the equipment and the continuous operation of instruments for a range of scientific projects. NPI offers services for national and foreign research institutions.

- *The FP6 project 'Developing Arctic modelling and observing capabilities for long-term environmental studies*" (DAMOCLES) hosted many activities on Svalbard, at the time of the Commissioner's visit, which are reported below.

- Sea ice plays a very active role in the Earth's climate system and reacts rather rapidly to climatic changes. To reflect the recent progress in our understanding of sea ice and its interaction with the ocean and the atmosphere, an 'International sea ice summer school' was organised between 2 and 13 July 2007 to provide a platform for interdisciplinary exchange between students and scientists as part of the Outreach Programme of IPY. It is held in association with the University of the Arctic (UArctic) at UNIS.
- *R/V Oceania* is a large sailing research vessel (50 m) owned by the Polish Academy of Science and operated by the Institute of Oceanology in Sopot, Poland. The vessel undertakes a number of activities in the Arctic in the context of the DAMOCLES project, including plankton sampling, marine optics and acoustics.
- *Vagabond* is a small yacht (15.3 m) acting as a dedicated base camp for DAMOCLES, to study the Arctic Ocean sea ice and its future. The *Vagabond* crew will work with scientists on the east coast of Spitsbergen, Norway, between 2004 and 2008.

Based on a press release, MEMO/07/272.

For further information on Commissioner Potočnik's journey to Svalbard, please visit:
http://blogs.ec.europa.eu/potocnik/seeing-is-believing

For further information on the 'Svalbard science forum':
http://ssf.npolar.no/pages/start.htm

For further information on the 'International sea ice summer school':
http://www.seaice.info

For further information on 'R/V Oceania':
http://www.iopan.gda.pl/oceania/oceania.html

For further information on 'Vagabond':
http://www.vagabond.fr

European Commission President José Manuel Barroso and Danish Prime Minister Anders Fogh Rasmussen visit Greenland

Commision President Barroso said: 'Greenland is on the front line of the battle against climate change. It is experiencing dramatic effects already. We literally risk a meltdown if we do not act now, not just for Greenland but for Europe and the world. There is no substitute for seeing with one's own eyes. I want to learn as much as I can from this visit, to help me get across to others the message that climate change is a global problem that needs global solutions, not in 10 or 20 years' time but right now.'

© European Community, 2007

José Manuel Barroso and Anders Fogh Rasmussen

Climate change is higher than ever on the international agenda following the outcome of the G8 summit in Heiligendamm, Germany. Commission President Barroso recalls: 'The significant move of major emitters was helped by strong and united EU pressure. I am glad that all major greenhouse gas emitters will now support the UN climate process and signed up to seriously consider EU goals of at least halving global emissions by 2050. The G8 accepted the need for a global agreement by 2009. This commitment will bring considerable impetus to the UN climate change negotiations starting in December 2007 in Bali [Indonesia] and hopefully end with a global agreement on a post Kyoto framework in Copenhagen, Denmark, in 2009.'

During the visit, President Barroso also discussed with the Danish Prime Minister Anders Fogh Rasmussen and the Greenlandic Premier Hans Enoksen about the relations between the EU and Greenland, including economic issues, marine mammals and the EU's Arctic policy.

© European Community, 2007

View of Illulisat Fjord

The EU has many links to Greenland, including a comprehensive partnership agreement and a fisheries' agreement. Greenland is also a party to the 'Overseas territories and countries' (OCT) decision which covers territories and countries with special constitutional ties with EU Member States.

The meeting venue, Ilulissat, is well known for one of the most stunning and active glaciers in the world and is on the UN's world cultural heritage list. The effects of climate change will hit Greenland and the Arctic region faster and harder than elsewhere. But the rest of the world, including other parts of Europe, will also feel the effects of climate change, particularly as a result of a future rise in sea levels. Greenland is a 'living laboratory' for researchers on environment and climate change. This research will benefit Europe and the rest of the world.

Based on a press release, IP/07/855.

IPY-CARE: International Polar Year — climate of the Arctic and its role for Europe

Climate models show that global warming will continue and be enhanced in the northern high latitudes in this century. However, climate model predictions are more uncertain for the Arctic region compared to mid and low latitudes. During IPY it is of high priority to enhance climate data collection in polar regions. The goal of IPY-CARE project is to plan and implement joint European climate research in order to improve the predictability of climate in the Arctic region.

Project title

International Polar Year — climate of the Arctic and its role for Europe

Project acronym

IPY-CARE

Programme

FP6

Project type

Specific support action

Project start date

1.7.2005

Project duration

21 months

EU funding

EUR 395 000

Project coordinator

Ola M. Johannessen,
Nansen Environmental and Remote Sensing Center (NERSC), Norway

Partner countries

13

Partner institutions

19

Project website

http://www.ipy-care.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 77692 in the search window on the CORDIS website.

http://cordis.europa.eu

At the end of this century, the Arctic Ocean is predicted to be 'a blue ocean' during summer time with a mean air temperature that is 5 to 8 °C higher than today. This will influence biodiversity, the marine ecosystem and the regional climate in ways that are poorly known.

There is lack of understanding of the processes coupling the atmospheric boundary layer with sea ice, the water column and the marine ecosystems. Moreover, a change in the climate system will affect the physical properties of the air-sea interface and biological production, both influencing the driving forces of the air-sea exchange of carbon dioxide (CO_2). A shift in the ventilation of deep and intermediate waters will also change the transport and mixing of CO_2 from the surface to the deep waters, contributing to the sequestration of anthropogenic CO_2 — the extent to which is essentially unknown.

Arctic climate change has many severe impacts on environment and society, such as:

- marine ecosystems and fisheries will change with a warmer ocean;
- exploitation of hydrocarbon resources will be more feasible with a warmer climate and less sea ice;
- new sea transportation routes in the Arctic Ocean will open up with the retreat of sea ice in the summer;
- sea ice mammals will be severely affected by a reduced ice cover.

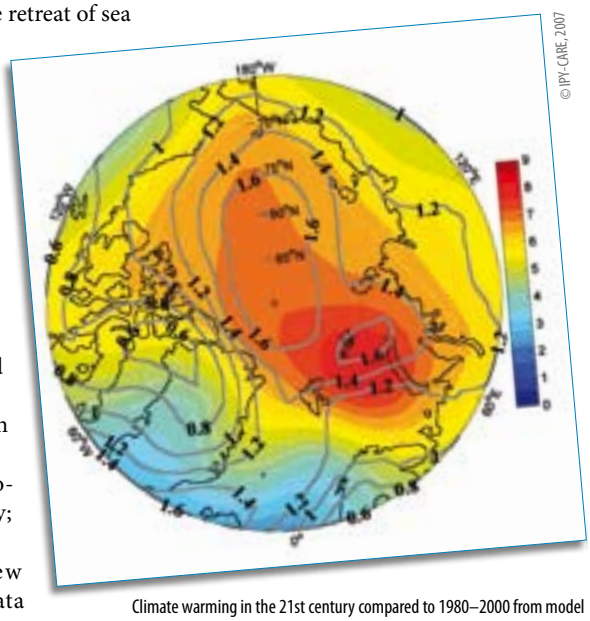
The aim of IPY-CARE is to coordinate and enhance European multidisciplinary research with focus on the following thematic areas:

- processes determining Arctic climate variability and changes;
- marine biological processes in response to climate change;
- air-sea-ice mesoscale processes and climate variability;
- past climate variability;
- remote sensing and new technology for climate data provision.

Arctic climate research activities include the following components:

- collection, analysis and harmonisation of historical and new modern data sets for atmosphere, sea ice, ocean and hydrology processes on land;
- development of new *in situ* observing systems for the ice-covered Arctic Ocean;
- planning, coordination and implementation of Arctic field experiments;
- use of satellite remote sensing observing systems and analysis of data from these systems;
- global climate models with improved parameterisation and validation;
- demonstration and use of new ice and underwater buoy technology for innovative data collection;
- exchange programmes for scientists and training for students;
- coordinated promotion and outreach activities;
- technology development and scientific service transferred to small and medium-sized enterprises (SMEs);
- modelling and prediction of the Arctic climate.

IPY-CARE has developed a multidisciplinary science plan, as well as an implementation plan based on funded IPY research projects downloadable from the project website.



Climate warming in the 21st century compared to 1980–2000 from model simulations. Contours lines are a measure of the accuracy of the predictions

DAMOCLES: Developing Arctic modelling and observing capabilities for long-term environmental studies

The main objective of DAMOCLES is to observe, identify, understand and quantify the ongoing climate changes in the Arctic sea ice, atmosphere and ocean circulation resulting from human activity.

Through such empirical analysis DAMOCLES will aim at developing and operating a long-term Arctic Ocean observing and forecasting system, enabling evaluation of global and regional climate forecasting models based on validation, assimilation and integration of the data collected.

This is an ambitious challenge facing scientists, as gathering data in the harsh Arctic environment is extremely difficult. While the researchers will use existing sources such as satellites, they will also be developing innovative technologies to obtain data on the ice, ocean and atmosphere in the far north.

A major priority for the project is developing techniques to measure the thickness of the ice. There is a need to understand why sea ice is changing, or if the multi-year ice is going to melt away and be replaced by first-year ice. For this, new technology is required to measure the ice thickness, more than the ice extent.

The ultimate goal is to lengthen the lead-time of extreme climate changes predicted to occur in the Arctic within this century, and thus have the possibility of preparing for its impacts.

The DAMOCLES project will therefore provide a substantial step forward from the present state-of-the-art by:

- improving monitoring capabilities of the Arctic Ocean, sea ice and atmosphere through innovative technological advances;
- increasing the understanding of Arctic Ocean sea ice interaction with the ocean and the atmosphere in the northern hemisphere climate system;
- improving the data transfer from instruments to users, in near real time;
- contributing to the development and implementation of observing and forecasting systems to make long-term systematic observations of marine and atmospheric parameters of the Arctic environment necessary for management strategies in the context of global change;
- improving significantly the ability to predict extreme climate events in the Arctic, such as the disappearance of the perennial ice cover and its consequences;
- improving the knowledge of the adaptive capacity and vulnerability of human activities in the case of extreme climate events, thus enhancing the EU's preparedness in environmental and societal terms.

Project title

Developing Arctic modelling and observing capabilities for long-term environmental studies

Project acronym

DAMOCLES

Programme

FP6

Project type

Integrated project

Project start date

1.12.2005

Project duration

48 months

EU funding

EUR 16 522 614

Project coordinator

Jean-Claude Gascard, Université Pierre et Marie Curie (UPMC), France

Partner countries

13

Partner institutions

49

Project website

http://www.damocles-eu.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 78411 in the search window on the CORDIS website.

http://cordis.europa.eu

SEARCH FOR DAMOCLES

In October 2006, the FP6-funded specific support action (SSA) 'SEARCH for DAMOCLES' brought the American scientists of the 'Study of environmental Arctic change' (SEARCH) programme together with the EU scientists from DAMOCLES. SEARCH is the United States equivalent of the European DAMOCLES project.

'SEARCH for DAMOCLES' is a joint initiative for the development of Arctic Ocean long-term observing and forecasting systems, infrastructure and data management in order to explore opportunities and potential benefits to coordinate these two large research programmes and to organise common workshops and international conferences.

The coordination and synchronisation of such research actions through a SSA, is a unique opportunity to ensure the necessary pan-Arctic coverage of observations and data evaluation for understanding Arctic system variability, avoiding major gaps and unnecessary overlaps.

Specific support action

SEARCH for DAMOCLES (Study of environmental Arctic change - Developing arctic modelling and observing capabilities for long-term environmental studies)

Programme

FP6

EU funding

EUR 605 000

DAMOCLES mobile exhibition

The Arctic Ocean has recently been projected into the centre of the world stage with news stories on the loss of the Arctic ice and its consequences for humanity, not only in terms of the impact on climate, but also with regard to the effect on the commercial activities in the north. There is growing public interest about the Arctic, this mysterious frozen ocean of the north.

The DAMOCLES mobile exhibition, put together by the International Polar Foundation (IPF) and the Atelier Brückner, showcases what the DAMOCLES project is doing in the Arctic and why — namely seeking to throw light on the interactions between Arctic Ocean, ice and atmospheric mechanisms and how they influence climate.

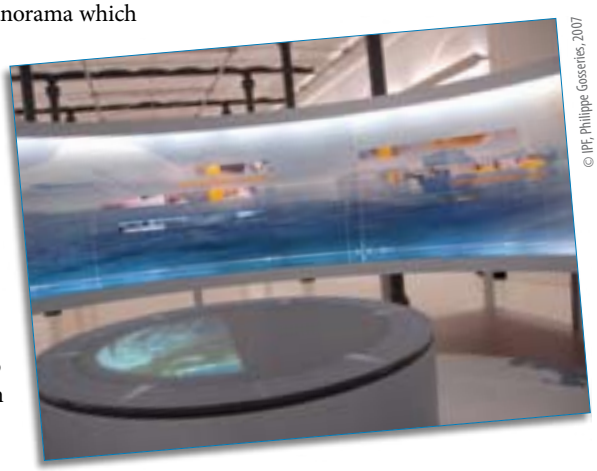
The exhibition was inaugurated at the Royal Belgian Institute of Natural Sciences in Brussels, Belgium, where it was on display from 5 to 15 March 2007. Several other cities will host the exhibition, including Copenhagen (Denmark), Berlin (Germany) and Frascati (Italy), where the exhibition was on display at the European Space Agency (ESA) during their 'Science week' in September 2007.

The exhibition consists of a large hollow square structure, which reveals its many surprises gradually to the visitor. There are three layers of introduction into the Arctic universe. Beginning with the aesthetic and the intuitive visual aspects, the visitor is confronted with a wide panorama of a fantastic Arctic landscape. This in turn draws the eye towards the observation slits in the panorama which reveal the dynamic history of the Arctic basin, and man's relationship with this through the wide spectrum of scientific research that is being conducted there under extreme conditions, provoking the question of what exactly the Arctic means to the rest of the world, and ultimately why we need to observe and understand it. Answers to these questions are provided on the outside of the box.

In the middle of the installation lies an interactive desk, where the north becomes the centre of the world and where the dynamics of the Arctic system are demonstrated using the visual images generated by mathematical models.

For further information, please visit:
http://www.polarfoundation.org
http://www.atelier-brueckner.de

To view the introductory film on the DAMOCLES exhibition, please visit:
http://www.polarfoundation.org/index.php?/damocles_exhibitions_introductory_film/&s=no&puid=596&uid=551&lg=en



© IPF, Philippe Gosseries, 2007

'Tara' and 'Vagabond': the ships for DAMOCLES

As an example of numerous field work activities in the Arctic contributing to DAMOCLES, two ships wintering on sea ice,* Tara *and* Vagabond*, are being used as science platform.

© Francis Latreille / Tara Expeditions.org 2007

Tara

Two years in the heart of the Arctic Ocean to study and understand climate change phenomena in the higher latitudes. Since September 2006, *Tara* has been anchored in the Arctic pack ice and it will be delivered from it nearly 18 months after a 1 800 km drift.

The main objective of *Tara* is to reduce the uncertainty in our understanding of climate change in the Arctic concerning sea ice cover, atmospheric key process and ocean circulation in order to improve our capability in simulating environmental change. This research will permit a better evaluation of the socio-economic impacts of a drastic retreat of the Arctic perennial sea ice cover, or even its disappearance in the near future. And through an ambitious educational programme, it is also an opportunity to coordinate dissemination of scientific data collected during the whole IPY.

During its 18 months drift among Arctic pack ice, *Tara* is the spaceship of the DAMOCLES observing system, in charge of collecting data related to sea ice, atmosphere and ocean. Its location, in the heart of the Arctic Ocean allows servicing of a sophisticated autonomous buoys web, disseminated in a 500 km range around the ship. Since September 2006, *Tara* has drifted at an unexpectedly high speed across the Arctic Ocean (on average 100 km per month during the first eight months).

With her rounded and flat hull, *Tara* can be embedded in the ice and withstand the extreme pressure that the Arctic pack ice exerts on her. At the crossroads between science, technology, education and communication, *Tara* offers a great human adventure whose goal is to heighten the awareness of world citizens on the importance of the Earth's ecological equilibrium. During the whole of IPY, *Tara* will serve as a central platform for research and communication not only for the scientists, but also for opinion leaders, political leaders, artists and polar explorers.

Vagabond, a 15.3 m long expedition yacht designed for sailing in ice, is a dedicated base camp for DAMOCLES in Storfjord, East Spitsbergen, Svalbard. For two years, the crew will test most of the new technology for DAMOCLES, before sending these instruments to the Arctic Ocean. The 'Vagabond Arctic camp' is also involved in many outreach and educational activities. In July 2007, in the heart of IPY, *Vagabond* achieved her third wintering in fast ice.

For further information, please visit:
http://www.damocles-eu.org
http://www.taraexpeditions.com
http://www.vagabond.fr

© Eric Brossier, 2007

Vagabond

DAMOCLES researcher interview

Recently **SciencePoles** *interviewed Dr Ralf Döscher, Senior Researcher in Ocean and Climate Modelling at the Swedish Meteorological and Hydrological Institute's Rossby Centre (SMHIRC). Dr Döscher is also a project coleader in charge of numerical modelling for the DAMOCLES project and was willing to tell us a bit about the kind of work he was doing within the project.*

Could you describe what exactly your duties as a project coleader of the DAMOCLES project include?

I coordinate numerical modelling activities within DAMOCLES. During the set-up phase I was responsible for constructing the work plan for the project. Now that the project is underway I oversee modelling activities and try to identify possible synergies out of the combination of the activities of the different groups modelling. Furthermore, I network and manage collaborations with external groups from Canada, Russia, the United States, and possibly Asia.

How did you become involved with the DAMOCLES project?

At SMHIRC where I work, we focus on regional climate modelling. Initially we concentrated only on northern Europe. We developed models aimed at describing and predicting the behaviour of the ocean, sea ice and the atmosphere. Integrating these different models can help to determine and predict the interaction between the ocean, ice and the atmosphere.

Dr Ralf Döscher

Both research institutes and meteorological services in regions outside of northern Europe have become interested in using these integrated models. Recently we started applying our regional simulation tools for the Arctic, and when DAMOCLES was initiated, the project found the kind of models we provide to be very useful.

Which natural phenomena are you currently trying to model within the DAMOCLES project? What is the significance of these phenomena you are trying to monitor and how might these models be of use?

We try to model variability of the Arctic Ocean-ice-atmosphere system together with the recent trend in diminishing Arctic sea ice cover. Both are results of complex interaction between large-scale changes and Arctic responses to these changes. Even regional interaction within the Arctic plays a role. Examples of important phenomena are the inflow of Atlantic and Pacific waters into the Arctic Ocean, and the relationship between ice cover and air humidity. As a result of our studies, we expect to obtain a better understanding of relevant mechanisms in the Arctic so that we can improve the models we use to simulate recent and future changes. This is expected to result in reducing uncertainties in modelling future climate change in the Arctic.

Climate scenarios are always uncertain due to unknown future greenhouse gas emissions, uncertainties inherent in models and natural variability. Two identical climate models starting from a slightly different initial conditions (start fields) may after a while diverge and give different results over a period of a few years or even decades. Therefore, many runs of the model using different levels of greenhouse gas emissions and different decadal-scale behaviour are necessary in order to collect adequate statistical data on the future of climate change. The better formulated the model and the smaller the uncertainty due to the model, the better the statistical data.

Do you think these models have the potential to evolve or change as new data are received, or are they relatively solid?

Most of the model components are robust with respect to the phenomena they try to describe and do a good job of predicting from a seasonal to a ten-year timescale. Models of ice cover in the Arctic Ocean can simulate the reduction of the actual extent of sea ice in the 1990s quite well. However it is necessary to improve important details of the model concerning the interaction between the ocean, the ice and the atmosphere in the Arctic, such as radiation, the reflection of sunlight by the ice — albedo feedback — and the relationship between atmospheric turbulence and the formulation of clouds. Such improvements are needed in order to simulate longer-term variability and to enable more realistic coupled ocean-ice-atmosphere simulations.

Coupled models (models that integrate two or more standalone models describing a particular aspect of the climate) are particularly sensitive. Coupling standalone models adds complexity to the simulated system, and can make validation with observational data more difficult. Coupled models are more sensitive than standalone models because energy is exchanged between the systems described in the component standalone models, and sometimes the energy release might 'fit' into one standalone model but not the other. This problem stems from the fact that oceanic and atmospheric models are often developed independently of one another. Each model works fine on its own, but when you couple them together complications arise.

For example, a model of atmospheric behaviour might be able to describe a heat flux from the atmosphere to the ocean. This [fits] the model of the atmosphere, but it might be too high for the model of oceanic behaviour. If no oceanic model is coupled to the atmospheric model, this problem is not directly relevant. However if the two models are coupled, then things become more complicated.

How do you go about creating computer models of natural phenomena you are trying to monitor and predict?

The computer models we use are based on well-known natural laws governing the circulation of water and air. These laws

continued on page 23

continued from page 22 **'DAMOCLES researcher interview'**

describe, for example, temperature change depending on the speed and direction of water and wind within a given time. However, these natural laws tend to be highly non-linear. This means that it becomes difficult or even impossible to predict what can happen after a certain given time.

A good analogy would be the movement of billiard balls on a billiard table. The physical laws describing the pathways the balls can take once set in motion are known, yet after a number of collisions, small irregularities on the surface of the table make it impossible to predict the exact movement of each ball.

The irregularities one encounters in Arctic Ocean and atmosphere modelling correspond to less well-understood processes such as cloud formation, sea ice behaviour and driving forces. In weather forecasting, this makes it impossible to make accurate predictions for longer than seven days. This does not mean that more general climate situations cannot be simulated, however.

Is there anything in particular you must take into account?

Climate simulation models have underlying non-linearities, which means that there will be variations in the climate scenarios we try to predict. Often these variations naturally occur in ice-albedo feedbacks, atmospheric circulation and feedbacks between surface ice and snow, but not necessarily at the time predicted by the model. Even nature is 'uncertain' as to whether to favour the one type of variability over another, because the 'choice' depends on the difficult-to-predict outcome of a 'competition' between different non-linear processes. Put simply, the Arctic climate is predictable only within certain limits.

In the Arctic, natural developments could for example lead to an anomalous ten-year period. It might be possible to simulate this anomalous period with a model, however the time frame might be staggered. To make things even more complex, Arctic variability is affected by large-scale changes. Changing atmospheric circulation patterns can trigger changes in the Arctic that create new initial conditions and restart the whole 'competition' between different non-linear processes.

The modelling work in DAMOCLES focuses on quantifying this kind of predictability, both the natural and the computer-generated components. Therefore we try to assess the sensitivity of the coupled system with respect to both initial conditions (start fields) and the physical description of non-linear processes. The former allows us to approach natural predictability while the latter gives us insight into the limits of our understanding.

Simulating regional Arctic climate with models allows us to assess the part of Arctic climate variability generated inside the Arctic coupled system. Simulation experiments with only slightly different initial conditions (start fields) can lead to notably different end scenarios (particularly ice thickness and air temperature) within certain periods of time, while many runs of the models can result in similar end scenarios during other periods. Similarities and differences between models indicate there are most likely externally driven or regionally generated processes. It is even possible that thresholds (bifurcation points) are passed, which can lead to different end scenarios.

Do you sometimes get drastically different results using the same model? If so, why?

Results are often different due to internal Arctic variability. Especially in fully coupled models, results can be drastically different for individual years due to non-linear interactions between the individual phenomena that make up the coupled system. This behaviour is not purely due to model inadequacies. Partly it is a reflection of natural sensitivities. This is known as the 'butterfly effect', in which small changes at one point in the process can sometimes lead to drastically different effects as the model continues to run.

Do you try different models when you are trying to predict the same climate phenomena?

In DAMOCLES we use a hierarchy of models to cover many aspects. As far as general circulation models are concerned, we use different models as well as different versions of otherwise identical models to cover predictability. Often this approach of using many model runs and compiling statistics on the results is called an 'ensemble' approach.

One of the main goals of the DAMOCLES project is to have better predictability of Arctic weather and climate. How would you judge the progress that has been made thus far in this regard?

We are just beginning. So far there has been a lot of setup work and sensitivity experiments. The weather forecast models aim at better prediction capabilities using extended data assimilation. The first improved ice forecasts are already available and the first results concerning climate predictability are expected by the end of this year. The climate models' capabilities are developed with the help of sensitivity experiments.

We expect to obtain major improvement of model performance by comparing the results our models predict with observations conducted within the context of IPY.

We can use observed data and assimilate it into our models, and the models can be used to fill observational gaps. This is known as data assimilation. This can be done without violating the basic dynamics of the model. The resulting fields, often called 'reanalysis', can be considered the best possible overall description of the recent behaviour of the ocean and the atmosphere in the Arctic. These reanalysis fields can be compared with the results obtained purely from the model in order to judge the performance of the model vis-à-vis the physical reality.

Source: SciencePoles website
http://www.sciencepoles.org
International Polar Foundation
http://www.polarfoundation.org

GLIMPSE: Global implications of Arctic climate processes and feedbacks

The main goal of the GLIMPSE project is to address the deficiencies in our understanding of the Arctic climate by developing improved physical descriptions, understanding and parameterisations of regional Arctic climate feedbacks in regional climate models in concert with the 'Arctic regional climate models, intercomparison' (ARCMIP) project.

The work quantified the performance scores of eight individual Arctic regional atmospheric models for the small Sheba sub domain and of three Arctic regional atmospheric models for the pan-Arctic GLIMPSE domain, and the scatter among them. The results show differences in the individual performances and considerable scatter among the different models. The results for the pan Arctic domain simulations emphasise the large influence of the domain size on the simulation results.

The seasonal large-scale flow patterns are reproduced remarkably well by the model ensemble. The across-model scatter in the 2 m air temperature for the Sheba sub domain is significant and is large over land areas (1 to 5 °C). While the near-surface variables (temperature and winds) were similar between the various models and Sheba observations, all of the models underpredicted the liquid water path in winter, resulting in a substantial negative bias in the downwelling infrared radiative flux at the surface. Through the aerosol radiation-circulation feedback, the scattering and absorption of radiation by aerosol cause pressure pattern changes which has the potential to modify Arctic teleconnection patterns like the Barents sea oscillation.

Three coupled regional atmosphere-ocean model systems of the Arctic have been applied in decadal scale simulations, and tunings and modifications have been done with the goal of reaching a stable system with a more realistic simulation of the present Arctic climate. The simulations on atmospheric variability and global impact of improved ice albedo schemes have been completed, using an improved albedo scheme which had been implemented into the global climate models ECHO-G and Echam4/OPYC. There is a strong need for further improvements in the physical parameterisation and the coupling processes.

In order to study the effect of climatic variability and climatic change on the ecosystem in the seasonal ice zone, an established ecological model coupled to a hydrodynamic-ice model of the Arctic Ocean and the Nordic seas was used. The atmospheric inputs for the lower and lateral boundary conditions are from IPCC B2 scenario simulations with Hirham4 for two time slices choosing negative and positive phases of the 'North atlantic oscillation' (NAO) index. The model does not show any differences in primary production in the Nordic seas as a consequence of different phases of NAO. The winter NAO index has no significant effect on the primary production in the Nordic seas. Wind and heat flux during the productive season from April to September are much more important for primary production bringing up nutrients into the euphotic zone.

Project title

Global implications of Arctic climate processes and feedbacks

Project acronym

GLIMPSE

Programme

FP5

Project type

Research project

Project start date

1.11.2002

Project duration

36 months

EU funding

EUR 1 149 535

Project coordinator

Klaus Dethloff,
Alfred-Wegener-Institut (AWI) für Polar- und Meeresforschung,
Germany

Partner countries

4

Partner institutions

7

Project website

http://www.awi-potsdam.de/www-pot/atmo/glimpse

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 64922 in the search window on the CORDIS website.

http://cordis.europa.eu

GREENICE: Greenland Arctic shelf ice and climate experiment

The aim of the GREENICE project was to study the structure and dynamics of the sea ice cover in a critical region of the Arctic Ocean, north of Greenland, and to relate these to longer-term records of climate variability retrieved from sediment cores. This thick and heavily deformed ice prevents access by even the most powerful icebreakers and has resulted in an almost complete lack of ice, ocean or geological data from the region.

Fieldwork in 2003 aimed at trialling systems and methods for the main ice camp the following year. Efforts centred on the Alfred Wegener Institut (AWI) vessel *Polarstern*, specifically during a two-week period when it was moored to a drifting ice floe in the Yermak Plateau area. Aerial campaigns were conducted with the AWI helicopter-borne electromagnetic induction system (HEM) and the Kort & Matrikelstyrelsen (KMS) swath laser profilometer, mounted on a Twin Otter aircraft. Activities on the ship included intensive ground-truthing using *in situ* thickness measurements, both by drilling (ice augers, hot water drill) and sledge-borne electromagnetic induction system (EM). The drift also allowed the development of thickness monitoring buoys based on the measurement of the spectrum of flexural-gravity waves in the ice. Concurrent data were obtained from an ice camp (APLIS) north of Alaska, providing long-range comparisons of waves necessary for testing the buoy concept.

In 2004 the project team installed and occupied an ice camp in the Lincoln Sea, north of Greenland, using Twin Otter aircraft. The camp was a novel, low-cost, lightweight effort, which provided an excellent platform for science in this otherwise inaccessible region. The activities included geological investigations of the seabed and sub-seafloor, a coordinated aerial thickness measurement campaign, *in situ* measurements of ice thickness and properties, and the deployment of an array of buoys designed to measure both path-integrated ice thickness and drift, hence deformation over the lifetime of the project and beyond.

The opportunity was taken to repeat the HEM and laser measurements north of Alert, Canada, with a limited campaign in 2005 to examine temporal as well as spatial ice thickness variability in the region.

The gravel-rich nature of the seabed prevented many samples from being obtained, but seven cores were obtained in all, of which two proved to be very high quality. The cores contained high abundances of sub-polar plankton species which suggest that the study area was ice-free during the last interglacial. This is a striking result, since at present the study area is heavily ice-covered, and forecast models of future shrinking Arctic sea ice cover suggest that this area is one of the least sensitive to warming in the Arctic. The geological results obtained from the GREENICE project challenge this view.

The HEM system was used extensively during the project to map the spatial variability of ice thickness in Fram Strait (2003) and in the Lincoln Sea. GREENICE demonstrated that the airborne laser scanner measurements are an effective way to measure sea ice thickness and freeboard over large scales (100 to 1 000 km).

Polarstern

Project title

Greenland Arctic shelf ice and climate experiment

Project acronym

GREENICE

Programme

FP5

Project type

Research project

Project start date

1.12.2002

Project duration

42 months

EU funding

EUR 1 842 255

Project coordinator

Peter Wadhams,
University of Cambridge,
United Kingdom

Partner countries

5

Partner institutions

7

Project website

http://www.greenice.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 67521 in the search window on the CORDIS website.

http://cordis.europa.eu

6C: Carbonate chemistry, carbon cycle and climate change

Among the most important challenges remaining to be addressed by Quaternary palaeoceanographers is the mechanism responsible for lowering partial pressure of carbon dioxide (pCO2) during the last glacial maximum (LGM) and possible feedback mechanisms with climate change. The 6C project set out to try a novel approach to tackle this question.

The reason for public concern about uncontrolled release of carbon dioxide (CO_2) into the atmosphere is the notion that global climate and CO_2 concentration is closely linked to the geological record.

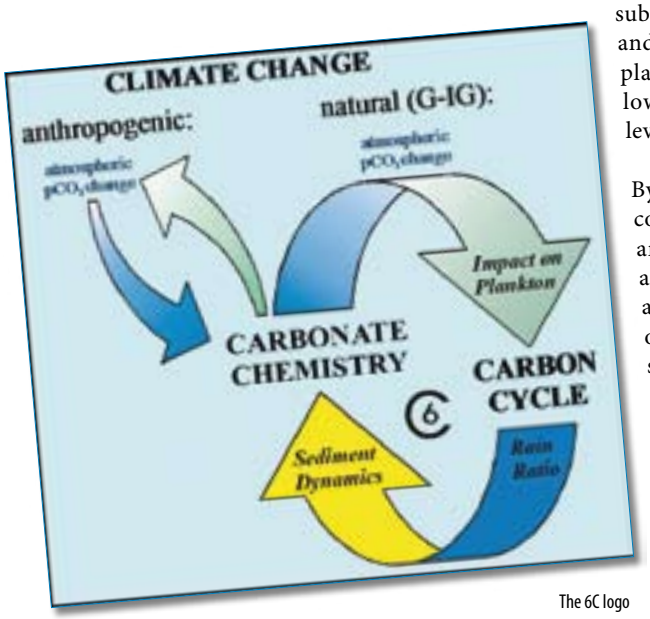
Clues for the underlying relationship between atmospheric pCO_2 and climate change have to be sought after in the ocean. Because the oceanic carbon reservoir is much larger than that of the atmosphere, the atmospheric concentration of CO_2 is determined by the amount of CO_2 dissolved in the surface waters of the world ocean. The processes that control the carbon content in the ocean are traditionally referred to as 'carbon pumps', because carbon is pumped from the surface water to the deep sea. Several such pumps operate in the ocean and are controlled by physical, chemical or biological processes.

To reconstruct the efficiency of these processes over geological time, palaeoceanographers investigate sediment cores. These cores have archived the ocean history, like pages in a book. What needs to be known is where the information is stored and how it has to be translated. Among the most powerful information carriers are some tiny organisms that are part of the so-called plankton that drifts in the surface waters of the ocean: foraminifera.

Planktonic foraminifera are unicellular organisms that produce carbonate shells. The elemental composition and isotopic ratios of the shells are determined by environmental conditions such as water temperature, the pH, nutrients, etc. At the end of their life cycle, the shells rain down onto the ocean floor and become part of the geological archive. Thousands or millions of years later, geochemists can extract the information recorded in the shells (termed 'proxies').

Several scenarios have been proposed to explain the glacial to interglacial (G-IG) pCO_2 change. Each of these requires a reorganisation of the carbon inventory of the ocean, leaving behind a specific fingerprint in the oceanic (carbonate) chemistry which is recorded by proxies. The researchers used a multiproxy approach to reconstruct the G-IG change in ocean parameters such as pH, $[CO_3^{2-}]$ and dissolved CO_2. In the Southern Ocean, cores from the South Tasman Rise (STR) were analysed. It was shown that surface water $[CO_3^{2-}]$ concentrations derived from shell weight variations were consistent with pH derived from their isotopic composition ($\delta^{11}B$). The calculated record of the difference between pCO_2 values in surface water and the atmosphere (as recorded in ice cores) indicates that the STR region was a sink for atmospheric CO_2 during the LGM, and that the magnitude of this sink was very much lower during the Holocene (i.e. the last 10 000 years). This supports the hypothesis that higher export production in the area between the sub Antarctic polar front and the subtropical front played a role in causing lower atmospheric CO_2 levels during the LGM.

By putting the different collected cores together, and applying regional and global modelling, a closer understanding of the natural relationship between the global carbon cycle and climate change was achieved, but much is still to be done.



The 6C logo

Project title

Carbonate chemistry, carbon cycle and climate change

Project acronym

6C

Programme

FP5

Project type

Research Project

Project start date

1.11.2002

Project duration

48 months

EU funding

EUR 1 652 751

Project coordinator

Jelle Bijma,
Alfred Alfred-Wegener-Institut (AWI) für Polar- und Meeresforschung, Germany

Partner countries

4

Partner institutions

11

Project website

http://www.awi-bremerhaven.de/Projects/C6/index.html

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 64900 in the search window on the CORDIS website.

http://cordis.europa.eu

CARBOOCEAN: Marine carbon sources and sinks assessment

CARBOOCEAN aims at improving the assessment of the marine uptake and fate of anthropogenic carbon in the ocean. CARBOOCEAN is carrying out field measurements to analyse and predict marine uptake of man-made carbon dioxide (CO_2) emissions.

Anthropogenic carbon is taken up by the oceans through air-sea gas exchange at the sea surface. The excess carbon is transported down to deeper layers by ocean circulation and mixing especially in the high latitude oceans, where surface water is cooled and enriched in salinity during sea ice formation. This transport process is considered the bottleneck for marine CO_2 uptake. The potential reduction in deep-water formation anticipated for a slowing down of the oceanic meridional overturning circulation would narrow this bottleneck and lead to a positive feedback of the ocean carbon cycle to atmospheric CO_2, though the biological organic carbon pump itself would work a bit more efficient during a slowing down of the general circulation. During CARBOOCEAN, a decrease in the northern North Atlantic air-sea difference in CO_2 partial pressure has been observed, implying a possibly ongoing slowing in total CO_2 uptake kinetics in the area. Water which is already saturated with respect to anthropogenic carbon will flow into the Arctic Ocean. Reduced deep water production rates due to a retreat of sea ice away from shelf seas, a reduction in general ocean overturning, and an increased advection of already CO_2 saturated water from lower latitudes may contribute to an accelerating positive feedback to climate change. The Southern Ocean represents a very large volume of sea water and hence also a large inorganic carbon inventory and recent evidence for a decrease in anthropogenic CO_2 uptake has also been found.

Uptake of anthropogenic CO_2 by the oceans is continuously leading to a change in the slightly alkaline ocean towards more acidic conditions (i.e. the anthropogenic CO_2 in the ocean causes the marine pH value to sink). Due to the temperature dependency of the marine inorganic chemistry system and the vertical mixing at high latitudes, the pH decrease in surface as well as deep waters is first seen at high latitudes. While the occurrence of ocean acidification is virtually certain, estimating the potentially consequences for marine ecosystems has only just begun. These consequences will also be most severe at high latitudes where the pronounced seasonal cycle can in addition lead to high amplitudes in surface ocean CO_2 concentration and pH with associated extreme values. Results on the impact of ocean acidification on marine ecosystems as derived from the CARBOOCEAN mesocosm study (controlled ecosystem experiments carried out in big plastic containers within natural seawater) are currently being published.

In order to make a reliable prediction of the anthropogenic carbon sinks at high latitudes and the impacts as well as feedbacks due to ocean acidification, rapid understanding of the associated processes for respective implementation in coupled physical-biogeochemical climate models is needed. More time series stations for measurements of physical, chemical and biological variables would be of vital importance to watch the ongoing changes and to calibrate models for more reliable predictions in the quickly changing polar regions.

© Leif G. Anderson, University of Gothenburg, Sweden, 2007

Project title

Marine carbon sources and sinks assessment

Project acronym

CARBOOCEAN

Programme

FP6

Project type

Integrated project

Project start date

1.1.2005

Project duration

60 months

EU funding

EUR 14 499 600

Project coordinator

Christoph Heinze,
Bjerknes Centre for Climate Research (BCCR), University of Bergen, Norway

Partner countries

14

Partner institutions

45

Project website

http://www.carboocean.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 80821 in the search window on the CORDIS website.

http://cordis.europa.eu

CARBO-North: Quantifying the carbon budget in northern Russia — past, present and future

CARBO-North addresses an important component of the Earth system. The northern tundra regions are characterised by low vegetation and frozen grounds due to the prevailing low annual temperatures. The tundra vegetation of dwarf shrubs, herbs, mosses and lichens has a low biomass compared to forest areas, but the amount of organic material stored underground is very large as cold conditions have prevented the decomposition of dead plant material. It is estimated that the northern permafrost soils contain more carbon than all forest biomass on Earth together. Furthermore, a significant portion of this organic material is frozen. Tundra wetlands are also an important source of the potent greenhouse gas methane.

CARBO-North aims at quantifying the carbon budget in northern Russia across temporal and spatial scales. Activities address rates of ecosystem change, effects on the carbon budget, and global climate and policy implications. How quickly will the Arctic treeline migrate? How quickly will permafrost thaw? How quickly will enhanced soil organic matter decay result in increased greenhouse gas emissions and leaching? A northward shift of the Arctic treeline would represent a temporary carbon sink (until new forests reach equilibrium with climate and become fully mature) and, therefore, a negative feedback to global warming. At the same time it would cause a permanent decrease in surface albedo, a positive feedback. High latitude terrestrial ecosystems are important reservoirs of soil organic matter. An as of yet not accurately determined proportion of this carbon pool is located in permafrost terrain. Very limited research has been conducted on below-ground organic matter quality, with poor understanding how climatic and permafrost conditions affect its susceptibility for decay. Global warming and permafrost thawing will affect surface hydrology and drainage patterns. Increased soil leaching and river export could play an important role in the future regional carbon budget.

The CARBO-North project will produce regional carbon budgets for northern Russia for successive time slices of the 21st century (and beyond) that are used to calculate changes in net radiative forcing and effects on future global climate predictions. Through a comparison of regional carbon budgets under past and recent natural climate variability with future 'transient' and 'equilibrium' responses under global warming, an attribution of the relative importance of anthropogenic climate change and natural variability can be made. Results will aid EU policy-makers to adjust criteria in greenhouse gas emission reduction targets.

The CARBO-North consortium is a multi-partner project with the coordinator based at Stockholm University, Sweden. A first fieldtrip was succesfully conducted in April 2007 as well as multiple field activities during the summer of 2007.

An important component of CARBO-North is outreach activities. Two small enterprises, one in western Europe and one in Russia, are part of the project. Their aim is to promote a greater public understanding of the significance of global warming impacts and human-induced and natural disturbances on sensitive ecosystems in the 'remote and frozen Russian North', which clearly have global implications in terms of future climate predictions and policy decisions.

© P. Kuhry, Stockholm University, Sweden, 2007

Project title

Quantifying the carbon budget in northern Russia — past, present and future

Project acronym

CARBO-North

Programme

FP6

Project type

Specific targeted research project

Project start date

1.11.2006

Project duration

42 months

EU funding

EUR 3 099 822

Project coordinator

Peter Kuhry,
Stockholm University, Sweden

Partner countries

7

Partner institutions

16

Project website

http://www.carbonorth.net

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 81391 in the search window on the CORDIS website.

http://cordis.europa.eu

CARBOEUROPE: Assessment of the European terrestrial carbon balance

The key innovation of CARBOEUROPE is to solve the scientific challenge of quantifying the terrestrial carbon balance at different scales and with known, acceptable uncertainties. The increase in spatial and temporal resolution of the observational and modelling programme will, for the first time, allow a consistent application of a multiple constraint approach of bottom-up and top-down estimates to determine the terrestrial carbon balance of Europe with the geographical patterns and variability of sources and sinks. CARBOEUROPE aims at providing a system for carbon accounting for the European continent, and will investigate further the main controlling mechanisms of carbon cycling in European ecosystems.

According to new research carried out in the framework of CARBOEUROPE and published in the journal *Nature*, human activities are having a major impact on the carbon balance of forests in the northern hemisphere.

During photosynthesis, the trees take up carbon dioxide (CO_2) from the atmosphere and then release oxygen back into it. However, trees also respire, a process which returns CO_2 back to the atmosphere. Furthermore, decomposing organic matter in the soil of forests also release CO_2. When conditions are right, forests absorb more CO_2 than they release, making them effective carbon sinks.

Researchers are working hard to understand the factors which control the balance between CO_2 absorption and release.

They found that forest management activities accounted for a large proportion of the variations in carbon balance in the temperate and boreal forests. When an area of forest is disturbed, it typically acts as a carbon source for some years before becoming a carbon sink again. However, once the effects of forest management and disturbance have been accounted for, the main factor driving carbon sequestration by forests was found to be nitrogen deposition caused by human activities.

'As a result of pollution of the atmosphere by active nitrogen from the internal combustion engine, from factories and from intensive agriculture, the whole planet receives an annual dose of what can be regarded as nitrogen fertiliser,' explained Professor Magnani of the University of Bologna, Italy. 'It comes for example in rain, snow and fog.'

By matching CO_2 uptake to nitrogen deposition, the researchers were able to reveal that for every kilogram (kg) of nitrogen that rains down onto forests, an extra 400 kg of carbon is absorbed from the atmosphere.

'This dual effect of humans on forests — causing release of carbon by management and increasing uptake of carbon by nitrogen pollution — is but one illustration of the way anthropogenic influences impact on the global environment in ways that were not intended,' commented Professor Magnani. 'Forests, often viewed as pristine ecosystems, are in reality deeply conditioned by mankind.'

As Peter Högberg of the Swedish University of Agricultural Sciences (SLU) points out, the study raises a number of important questions. 'Should forests be fertilised with nitrogen to sequester more atmospheric CO_2?', he asks. 'And should strategies to reduce levels of CO_2 emissions include forest fertilisation to produce more wood products to replace fossil fuels, or to replace concrete as a building material as large amounts of CO_2 are generated during concrete production?'

Project title

Assessment of the European terrestrial carbon balance

Project acronym

CARBOEUROPE

Programme

FP6

Project type

Integrated project

Project start date

1.1.2004

Project duration

60 months

EU funding

EUR 16 310 000

Project coordinator

Schulze Ernst-Detlef,
Max Planck Gesellschaft zur Förderung der Wissenschaft E. V., Germany

Partner countries

17

Partner institutions

75

Project website

http://www.carboeurope.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 55316 in the search window on the CORDIS website.

http://cordis.europa.eu

MILLENNIUM: European climate of the last millennium

MILLENNIUM will reconstruct the climate of Europe over the last thousand years by using a range of instrumental, documentary and natural archives of climate information. These data are then used to improve model predictions of future changes and their impacts.

Models of future climate predict that some of the greatest changes are likely to occur at high latitudes. Considerable research effort within MILLENNIUM is therefore targeted at understanding the magnitude and rate of past climate changes in the far north and of their consequences for the local ecosystems. The project is divided into five interacting subgroups, each of which involves some research in the polar regions.

Instrumental and documentary archives are being collated and analysed to yield an index of seasonal temperature and precipitation. Sources include ships' logs, port records, and a wide range of administrative documents from all over Europe. These include the logs of ships that sailed in Arctic waters, with their detailed weather observations, and port records that reveal the length of time that northern harbours were frozen each winter, providing an unrivalled proxy indicator of winter temperatures.

Conifers from the Arctic tree lines in Finland, Norway, Russia and Sweden are being studied in detail, because they are growing so close to their environmental limits that their annual rings provide a continuous and sensitive record of environmental change. As well as measuring the width of the rings, MILLENNIUM scientists are also measuring the density of the wood and subtle changes in wood chemistry. As these trees grow, they take water from the soil and carbon from the air and fix them in their cell walls. The stable isotopic ratios of carbon, oxygen and hydrogen from these wood cells not only retain a record of changes in summer temperature and moisture supply, but also of the way that the trees have responded to changes in the atmosphere's composition caused by humans.

The subgroup dealing with the accumulation of sediments over the last millennium includes ice core sites in Svalbard, where the accumulation of snow records changes in atmospheric chemistry and local climate. Peat and lake deposits from Finland, Iceland and Sweden are also included. A wide range of physical, chemical and biological proxies of past climate are being used, each providing a different perspective on past changes. The head capsules of non-biting midges in lake sediments, for example, provide a reliable indication of changes in summer temperature, whereas the fossil remains of *testate amoebae* from peat profiles indicate changes in wetness.

The MILLENNIUM marine group is focusing much of its efforts on obtaining a high resolution record of such changes using marine sediments from north of Iceland. Within these sediments, and on the sea bed, are the shells of the extraordinarily long-lived mollusc *Arctica islandica*. The annual layers of these shells can be counted and cross-matched in the same way as tree rings, and changes in chemistry can be used to infer changes in water temperature, the amount of mixing of surface and deep waters, and thus in the strength of ocean currents.

The ultimate aim of MILLENNIUM is also to improve our predictions of the future climate by using the most accurate, high resolution records of past climate to test the behaviour the used general circulation models (HadCm3) and its lower resolution equivalent (Famous).

Courtesy of Risto Jalkanen

Project title

European climate of the last millennium

Project acronym

MILLENNIUM

Programme

FP6

Project type

Integrated project

Project start date

1.1.2006

Project duration

48 months

EU funding

EUR 12 600 000

Project coordinator

Danny McCarroll,
Swansea University,
United Kingdom

Partner countries

16

Partner institutions

39

Project website

http://www.millenniumproject.net

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 78551 in the search window on the CORDIS website.

http://cordis.europa.eu

EPICA-MIS: Enhanced palaeoreconstruction and integrated climate analysis through marine and ice core studies

The 'European project for ice coring in Antarctica' (EPICA) is a joint European Science Foundation (ESF)/European Commission scientific programme. 'Enhanced palaeoreconstruction and integrated climate analysis through marine and ice core studies' (EPICA-MIS) is the current FP6 project.

Project title

Enhanced palaeoreconstruction and integrated climate analysis through marine and ice core studies

Project acronym

EPICA-MIS

Programme

FP6

Project type

Specific targeted research project

Project start date

1.12.2004

Project duration

36 months

EU funding

EUR 2 500 000

Project coordinator

Dominique Raynaud,
Centre national de la recherche scientifique (CNRS), France

Partner countries

10

Partner institutions

15

Project website

http://www-lgge.ujf-grenoble.fr/epica-mis

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 77716 in the search window on the CORDIS website.

http://cordis.europa.eu

The initial overall objective of the EPICA was to reconstruct a continuous, highly resolved history of global climate and environmental changes extending from centuries to several hundred thousand years from two ice cores drilled in East Antarctica: one named EDC core, with its central part at Dome Concordia, the other, named EDML core, in its Atlantic sector at Kohnen Station in Dronning Maud Land. The first objective in the framework of the EPICA proposal was to complete the two drilling operations.

EPICA-MIS will contribute to the development of novel palaeoreconstruction methods by providing unique palaeorecords and developing new proxies of critical properties of the climate system. Once completed, the two Antarctic deep ice cores will for the first time reveal atmospheric records of greenhouse gases like carbon dioxide (CO_2) and methane (CH_4) reaching 800 000 years back in time. Novel multi-parameter and high-resolution records of climate-relevant parameters like ice isotopes, greenhouse gases, dust and soluble impurities are being produced from the new Antarctic ice cores. They are compared and correlated with palaeoreconstructions from marine, Greenland and other Antarctic regions.

A key task of the project is to produce common timescales for the different records by comparing the individual datings and by investigating novel tephra and palaeomagnetic correlation methods. The produced multi-proxy reconstructions provide an outstanding platform for understanding and modelling the past and present climate. The ice core record of basic climate parameters (temperature, precipitation) is generally obtained by getting continuous records of the isotopic composition of the ice.

As strategies for mitigation and adaptation to global change have to be based on predictions on future climate, the EPICA-MIS novel palaeoreconstructions will produce new evidence about climate dynamics and variability necessary to improve and test policy-relevant models.

The project, which includes marine and ice research groups, highlights the study of the interglacial periods because we are now living in one of these warm periods and the EDC ice core is the first ice core recording an undisturbed sequence of the long and very special interglacial having occurred around 420 000 years before present and known 'marine isotopic stage 11' (MIS 11). In doing so, EPICA-MIS will provide new insights into the mechanisms, which would drive the future Holocene climate in the absence of anthropogenic perturbation. This is a prerequisite for simulating our future climate.

The Vostok record revealed a close relation between the greenhouse gases CO_2 and CH_4 and the climate over the four last glacial-interglacial cycles.

One of the major results obtained from the EDML core analysis reveals that each of the Greenland glacial abrupt climatic events has a counterpart in Antarctica, with the amplitude of the Antarctic warm events being linearly dependent on the concurrent stadial in the North, suggesting a similar reduction in the meridional overturning oceanic circulation.

ENSEMBLES: Ensemble-based predictions of climate changes and their impacts

Modelling climate change has traditionally been looked on as a so-called delta change approach: the present climate state is modelled and then a simulation of the future is made, either for a new equilibrium state or with a transient change, in which all the time lags are included, at least in principle. The next step is to compare the climate of the two periods and analyse the difference.

Such an approach works well for most regions of the globe, and it has the virtue that many systematic model biases tend to cancel out this way. A good example is illustrated by the relatively good agreement between coupled Global Climate Models (GCMs) in simulating the global temperature under the assumption of a particular future emission scenario. When normalised to a common period, the systematic errors do cancel at the planetary scale. In the polar regions, however, this is less obvious. Therefore, great accuracy is needed in simulating present day conditions of snow and ice in order to give credible information about the likely change in a warmer world.

Recent observations and models indicate that polar climate variability and change on a century-long time scale need to include processes that so far have been more or less neglected in climate models. Ice sheets, such as in Greenland and Antarctica, are exhibiting changing dynamical behaviours that seem to indicate that these processes so far ignored cannot be so anymore and models need to address this. Regions underlain by permafrost are not well described by climate models that only include a shallow soil layer rarely deeper than 3 to 5 m to interface with the atmosphere. Soil processes in permafrost soils may need to be described to a much greater physical depth in order to address the phase transition of water, when infiltrated in complex soil textures. Last but not least, the carbon cycle in the polar regions, and in the Arctic in particular, is only starting to be understood at the process level. There is a long way before it can be claimed that models are giving a fair representation of what really happens. In this case, an even better understanding of the carbon cycle itself is needed before the models can start to show their full effect.

Within the ENSEMBLES project, a series of comprehensive climate models have been set up to carry out a coordinated set of simulations that enable a first serious attempt to this approach. A total of seven comprehensive coupled atmosphere-ocean general circulation models and 10 regional climate models have been applied to a specific set of future emission scenarios. The same models have also been used to simulate the climate of the last century, so that the models can be evaluated against observations. Although the focus is global (GCMs) or on Europe (including the Nordic countries), this combination of models allows for a first probabilistic approach to describe the most likely climate development within this coming century, and the impacts of a changing climate, also for parts of the Arctic. This will provide the roadmap for future climate change projection studies continuing to use a variety of climate models which can be used to explore uncertainties through ensemble-based predictions.

Project title

Ensemble-based predictions of climate changes and their impacts

Project acronym

ENSEMBLES

Programme

FP6

Project type

Integrated project

Project start date

1.9.2004

Project duration

60 months

EU funding

EUR 15 000 000

Project coordinator

David Griggs,
Met Office, United Kingdom

Partner countries

21

Partner institutions

74

Project website

http://www.ensembles-eu.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 74001 in the search window on the CORDIS website.

http://cordis.europa.eu

QUOBI: Quantitative understanding of ozone losses by bipolar investigations

The QUOBI project aimed to support EU requirements for continued monitoring and understanding of ozone (O_3) changes over Europe, in connection with the 'Montreal protocol' and climate change research (Kyoto-related).

The Antarctic O_3 hole was discovered in 1984. During the period of O_3 loss, which lasts from September to late October, more than 70 % of the total column of O_3 is depleted. In the Arctic the O_3 loss has been much less severe than in Antarctica, but significant anthropogenic O_3-depletion has been identified in some Arctic winters.

Catalytic O_3-depletion cycles involving chlorine and bromine constituents that result from the breakdown of man-made chlorofluorocarbons (CFCs) and halons have been identified as the main O_3 destroying process in the polar stratosphere. But the quantitative understanding of the process is not complete. Significant discrepancies between observed and modelled O_3 loss rates have been reported.

QUOBI was the first concerted effort to apply various approaches to measure chemical O_3 loss in both polar regions and to compare their results with a wide range of state-of-the-art chemical models. For the first time we were able to directly compare O_3 loss rates from Antarctica with rates from the Arctic, both measured in a consistent way with the same approach. The Arctic measurements took place during the winter of 2002/03 and the Antarctic experiment was conducted during the austral winter of 2003.

International campaigns that integrate the measurements of about 35 international stations in the northern hemisphere and 9 stations in the Antarctic are used to measure the rate of chemical anthropogenic O_3 destruction and to separate it from natural dynamical variability. During these campaigns, hundreds to over a thousand O_3 sonde launches from these stations are coordinated each winter in real time, such that the rate of chemical loss is measured precisely. The general strategy during the campaigns is to launch many pairs of O_3 sondes into the same air mass a few days apart, while the air mass drifts with the stratospheric circulation over the participating stations.

Analysing measurements from several hundreds such O_3 sonde pairs allows quantifying the seasonal evolution and vertical distribution of O_3 loss rates. The 'Match technique' has been used to assess the O_3 loss during most Arctic winters from 1991/92. During QUOBI, the first Match campaign took place in the Antarctic.

Based on current standard assumptions on atmospheric composition and key kinetic parameters of the underlying chemistry, the measured loss rates cannot be reproduced. However, by combining the model studies and measured O_3 loss rates with *in situ* aircraft and balloon measurements of key chemical species, an alternative set of assumptions was developed during QUOBI that allowed a consistent reproduction of all observations in atmospheric models.

Considering these changes in models of the stratospheric chemistry increases calculated O_3 loss rates by up to 20 % and results in overall good agreement between *in situ* observations of chemical species and model results. This is the first picture of polar O_3 loss that is quantitatively consistent with all available atmospheric observations, and future laboratory studies are needed to verify the assumptions that have been developed within QUOBI.

Courtesy of Markus Rex, 2007

Polar stratospheric clouds above Kiruna, Sweden

Project title

Quantitative understanding of ozone losses by bipolar investigations

Project acronym

QUOBI

Programme

FP5

Project type

Research project

Project start date

1.1.2002

Project duration

36 months

EU funding

EUR 1 749 999

Project coordinator

Peter von der Gathen,
Alfred-Wegener-Institut (AWI) für Polar- und Meeresforschung, Germany

Partner countries

9

Partner institutions

16

Project website

http://www.nilu.no/quobi

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 59904 in the search window on the CORDIS website.

http://cordis.europa.eu

SCOUT-O3: Stratosphere-climate links with emphasis on the upper troposphere and lower stratosphere

Scientists from the SCOUT-O3 project have been studying the links between stratospheric ozone (O_3) and climate change. The overall aim is to improve the predictions of future O_3 and other stratospheric changes as well as the associated ultraviolet (UV) and climate impact.

Ongoing observation of O_3 loss during successive Arctic winters shows that substantial losses can occur. A striking feature of Arctic O_3 loss has been the large interannual variability of the O_3 loss and its strong dependence on temperature. For example, there were losses of less than 10 % in 1998/99 and more than 65 % in 1999/2000 at around 18 km. Losses of 50 % or more have been seen at the similar altitude in the Arctic in several winters since the early 1990s. Chemical losses in total O_3, i.e. the overall thickness of the O_3 layer, in the Arctic vortex have varied between about 5 to 30 % since the early 1990s. O_3 loss during 2004/05, the first winter of the SCOUT-O3 project, reached record levels and exceeded one third of overall total column of O_3. In 2005/06 losses were weak, while they were again substantial in 2006/07. This year-to-year variability is random and driven by internal variability in the atmospheric system. Overall, a decrease in total O_3 in the Arctic region has been observed since 1980, with considerable year-to-year variation in the observed values. This variability in the O_3 loss in the Arctic, is to be contrasted with the Antarctic where almost complete O_3 loss has taken place in nearly all winters since the 1990s at altitudes between about 15 and 20 km.

The basic mechanism leading to rapid polar O_3 loss is well established. The air over the poles gradually cools at the start of the dark winter months, and a westerly, circumpolar flow of air (a polar vortex) is established. If the temperatures drop below a critical point, polar stratospheric clouds (PSCs) can form. Chlorine compounds can react on the surface of PSCs, with unreactive forms being converted to active forms (chlorine monoxide, ClO) which, in conjunction with other chemicals, rapidly destroy O_3.

Detailed studies of O_3 loss mechanisms, such as the 'European polar stratospheric cloud and lee wave experiment (Euplex) project and rates showed that a good quantitative understanding of the polar O_3 loss could be reached with certain assumptions of a few critical quantities in the chemical system. However, recent new laboratory measurements of these parameters cannot be reconciled with the measured loss rates. This discrepancy is currently under investigation within the SCOUT-O3 project .

The degree of polar O_3 loss depends strongly and in a highly non-linear way on temperatures in the polar stratosphere. The results from the project show that the degree of Arctic O_3 loss in a particular winter is largely determined by the volume of air that encountered temperatures below this threshold, defining the climate sensitivity of Arctic O_3 loss.

Past observations show a strong cooling trend in the coldest Arctic winters. The magnitude of the trend is currently not understood and is not reproduced by models. It leads to concern that Arctic O_3 loss may worsen over the next few decades, before the recovery due to the regulations of the 'Montreal protocol' start to dominate the long-term evolution.

Looking ahead, the prospects for polar O_3 and UV radiation seem brighter as the amounts of O_3-depleting substances are diminishing as a result of measures taken under the 'Montreal protocol'. Predictions see a return to pre-1980s values between 2060 and 2075. The interaction between climate change and the stratosphere, the main objective of SCOUT-O3, will be critical in determining how the polar stratosphere changes.

Project title

Stratosphere-climate links with emphasis on the upper troposphere and lower stratosphere

Project acronym

SCOUT-O3

Programme

FP6

Project type

Integrated project

Project start date

1.5.2004

Project duration

60 months

EU funding

EUR 15 000 000

Project coordinator

John Adrian Pyle,
University of Cambridge,
United Kingdom

Partner countries

18

Partner institutions

60

Project website

http://www.ozone-sec.ch.cam.ac.uk/scout_o3

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 74263 in the search window on the CORDIS website.

http://cordis.europa.eu

GEOmon: Global earth observation and monitoring of the atmosphere

The presently observed change of climatic conditions in the Arctic is much larger than expected on the basis of increasing greenhouse gas concentrations. Furthermore, the trend in stratospheric water vapour, involved in the formation of polar stratospheric clouds, is uncertain at present. Moreover, the high interannual variability and strong sensitivity to temperature of polar ozone (O_3) make it difficult to detect its long-term trend. This also applies to the Antarctic, where O_3-depletion is still significant and subject to large interannual variability: in 2006, the O_3 mass deficit was the largest ever observed.

As a result, it is essential to continue observing the polar stratosphere in the coming years to better understand the evolution of the coupled ozone-climate system in this vulnerable region. GEOmon supports eight polar stations in the northern and six polar stations in the southern hemisphere. These stations will be observing the polar stratosphere above Antarctica, and between northern Europe and the Arctic. In the latter they cover the region from Greenland to the east of Russia. All the sites involved are contributing to the 'Network for the detection of atmospheric composition change' (NDACC).

A variety of instruments are operational; together, they enable the observation of O_3 and the important parameters that play a key role in the processes that determine the abundance of stratospheric O_3. These parameters are: stratospheric temperature, water vapour, the occurrence of polar stratospheric clouds, nitrogen dioxide (NO_2) and the halogenated species (BrO, HCl, HF).

HCl is one of the key compounds involved in the stratospheric O_3-depletion. Since 1992, HCl has been measured at Ny-Ålesund in the high Arctic on Spitsbergen, Norway. The results give a clear increase for the first years, following the production of the CFCs. The timing of the maximum is not clearly pronounced, but appears to be around 1996–98.

GEOmon will also observe greenhouse gases like carbon dioxide (CO_2). The surface concentration of these gases has been measured routinely for many years by *in situ* networks. However, the spatial coverage of such observations is still sparse. Inverse models are used to quantify the sources and sinks of greenhouse gases on a global scale, but the need to simulate the vertical mixing in the boundary layer limits the confidence in such estimates. Remote-sensing techniques, by contrast, sample the whole atmosphere, and are therefore less impacted by vertical mixing processes. Ground-based observations of the column mass are complemented by satellite observations that provide global coverage. The first successful observations of CO_2 by satellite were performed with the 'Scanning imaging absorption spectrometer for atmospheric cartography' (Sciamachy) instrument and new missions are planned. For these observations to be valuable, they must be linked to the ground-based *in situ* networks. If *in-situ* observations and ground-based remote sensing measurements are performed at the same site, the required link between the *in situ* data for surface concentrations and the remote sensing results is achieved.

The observational activities of GEOmon are complemented by a strong modelling component, among others to distinguish between contributions to observed O_3 loss from dynamical and chemical processes.

The NDACC station at Ny-Ålesund, Svalbard

Project title

Global earth observation and monitoring of the atmosphere

Project acronym

GEOmon

Programme

FP6

Project type

Integrated project

Project start date

01.02.2007

Project duration

48 months

EU funding

EUR 6 621 714

Project coordinator

Philippe Ciais,
Commissariat à l'energie atomique (CEA), France

Partner countries

16

Partner institutions

38

Project website

http://geomon.ipsl.jussieu.fr

INUENDO: Biopersistent organochlorines in diet and human fertility — epidemiologic studies of time to pregnancy and semen quality in Inuit and European populations

The main reason for human contamination with persistent organochlorine pollutants (POPs) in the Arctic is because of the bioaccumulation of organochlorine contaminants, such as polychlorinated biphenyls (PCBs), in the food chain and considerable consumption of sea mammals as part of the traditional diet in Arctic populations.

The aim of INUENDO was to investigate if the present level of exposure to POPs causes human reproductive toxicity among the European and Inuit populations.

Couple fertility and male reproductive function were investigated in four regions, Greenland, Poland (Warsaw), Sweden and Ukraine (Kharkiv). Pregnant women and their partners were enrolled during antenatal visits except for Swedish fishermen and their partners who were recruited separately. Interviews on time to pregnancy and other reproductive characteristics were obtained from 2 269 women. Blood was sampled in 1 992 women and 1 172 men, and a subset of 798 men provided a fresh semen sample. On all of these samples, serum concentrations of hexachlorobiphenyl (CB-153) as an indicator of the industrial chemicals PCBs and dichlorodiphenyldichloroethylene (DDE), which is the main degradation product of the dichlorodiphenyltrichloroethane (DDT) pesticide, were measured. The estrogen, androgen and dioxin activity of blood cleared for natural hormones were measured in cell lines in a subset of 362 men. Male reproductive function was evaluated by reproductive hormones in blood and a range of sperm characteristics, together with biochemical markers of the epididymal and the accessory sex gland function.

The median serum concentrations of CB-153 and DDEs in the four regions were spanning more than one order of magnitude. Estrogen, androgen and dioxin receptor activity of blood cleared for natural hormones also differed between regions.

Male and female serum concentrations of POPs were related to reduced fertility measured as prolonged waiting time to pregnancy among Inuit couples. Both in Greenland and in the other European regions included in the study, the sperm motility decreased with increasing CB-153 level in the blood. In addition, the study revealed a remarkable high level of sperm chromatin stability and low level of sperm DNA damage among Inuit men. This may explain why Inuit may escape the rather strong PCB-related effect on sperm chromatin found among Caucasian men.

On the other hand, serum concentrations of DDE and xenobiotic-induced steroid receptor activities were not related to female and male fertility. No evidence was found that CB-153 and DDE interfere with the regulation of induced sperm cell death. However, genetic analysis of androgen receptor polymorphism revealed that among men with short Androgen receptor CAG repeat length, high levels of CB-153 were related to low sperm counts and high levels of DDE were related to a high degree of sperm chromatin damage.

The study revealed several associations between blood levels of POPs markers and male reproductive hormones as well as Y/X sperm chromosome ratio but the non-consistent associations across regions complicate the interpretation.

POPs in the male adult may interfere with reproductive function without major impact on fertility or sperm counts in European populations. PCBs seem more to blame than DDTs. Findings provide limited direct evidence that xenobiotic disruption of endocrine regulation is at stake, but do not exclude mechanisms related to receptor functions.

The inhabitants of Ilulissat, Greenland in traditional dress

Project title

Biopersistent organochlorines in diet and human fertility — epidemiologic studies of time to pregnancy and semen quality in Inuit and European populations

Project acronym

INUENDO

Programme

FP5

Project type

Research project

Project start date

1.1.2002

Project duration

42 months

EU funding

EUR 1 745 000

Project coordinator

Jens Peter Bonde,
Århus Kommunehospital, Denmark

Partner countries

5

Partner institutions

8

Project website

http://www.inuendo.dk

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 64556 in the search window on the CORDIS website.

http://cordis.europa.eu

ANEMONE: Assessment of neurobehavioural endpoints and markers of neurotoxicant exposures

Methylmercury (CH_3Hg^+) is present worldwide in seafood and freshwater fish. Accumulation of CH_3Hg^+ in species that contribute to the human diet results in increased exposures in many fishing communities. This contaminant often occurs along with polychlorinated biphenyls (PCBs). Because of their toxicity to the developing nervous system, joint effects are suspected.

Risks associated with complex food contaminants are difficult to assess. These problems were examined in a well-characterised birth cohort where increased exposures to PCBs and CH_3Hg^+ are known to occur.

The exposures were documented in detail up to the age of seven years, where the children's cognitive functions were examined.

In addition, sensitive blood analyses that reflect adverse effects on the brain were developed in laboratory experiments and examined to elucidate their application as biomarkers of early cognitive effects.

The results can therefore provide information on biomarker validity, integrated risks caused by complex exposures and susceptibility of the foetus and child to cognitive effects.

Among the key findings and conclusions resulting from the assessment, the following has been found:

- unexpected patterns of persistent pollutants in marine food chains in the North Atlantic;
- concentrations of PCBs found in fulmar egg and muscle are in the same range as previously seen in the pilot whale, thereby significantly contributing to human exposures;
- in the cohort children examined, PCBs' concentrations averaged about 60 % of the concentrations in their mothers, but concentrations in the children increased with the duration of the breastfeeding period;
- hydroxylated PCBs' concentrations in serum were lower in the children than in serum from the mothers during pregnancy, except for 4-OH-CB107;
- brominated flame retardant concentrations showed substantial increases in milk and serum, when compared to samples collected in 1987 and 1994;
- methods for determining biochemical markers of neurotoxicity were optimised and quality assurance programmes established;
- the effects on these biomarkers caused by CH_3Hg^+ and halogenated organic pollutants and their combinations were determined in experimental studies;
- cholinergic muscarinic receptors of the brain constitute a sensitive biochemical endpoint altered by developmental exposure to CH_3Hg^+ and PCB-153, especially the cerebral cortex and the cerebellum;
- new results were obtained for biomarkers in children for possible comparison with other populations and with levels of exposure to toxic substances;
- children with different degrees of prenatal exposure to CH_3Hg^+ and PCBs and other halogenated organic pollutants were examined at the age of seven, with performance in neurobehavioural tests decreasing at higher prenatal CH_3Hg^+ exposures;
- data on prenatal and postnatal exposure levels, current brain function levels, and biomarker results are being further analysed and used in additional follow-up examinations to supplement current risk assessment on seafood contaminants.

The chemical methods for identification and measurement of halogenated organic pollutants may be applied in EU wide studies to determine population exposures to these substances, such as the monitoring activities to be conducted as part of the European Commission's 'Environment and health strategy' as well as from the European Food Safety Authority (EFSA).

Project title

Assessment of neurobehavioural endpoints and markers of neurotoxicant exposures

Project acronym

Anemone

Programme

FP5

Project type

Research project

Project start date

1.1.2002

Project duration

36 months

EU funding

EUR 1 040 000

Project coordinator

Philippe Grandjean,
Institute of Public Health (NIPH),
University of Southern Denmark (SDU),
Denmark

Partner countries

5

Partner institutions

5

Project website

http://www.anemone-project.dk

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 64574 in the search window on the CORDIS website.

http://cordis.europa.eu

EDEN: Emerging diseases in a changing European environment

In recent years, several vector-borne, parasitic or zoonotic diseases have reemerged and spread in Europe with major health, ecological, socioeconomical and political consequences. Most of these outbreaks are linked to global and local changes resulting from climate change, human induced landscape changes or the activities of human populations.

Europe must anticipate, prevent and control new emergences to avoid major societal and economical crises such as the 'Severe acute respiratory syndrome' (SARS) in Asia and the 'West Nile virus' in the United States. EDEN offers a unique opportunity to prepare for uncertainties about the future of the European environment by exploring the impact of environmental and other changes on human health.

EDEN's aims are to identify, evaluate and catalogue European ecosystems and environmental conditions linked to global change, which can influence the spatial and temporal distribution and dynamics of human pathogenic agents. The project will develop and coordinate at European level a set of generic methods, tools and skills such as: predictive emergence and spread models, early warning, surveillance and monitoring tools and scenarios, which can be used by decision makers for risk assessment, decision support for intervention and public health policies both at the EU and at national or regional level. Part of EDEN's innovation will be to combine spatial data (Earth observation and geographic information system data) with epidemiological data.

EDEN has selected for study a range of indicator human diseases that are especially sensitive to environmental changes and will be studied within a common scientific framework (involving landscapes, vector and parasite bionomics, public health, and animal reservoirs). Some of these diseases are already present in Europe (tick- and rodent-borne diseases, Leishmaniasis, West Nile fever), others were present historically (malaria) and so may reemerge, whilst others are on the fringes of Europe (Rift Valley fever) in endemic regions of west and north Africa.

EDEN integrates research in 47 leading institutes from 24 countries with the combined experience and skills to reach the project's common goals. EDEN is organised into a series of vertical sub-projects led and managed by internationally recognised experts, and linked together by a series of integrative activities that include biodiversity monitoring, environmental change detection, disease modelling, remote sensing and image interpretation, information and communication. The proposed management structure, including a steering committee and an advisory group, takes into account both the diversity of the partners and the size of the project.

The ecogeographical diversity of the project area covers all relevant European ecosystems from polar areas in the north to the Mediterranean basin and its link with west Africa in the south, and from Portugal in the west to the Danube delta in the east.

© ShutterStock, 2007

Project title

Emerging diseases in a changing European environment

Project acronym

EDEN

Programme

FP6

Project type

Integrated project

Project start date

1.11.2004

Project duration

60 months

EU funding

EUR 11 497 856

Project coordinator

Renaud Lancelot,
Centre de coopération international en recherche agronomique pour le développement (CIRAD), France

Partner countries

24

Partner institutions

47

Project website

http://www.eden-fp6project.net

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 74246 in the search window on the CORDIS website.

http://cordis.europa.eu

FIRE: Flame retardants integrated risk assessment for endocrine effects

FIRE was an interdisciplinary project aiming at improving the risk assessment of brominated flame retardants (BFRs) for human health considering their potential endocrine disruption effects.

Project title

Flame retardants integrated risk assessment for endocrine effects

Project acronym

FIRE

Programme

FP5

Project type

Research project

Project start date

1.12.2002

Project duration

48 months

EU funding

EUR 4 862 885

Project coordinator

Antoon Oppenhuizen,
National Institute for Public Health and the Environment (RIVM), Netherlands

Partner countries

7

Partner institutions

19

Project website

http://www.rivm.nl/fire

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 72707 in the search window on the CORDIS website.

http://cordis.europa.eu

Hazard identification for humans and aquatic wildlife, including assessment of endocrine, reproductive and immune functions, was studied with a smaller selection of BFRs in rats, zebrafish and flounder. Human exposure was measured in breast milk and human diets in Europe. Aquatic ecosystem exposure was measured in the aquatic food chain, including top predators in polluted and reference sites in Europe.

BFRs are man-made chemicals that are used to inhibit or resist the spread of fire. Many BFRs are persistent to natural degradation and are biomagnified in food chains, and due to their semi-volatile properties they are spread via atmospheric transport to the Arctic.

As there is particular concern about the exposure and possible endocrine disruptive effects of persistent organic pollutants (POPs), including BFRs in Arctic mammals and seabirds, the FIRE project put particular focus on polar bears, seals and the Arctic tern.

Most of the investigated polybrominated diphenylethers (PBDEs) and hexabromocyclododecane (HBCD) biomagnified in the food chain, from zooplankton to ringed and harbour seals. A noticeable exception occurred at the highest tropic levels, the polar bear, in which only one PBDE-congener (PBDE-153) was found to biomagnify from its main prey, the ringed seal. Although recently banned, the PBDE-congener no. 47 was the most abundant BFR in almost all trophic levels. The deca-brominated PBDE-209 was also detected in several animals, including polar bears.

Levels of most BFRs were higher in ringed seals than in harbour seals, and this may indicate species differences among seals with respect to uptake, metabolisation and excretion of BFRs.

A characterisation of exposure to BFRs in animals, from different trophic levels in north-east Atlantic coastal marine ecosystems along a latitudinal gradient from the Netherlands via southern Norway to Svalbard in the Arctic showed that levels of PBDEs and HBCD generally decreased as a function of increasing latitude, reflecting distance from release sources. The clear latitudinal decrease in levels of BFRs was not that pronounced in two tern species, the common and Arctic tern. This is most likely because they are exposed during migration. The deca-brominated compound PBDE-209 was detected in animals from all the three ecosystems, and the highest levels were found in Arctic tern eggs from Svalbard. HBCD was found in animals from all trophic levels, except for in calanoids at Froan and Svalbard.

In the same FIRE project, laboratory rats were exposed to these BFRs to detect potential adverse health effects, particularly in the endocrine system. PBDE-47 and HBCD appeared to affect the thyroid hormone system and PBDE-209 the androgen hormone system.

In conclusion, even though the levels of PBDEs and HBCD are generally low in north-east Atlantic coastal marine ecosystems, there are concerns about the relatively high presence of PBDE-209 and HBCD in Arctic mammals and seabirds, because of potential further increases due to continued use of these BFRs in the industrialised world. Of the analysed BFRs, the levels of PBDE-47 in ringed seals and polar bears are of particular concern in view of potentially adverse health effects.

Harbour seal at Svalbard

EUR-OCEANS: European network of excellence for ocean ecosystems analysis

The EUR-OCEANS project focuses on global change and the effects of human activities on ecosystems in the open ocean and aims to create a lasting integration of research into ocean ecosystems, biogeochemistry and marine resources. Work within EUR-OCEANS is coordinated across seven ocean systems, including Arctic and Nordic Seas, Baltic Sea, North Atlantic and the Southern Ocean.

The Southern Ocean completely surrounds the Antarctic continent. It links the Atlantic, Pacific and Indian Oceans, driving global weather patterns and supporting economically and politically important fisheries, and a unique polar habitat.

Understanding how climate, biogeochemical and ecological processes interact to influence the dynamics of the Southern Ocean ecosystem will enable scientists to predict the impact of human activity on the polar marine ecosystem. This is fundamental to the development of international policy on Southern Ocean ecosystem conservation and management strategies, and crucial to understanding global Earth Systems.

To effectively unite the Southern Ocean research community, the EUR-OCEANS Southern Ocean System has made a vital contribution to the development of a new international initiative, the 'Integrating climate and ecosystem dynamics in the Southern Ocean (ICED).

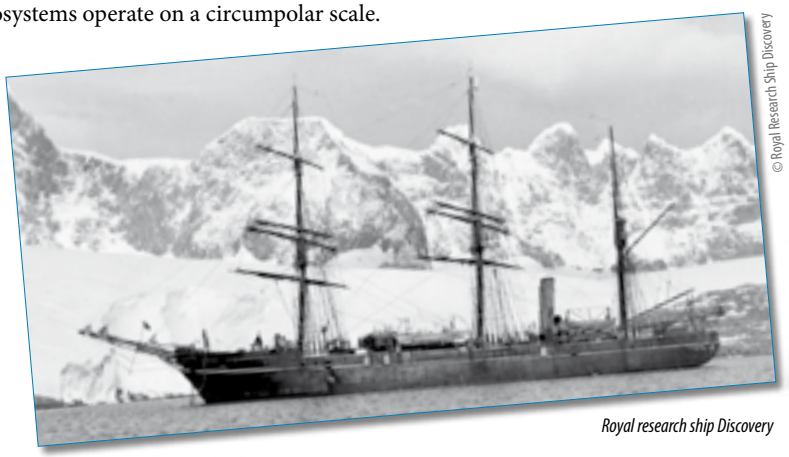
ICED brings together scientists from 20 countries across a range of research disciplines. Envisaged as a decade-long programme of Southern Ocean research, it will contribute to 'Global ocean ecosystem dynamics' (Globec), 'Integrated marine biogeochemistry and ecosystem research' (IMBER) and the ocean programmes of the 'International geosphere biosphere programme' (IGBP).

IPY was the catalyst for the launch of ICED in the shape of the ICED-IPY project, which forms the umbrella for studies on ecosystems and biogeochemistry of the Southern Ocean during 2007/08. Its main aim is to develop a coordinated approach to furthering our understanding of how Southern Ocean ecosystems operate on a circumpolar scale.

ICED-IPY activities include data mining, fieldwork and modelling as well as a number of research cruises to investigate the mechanisms controlling biogeochemical cycles and ecosystem structure in the Southern Ocean. ICED-IPY projects are:

- SCACE: 'Synoptic circum-Antarctic climate-processes and ecosystem study';
- ATOS: Atmospheric inputs of organic carbon and pollutants to the polar ocean: rates, significance and outlook (a Spanish component of the OASIS programme);
- Effects of carbon dioxide (CO_2) on calcium carbonate ($CaCO_3$) accretion;
- SOSA: 'Southern Ocean South Atlantic' box. Physical and biogeochemical fluxes in the Atlantic Sector of the Southern Ocean during IPY;
- BONUS-Goodhope: Biogeochemistry of the Southern Ocean: interactions between nutrients, dynamics, and ecosystem structure;
- SASIE: 'Study of Antarctic sea ice ecosystems';
- BASICS: 'Biogeochemistry of Antarctic sea ice and the climate system';
- SOS-CLIMATE: 'Southern Ocean studies' for understanding global-climate issues;
- CLIMANT: 'Climate change in Antarctica', a pelagic-benthic coupling approach to the extremes of the Weddell Sea.

During IPY, the Southern Ocean system will be using a EUR-OCEANS data rescue grant to begin a new project to recover data from a series of historic research cruises. These cruises include the *Discovery* investigations, which formed the first major scientific exploration of the Southern Ocean beginning in 1925 onboard the *RRS Discovery*. Combining this information with more modern research cruise series will provide new insights into the distribution and abundance of pelagic species in the Southern Ocean.



Royal research ship Discovery

Project title

European network of excellence for ocean ecosystems analysis

Project acronym

EUR-OCEANS

Programme

FP6

Project type

Network of excellence

Project start date

1.1.2005

Project duration

48 months

EU funding

EUR 10 000 000

Project coordinator

Paul Tréguer,
Centre national de la recherche scientifique (CNRS), France

Partner countries

25

Partner institutions

66

Project website

http://www.eur-oceans.eu

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 75677 in the search window on the CORDIS website.

http://cordis.europa.eu

HERMES: Hotspot ecosystem research on the margins of European seas

HERMES investigates deep-sea ecosystems and their environments at selected study sites around the European margin, from the Arctic to the Gulf of Cadiz and across the Mediterranean to the Black Sea.

HERMES research focuses on four 'ecosystem hotspot' types: submarine canyons, cold seeps, anoxic microbial systems, and cold-water coral systems. They are placed into context by using the characteristics of the surrounding open slope environment as a 'baseline' for monitoring and comparison.

The Nordic margin provides opportunities to study all these biodiversity 'hot spots' in a polar environment and compare their characteristics with their warmer water counterparts in more southerly regions of the European margin.

In order to do this, the HERMES project has invested in the latest sea-going technology to ensure the highest-quality data possible, including the 'remotely operated vehicles' (ROVs), the 'autonomous underwater vehicles' (AUVs), a manned submersible, 3D seismic technology, ocean-bottom seismometers and *in situ* experiments.

The northernmost coral reef province occurs in the fjords, sounds and shelf area of the Finnmark District facing the Barents Sea. In a combined effort, Norwegian and German HERMES partners have analysed some of these reefs using the latest ROV and submersible technology to better understand biodiversity patterns and the post-glacial evolution of reefs within a formerly fully glaciated environment.

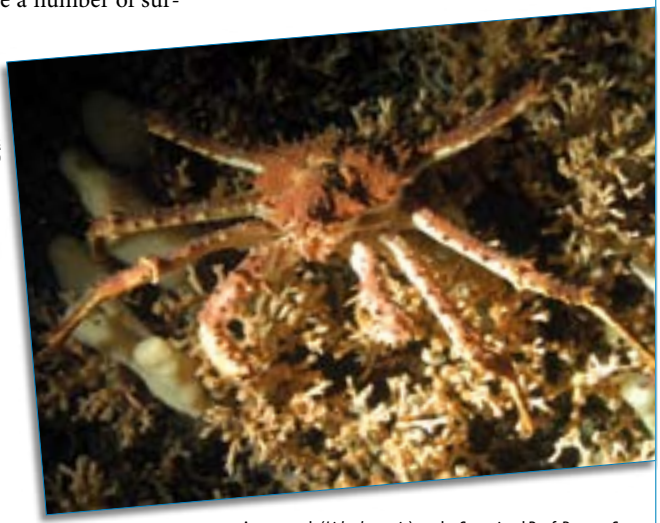
HERMES is also investigating the cold seeps and associated anoxic and chemosynthetic communities in the Arctic. Europe's most famous mud volcano — the Håkon Mosby Mud Volcano, located on the Barents Sea margin — has undergone a number of surveys and investigations, including a 3D seismic survey using the new P-Cable system developed by HERMES SME partner Volcanic Basin Petroleum Research, ocean bottom seismometer (OBS) experiments, as well as detailed chemical and microbiological sampling. A major multidisciplinary cruise to the area aboard the *RV Pourquoi pas?* in summer 2006 enabled HERMES scientists to carry out *in situ* geothermal and geochemical characterisation of the different fauna colonies and microbial mats using a variety of newly developed sensors and ROV-mounted instruments.

The latest Arctic cruise to add to this growing vault of knowledge is the 'ARK XXII/1a-c' expedition aboard the German *RV Polarstern* during summer 2007. The science teams on board investigated ecosystems as diverse as the spectacular cold-water coral reefs around Lofoten, Norway, and the intriguing microbiological and chemosynthetic communities of the Håkon Mosby Mud Volcano.

The first cruise leg concentrated on the study of the cold-water coral sites offshore Norway using the manned submersible *JAGO*. Preliminary results suggest that cold-water ecosystems are very sensitive to changes in physical factors such as ocean currents, temperature, oxygen, salinity and particle concentrations. This has important implications for the Arctic, since climate change will have stronger effects here.

The second cruise leg focused on microbiological studies of the Håkon Mosby Mud Volcano. To undertake these detailed investigations, the ROV Quest was equipped with high-resolution video cameras and a myriad of sampling tools.

The *RV Polarstern* then moved to its final destination — the high-latitude *Hausgarten* site where scientists are undertaking long-term, large-scale ecological investigations of the benthic communities.



A stone crab (*Lithodes maja*) on the Sternsjund Reef, Barents Sea

Project title

Hotspot ecosystem research on the margins of European seas

Project acronym

HERMES

Programme

FP6

Project type

Integrated project

Project start date

1.4.2005

Project duration

48 months

EU funding

EUR 14 999 974

Project coordinator

Philip P. E. Weaver,
National Oceanography Centre Southampton (NOCS), United Kingdom

Partner countries

16

Partner institutions

45

Project website

http://www.eu-hermes.net

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 75680 in the search window on the CORDIS website.

http://cordis.europa.eu

IRIS: Ice ridging information for decision making in shipping operations

In order to make year-round navigation continuous and free from unexpected delays, ice-strengthened merchant ships operating in the northern Baltic Sea need reliable ice information services. Experienced ship masters and mates use this information to avoid the most difficult areas. However, if the ship ends up in severe ice conditions, its speed may decrease drastically. In worst cases it may be completely stuck in ice and thus, icebreaker assistance will be needed.

Ice ridges, which are the result of ice field dynamics, represent often the most difficult obstacles for winter navigation. Thus, improved ice monitoring and forecasting services have an immediate effect on the competitiveness and employment in the northern communities through decreased passage times and more reliable planning of shipping operations. They will decrease the risk of damage to the ships due to the ice loads and thereby reduce repair costs and prevent pollution.

The ice information of today is largely based on the use of satellite imagery. The information about ice conditions derived from these images represent the past, therefore this information has to be extended to the near future. This extension, which is necessary to aid the advance planning of shipping operations, is carried out by advanced ice forecast models with the support of weather data and forecasts. The main ice parameter affecting navigability and damage risk is the degree of ridging, characterised by ice ridges.

The ice ridges are elongated formations of ice rubble created by ice cover compression. In the Baltic Sea, where the maximum thickness of level ice is usually less than 1 m, the thickness of ridge formations is typically about 10 m with a maximum of 30 m. The essential parameters describing the size and frequency of ridges could not previously be derived from satellite images or predicted by models.

The main objective of IRIS was to render ridge parameters a standard part of ice information. Field studies both in the Baltic Sea and in the Arctic were included in the project. The key feature was that ridge-resolving ice forecast models were developed simultaneously with new methods of determining ridging parameters from the satellite images. The linkage between the two research areas was established through extensive field campaigns. The ridging parameters could then be used to estimate ship travel times with algorithms developed in the project. This was most conveniently done by an onboard terminal which acted as a decision support tool for icebreakers and commercial vessels. Ship passage through ridged ice cover was studied by model tests and ship transit simulations to develop further the route selection methods. Using the digitally supplied ice information, the terminal software suggested optimal routes between certain waypoints.

The end result of the IRIS project was a system of ice information presentation, delivery and application. It includes ridging information, and it can be used in ship routing as well as assimilate future results from basic ice geophysical and ship research. It lays foundations for developing towards a routine, standardised operational system that can use quantitative methods to optimise operations, involving the complete configuration of ships in a specific ice-covered sea area in the polar region.

Project title

Ice ridging information for decision making in shipping operations

Project acronym

IRIS

Programme

FP5

Project type

Research project

Project start date

1.1.2003

Project duration

36 months

EU funding

EUR 2 008 432

Project coordinator

Risto Jalonen,
Helsinky University of Technology (TKK),
Finland

Partner countries

5

Partner institutions

9

Project website

http://www.tkk.fi/Units/Ship/Research/Iris/Public

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 67959 in the search window on the CORDIS website.

http://cordis.europa.eu

Project title

Enhanced transnational access to Abisko scientific research station

Project acronym

ATANS

Programme

FP6

Project type

Marie Curie actions (Incoming International Fellowships)

Project start date

1.1.2005

Project duration

48 months

EU funding

EUR 504 000

Project coordinator

Terry Callaghan, The Royal Swedish Academy of Sciences (KVA), Sweden

Partner countries

1

Partner institutions

1

Project website

http://www.ans.kiruna.se/ans.htm

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 73804 in the search window on the CORDIS website.

http://cordis.europa.eu

ATANS: Enhanced transnational access to Abisko scientific research station

The aim of ATANS is to finance travel and accommodation costs at the Abisko Station, Sweden, for scientists. Proposals are being invited from both established and young researchers that relate to research on the natural environment of the Abisko area, which comprises diverse sub Arctic and alpine landscapes, biodiversity and biogeochemical cycling processes.

During the first two years of ATANS, 39 projects have been supported. Within these projects, 78 scientists spent in total 1 341 man-days at the Abisko Scientific Research Station. Research ranges from small, single-researcher projects to large international EU consortia that link to the wider global research community, particularly within IPY. Topics include basic science and many projects with a focus on climate change impacts on sub Arctic ecosystems that are of particular concern in local, regional and global contexts. Such attention is placed on the one hand because of the sensitivity of the Abisko area to climate change (it has mean annual temperatures close to 0 °C) and on the other because the impacts of climate warming are leading to positive feedbacks to the climate system that are likely to have importance beyond the sub Arctic.

Among the many projects and activities conducted within ATANS we find the following ones:

ABACUS-IPY: Arctic biosphere atmosphere coupling at multiple scales

ABACUS-IPY is a research consortium funded by the Natural Environment Research Council (NERC) in the United Kingdom. As part of IPY, ABACUS is designed to improve the understanding of the controls on carbon, water and energy exchange between Arctic terrestrial ecosystems and the atmosphere. The project contributes to IPY project 'Environmental baselines, processes, changes and impacts on people in sub Arctic Sweden and the Nordic Arctic region' (ENVISNAR) led by the Abisco station and new collaborations, made possible by ATANS.

Simulation of extreme winter warming events

This project is performing an experiment that manipulates the environment in order to predict likely consequences of extreme climate events in winter. It is of major concern that long-term climate data from northern Europe suggests that these events are increasing in frequency. Extreme and sudden winter warming events are among the most profound of climatic changes facing the Arctic. During these events, temperatures increase rapidly to well above freezing. This is not only damaging to vegetation but can also make plants inaccessible to herbivores, (including reindeer of indigenous peoples) reliant on these food sources for winter survival.

Dynamics and processes of tree and shrub vegetation in relation to climate change

An expected impact of climate warming in the Arctic is an altitudinal and latitudinal expansion of shrub and tree vegetation into areas of tundra and alpine vegetation which would cause changes in biodiversity and feedbacks to the climate system. A new experiment has been set up in the sub Arctic treeline environment of Abisko. In the collaborating study, a multidisciplinary assessment is being made of climatology, species interaction, herbivory and geomorphology, to capture the range of treeline processes affecting both the local scale as well as the landscape level.

EISCAT: European next generation incoherent scatter radar

The EISCAT Scientific Association owns and operates three powerful upper atmosphere research radar systems above the Arctic Circle in northern Europe. It is supported by the research councils (or equivalents) of China, Finland, Germany, Japan, Norway, Sweden and the United Kingdom.

In addition to its normal work, the EISCAT Scientific Association is presently working on the design of a new European atmospheric and ionospheric radar system with support from FP6 (EISCAT_3D project), and conducting an extensive additional observational programme on Svalbard (with funding support from the Norwegian Research Council) related to IPY. Access to the EISCAT radar facilities is available to new users through a 'Transnational access award' also funded by FP6 (EISCAT_USERS_1 project).

The 'EISCAT Svalbard radar' (ESR) will most of the time be operating continuously during the whole IPY period. The radar normally operates for approximately 2 000 h per year, and the additional 7 000 h of observational data are being collected as part of a collaboration with other incoherent scatter radars in Greenland (Denmark), Russia, Massachusetts and Alaska (United States) — as part of the ICESTAR/IHY (International Heliophysical Year) cluster of projects — endorsed by IPY committee, which is dedicated to investigating interactions between the Sun and the Earth and, in particular, the different responses of the northern and southern polar regions.

For IPY, ESR is operating an observing programme which records behaviour of the atmosphere from below 90 km to around 500 km and the effects, on timescales ranging from minutes to months, of the varying solar energy inputs resulting from solar eruptions, flares, sunspots, etc. In addition to these standard measurements, the radar data are also processed to extract information on other aspects of the near Earth environment, including the statistics and behaviour of small-scale space debris, the flotsam left-over from space craft launches, materials which have detached from satellites of various types, satellites which are no longer active, pieces generated by collisions between satellites and other pieces of space junk. The space debris environment is of crucial interest to satellite operators, both manned and unmanned, since space debris collisions with operational satellites can occur at very large relative velocities, involving huge energies and having potentially disastrous consequences. The space debris detection system was developed under a contract with the European Space Agency (ESA), and is presently operated as an independent venture by the EISCAT Scientific Association.

Since ESR started routine operations for IPY at the beginning of March 2007, the radar has been observing the development of a large cloud of space debris which was not present one year ago when the radar made a preparatory month-long series of observations in March 2006. The cloud is clearly seen passing through the radar beam twice each day.

ESR's one-year long operation for IPY provides a unique opportunity to monitor the cloud and, crucially, to study the way it disperses and spreads to occupy adjacent orbits over the coming months.

EISCAT Svalbard Radar

Project title

Project 1: European next generation incoherent scatter radar

Project 2: Access to EISCAT facilities for new users

Project acronyms

EISCAT_3D

EISCAT_USERS_1

Programmes

FP6

FP6

Project types

Specific support action (Design studies for new infrastructures)

Specific support action (Transitional access to research Infrastructures)

Project start dates

1.5.2005

1.1.2006

Project durations

48 months

48 months

EU fundings

EUR 2 017 445

EUR 580 213

Project coordinators

Gudmund Wannberg, European Incoherent Scatter Scientific Association (EISCAT), Sweden

Anthony Paul Van Eyken, European Incoherent Scatter Scientific Association (EISCAT), Sweden

Partner countries

3

1

Partner institutions

4

1

Project websites

http://www.eiscat.se

Please access the fact sheets of the projects in the CORDIS projects database by entering the record control numbers 74856 (for EISCAT_3D) and 78514 (for EISCAT_USERS_1) in the search window on the CORDIS website.

http://cordis.europa.eu

ARCFAC V: The European Centre for Arctic Environmental Research

The Ny-Ålesund International Research and Monitoring Facility is one of the world's northernmost human settlements, situated on Svalbard, Norway. This site represents an ideal permanent research platform in the European Arctic, with its mild climate, clean environment and easy accessibility by plane and boat. Together with the well-developed infrastructure with highly specialised research facilities established and used by a broad international research community, Ny-Ålesund strongly demonstrates its value as the European Centre for Arctic Environmental Research (ARCFAC).

Project title

The European Centre for Arctic Environmental Research

Project acronym

ARCFAC V

Programme

FP6

Project type

Transnational access (Infrastructures)

Project start date

1.3.2006

Project duration

48 months

EU funding

EUR 1 833 600

Project coordinator

Marzena Kaczmarska,
Norwegian Polar Institute, Svalbard

Partner countries

5

Partner institutions

8

Project website

http://arcfac.npolar.no

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 79876 in the search window on the CORDIS website.

http://cordis.europa.eu

Several research platforms form the basis of this research infrastructure, together with the general infrastructure providing accommodation and transportation as well as logistical services offered for field campaigns. The high latitude location and multidisciplinary research environment are ideal for research and monitoring within a broad range of contemporary Arctic environmental research, with emphasis on climate change and ecosystem response, ultraviolet (UV) radiation and biological effects, long-range transported pollutants and ecotoxicology as well as many other disciplines.

ARCFAC forms the northernmost baseline node within several climate research programmes and international networks. It is unique in Europe in light of the multitude of different environmental research and monitoring programmes running simultaneously at the same site, providing excellent conditions for multi- and interdisciplinary cooperation projects and data exchange. As a modern research station in a clean natural laboratory, the ARCFAC will continue to play an important role in Europe, providing access to a large number of scientists from an increasing number of countries taking part in Arctic research.

All scientists are encouraged to submit a research project proposal to ARCFAC. The programme allows to get free access to the research infrastructure to conduct the fieldwork (or laboratory work) necessary for the project. Calls for proposals are announced twice a year. Deadlines for sending the project proposals are 30 September and 31 January each year.

Research stations:

- NPI: the Norwegian Polar Institute (Radiation Observatory, Biological Research Facility, greenhouse facility, meteorology, and polar logistics, project coordinator);
- KB: Kings Bay AS company (Arctic Marine Lab, experimental lab for research in marine biology and some physical sciences, manager of Ny-Ålesund transport and logistics);
- AWIPEV: a joint French-German research station run by the Alfred-Wegener Institute for Polar and Marine Research, and the Institut polaire français Paul Emile Victor (atmospheric, geophysical, glaciological, and biological research, and dedicated balloon launch facility);
- NILU: the Norwegian Institute for Air Research (Zeppelin Mountain Station meteorology, atmospheric and stratospheric research, and several global monitoring programmes);
- NMA: the Norwegian Mapping Authority (Space Geodetic Observatory, monitoring of the Earth's crust surface displacements and gravity variations, sea level changes, and interrelation between different space-geodetic techniques);
- NERC: the Natural Environment Research Council (Harland House, Earth and life sciences, laboratory, workshop, and logistics and safety support);
- CNR: the National Research Council of Italy, Dirigibile Italia (mostly atmospheric and biological research related to global change).

Landscape in Svalbard

'Aurora Borealis' icebreaker project

***The German Science Council evaluated the* Aurora Borealis *project in May 2005 and recommended the construction of the research icebreaker in 2006. Since March 2007, the German Federal Ministry for Science and Education (BMBF) has been funding a portion of the preparatory work for* Aurora Borealis.**

Polar research, both on land and in the sea, cannot achieve the needed progress without novel and state-of-the-art technologies and infrastructure. In addition there is the obligation to equip the upcoming young and courageous generation of polar researchers with the most modern and safest research platforms the 21st century can provide. This effort will require major investments, both in terms of generating new tools, as well as maintaining/renovating existing infrastructure. Major infrastructure items are in many cases too expensive, complicated and/or technically demanding to be run as national facilities. Schemes will have to be developed to found international consortia to generate and manage large scale international polar research infrastructures.

The European Commission identified this project for the European Strategy Forum on Research Infrastructures (ESFRI) roadmap. The Commission found that it reached the highest scientific priority for developing this large-scale infrastructure for basic research in Europe.

Polar research and in particular the properties of northern and southern high latitude oceans are currently a subject of intense scientific debate and investigations, because they are (in real time) and have been (over historic and geologic time scales) subject to rapid and dramatic change. Polar regions react more rapidly and intensively to global changes than other regions of the Earth. News about shrinking of the Arctic sea ice cover, potentially leading to an opening of sea passages to the north of North America and Eurasia, to a 'blue' Arctic Ocean, as well as about the calving of giant table icebergs from the ice shelves of Antarctica are examples for these modern dynamics.

Until now, it has not been clear how many of the profound changes in all areas of the Arctic are natural fluctuations or are due to human activity. Since this change has been a phenomenon for decades, long-term data series of atmospheric and oceanic conditions are needed to understand and predict its further development. Despite the strong seasonality of polar environmental conditions, research in the central Arctic Ocean up to now could essentially only be conducted during the summer months, when the Arctic Ocean is accessible to the currently available research icebreakers.

There are few modern research vessels capable of penetrating into the central Arctic. A new state-of-the-art research icebreaker is therefore urgently required to fulfil the needs of polar research and to document multinational presence in the Arctic. This new icebreaker would be conceived as an optimised science platform from the keel up and would allow the conducting of long, international and interdisciplinary expeditions into the central Arctic Ocean throughout all seasons of the year.

Aurora Borealis will be a novel research icebreaker with no national or international competitor because of its:

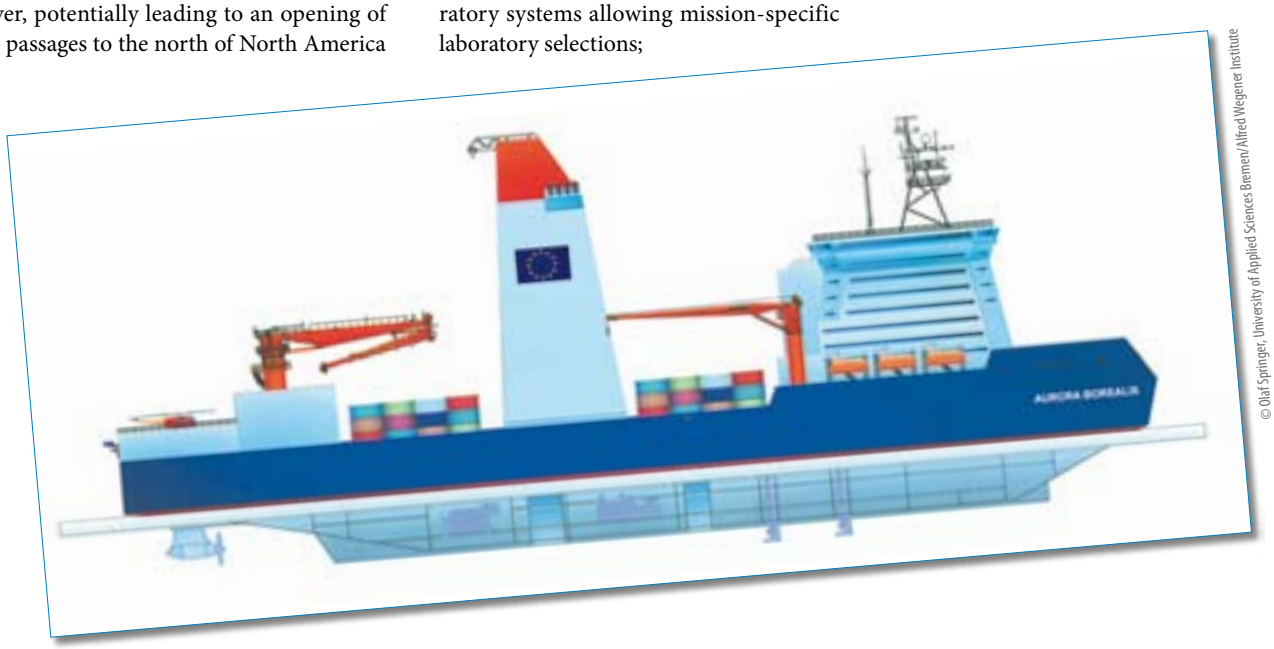
- drilling capability;
- sophisticated modularised mobile laboratory systems allowing mission-specific laboratory selections;
- moon pools for drilling and for the deployment of ROV and AUV for sub-ice surveys;
- propulsion and dynamic positioning systems and its capability for polar expeditions into high latitude ice-covered deep-sea basins also during the unfavourable seasons of the year.

The research vessel will be a powerful icebreaker with 44 000 t displacement and a length of 196 m, with 50 MW azimuth propulsion systems and a deep drilling capability for use in extreme conditions in excess of 4 000 m water depth. It will have high ice performance to penetrate autonomously into the central Arctic Ocean with 2.5 m of ice cover, during all seasons of the year.

The construction of *Aurora Borealis* as a joint European research icebreaker will result in a considerable commitment of the participating countries to coordinate and expand their polar research programmes in order to operate this expensive ship continuously and with the necessary efficiency. The *Aurora Borealis* will also be used to address Antarctic research targets, both in its mode as a regular research vessel as well as a polar drill ship.

In this project the final engineering work for the development of the vessel will be carried out under the coordination of the AWI and the University of Applied Sciences in Bremen, Germany. Additionally, the commitment of the European Science community will be promoted by organising workshops in different European countries to discuss the scientific plans and technical requirements for the *Aurora Borealis*.

Based on the contribution of Professor J. Thiede to the proceedings of the international symposium 'Polar environment and climate: The challenges'.



EUROPOLAR: The European Polar Consortium — strategic coordination and networking of European polar RTD programmes

The European Polar Consortium (EPC) is composed of 25 ministries and funding agencies from 19 countries, including the Russian Federation, and uses the mechanism and support of the FP6 ERA-Net scheme to structure and enhance the coordination of agencies and polar programmes, including those of the EU Member States and accession countries, and the Russian Federation.

EPC is jointly managed by the Institut polaire français Paul Emile Victor (IPEV) based in Brest, France, and the European Science Foundation (ESF). It contributes strongly to the ESF's role in the coordination of national research programmes in Europe and is the brainchild of the ESF European Polar Board.

EPC has completed a Europe-wide strategic survey of the programmes and infrastructures to determine overall European polar capacity and build the fundamental basis of a European polar management information system decision support/advisory mechanism for Europe in the polar regions. The survey indicate that Europe invests approximately EUR 500 million per year in programmes and infrastructures in the Arctic and Antarctic.

The assessment of the overall European polar research landscape is coordinated by the Italian Ministry of Education, University and Research and the Swedish Research Council. EUROPOLAR provides a basis for an overview of the entire elements of European polar financing, evaluation, management systems and facilities. It is a major step forward in planning and mutual cooperation between European countries and polar programmes, in a networking vision.

During the next year, EPC will develop European research partnerships in climate research, ice core science, polar technology and frontier sciences, including life in extreme environments. Major European polar infrastructure initiatives such as the *Aurora Borealis* European research icebreaker have been identified by the Commission's European Strategy Forum on Research Infrastructures (ESFRI) as a European priority, and will have synergies with the programmes developed within EPC. The basis for creating a European level network, and the reciprocal opening of Arctic and Antarctic research stations, is also being pursued within EUROPOLAR.

EPC has established for the first time in Europe a programme coordination framework for polar research involving government ministries. Dedicated funding instruments and the launching of calls in thematic areas will allow synergies with Framework Programmes and national priorities. The critical mass at European level that has been generated by bringing together the Arctic and Antarctic facilities will enable effective cooperation with Canada, southeast Asia and the United States. It has also contributed to the strategic development of IPY and enabled agencies to plan financial inputs and dialogue relating to evaluation.

The long-term goal of EPC is to establish robust and durable structures for coordination between European governments in the polar regions, and the strong input and cooperation with the Russian Federation is a major aspect of the consortium.

© Institut polaire français Paul Emile Victor (IPEV)

Project title

The European Polar Consortium — strategic coordination and networking of European polar RTD programmes

Project acronym

EUROPOLAR

Programme

FP6

Project type

Coordination action (ERA-Net)

Project start date

1.3.2005

Project duration

48 months

EU funding

EUR 2 484 993

Project coordinator

Gérard Jugie,
Institut polaire français Paul Emile Victor (IPEV), France

Partner countries

19

Partner institutions

25

Project website

http://europolar.esf.org

Please access the fact sheet of the project in the CORDIS projects database by entering the record control number 75895 in the search window on the CORDIS website.

http://cordis.europa.eu

ZZ-AH-07-S25-EN-C

Community Research and Development Information Service

CORDIS — the Community Research and Development Information Service — is an interactive information platform that keeps you up-to-date with the latest news, progress and initiatives in European research and development (R & D) activities.

CORDIS is free of charge and offers access to R & D funding programmes of the EU as well as to information on partnerships and involvement in R & D activities, and on research projects and their results. As such, it is the official entry point to the Seventh Framework Programme (FP7), its specific programmes, activities, themes and latest developments.

Further information on polar changes

http://ec.europa.eu/research/environment/index_en.htm

The EU supports research activities aimed at recommending practical ideas and technologies to help solve the environmental problems facing Europe and the world. The website explains how the European Commission's 'Environment research programme' is tackling this huge research challenge through the right policies, projects and people.

http://www.ipy.org

The 'International Polar Year' (IPY) is a programme focused on the Arctic and the Antarctic from March 2007 to March 2009. IPY will involve thousands of scientists, students, engineers, technicians from at least 60 countries and represents the largest coordinated international scientific effort. The website provides information on all the projects endorsed by IPY.

http://ec.europa.eu/environment/climat/campaign/index_en.htm

Climate change is a global problem, and yet each one of us has the power to make a difference in our daily behaviour to help preventing greenhouse gas emissions without affecting our quality of life. The Commission's 'You control climate change' campaign is helping individuals contribute to the fight against climate change.

CORDIS *focus*

Free!

Subscription form

Title First Name Surname

Address Postcode Country

Language and quantity required: ☐ Spanish ☐ German ☐ English ☐ French ☐ Italian ☐ Polish

To change or cancel an existing subscription, please supply your 'subscription registration' number: 0/.....
and tick as appropriate: ☐ Change ☐ Cancel

To subscribe, fill in and return this form to: CORDIS *focus*, OPOCE, B.P. 2201, L-1022 Luxembourg
or subscribe online at: http://cordis.europa.eu/news/focus/subscribe_en.html

EN

Publications Office
Publications.europa.eu