

## Programme of Work

### Wednesday 26 October

- 10:00 - 12:00 Arrival, registration and poster set up
- 12:00 - 13:00 Lunch
- 13:00 - 13:45 Opening session:
  - Ki Andersson, British Council Sweden – “INYS”
  - Svante Björck – Welcome to the GeoBiosphere Science Centre
  - Ian Snowball – The programme
- 13:45 - 14:45 Keynote Lecture I:
  - Prof. Hans von Storch
  - “Determining the added value of Regional Climate Modelling”*
- 14:45 - 15:15 Short poster presentations I
- 15:15 - 15:45 Coffee break and posters
- 15:45 - 16:15 Short poster presentations II
- 16:30 - 17:30 Keynote Lecture II:
  - Prof. Eelco J. Rohling
  - “Centennial-scale climate cooling with a sudden cold event around 8,200 years ago”*
- 18:00 - 19:00 Reception at Hotel Concordia
- 19:30 Dinner at Fellini

### Thursday 27 October

- 08:30 - 09:00 Short poster presentations III
- 09:00 - 10:15 Round-table discussion I:
  - “Back to basics – how do studies of past climates, of the present climate and of the future climate(s) relate to each other?”*
- 10:15 - 10:45 Coffee break and posters
- 10:45 - 11:45 Keynote Lecture III:
  - Dr. Richard Jones
  - “What can we use a global climate model for?”*
- 11:45 - 13:00 Lunch
- 13:00 - 14:15 Round-table discussion II:
  - “What has been observed but not modelled, and what has been modelled but not observed?”*
- 14:15 - 15:15 Keynote Lecture IV:
  - Prof. Bert Bolin
  - “To use scientific knowledge on climate change in politics”*
- 15:15 - 15:40 Coffee break and posters
- 15:40 - 16:15 Short poster presentations IV
- 16:15 - 17:30 Round-table discussion III:
  - “Climate change: is it a storm in a tea cup?”*
- 17:30 - 18:30 Keynote Lecture V:
  - Dr. Jouni Räisänen
  - “Anthropogenic climate change versus natural variability: a probabilistic view on the next few decades”*
- 19:30 Dinner at the Grand Hotel

### Friday 28 October

- 09:00 - 10:00 Keynote Lecture VI:
  - Prof. Torben Christensen
  - “Towards a comprehensive understanding of land-atmosphere interactions in the sub-Arctic”*
- 10:00 - 10:30 Coffee break and posters
- 10:30 - 11:45 Round-table discussion IV:
  - “Climate sensitivity: how much shade can there be in the future greenhouse?”*
- 11:45 - 12:45 Lunch and posters down
- 12:45 - 14:00 Summary and concluding remarks
- 14:15 Bus to Copenhagen and the Ice Core visit
- 19:30 Dinner at Restaurant Cap Horn

## Organisers' Biographies



### Professor Svante Björck

*Quaternary Sciences, GeoBiosphere Science Centre, Lund University, Sweden*

Professor Svante Björck, Head of Quaternary Sciences at the GeoBiosphere Science Centre in Lund, took his Doctoral degree in Quaternary Geology in 1979 at Lund University. He spent one year as a post-doc in the USA, followed by 6 years as a senior research assistant in Quaternary Geology in Lund. In 1988 he was appointed to a higher research position in Cenozoic palaeoclimatology by the Swedish Research Council, and in 1994 he was appointed professor in Quaternary Geology at the Geological Institute, University of Copenhagen.

In 2000 he returned to Lund and the professorial chair in Quaternary Geology/Quaternary Sciences. Svante Björck has worked with palaeoclimatology and sea level related research in many regions, from Greenland to Antarctica, focused on the last glacial cycle.

His work has often been aimed at chronological issues and lead-lag related mechanisms, and inter-hemispheric palaeoclimatic correlations. He is a member of the Swedish Royal Academy of Science.



### Professor Richard Bradshaw

*Department of Geography, Liverpool University, UK*

Richard Bradshaw is a palaeoecologist with broad interests in long-term environmental change and biodiversity. A focus of his research has been the relative importance of climate change and human activity as drivers of landscape dynamics. During his Ph.D. at Cambridge University, he developed techniques for generating vegetation reconstructions of high spatial resolution that provide the link between local and regional scales in the study of vegetation dynamics. He held post-doctoral positions in the USA and at Edinburgh and his first faculty position was at Trinity College Dublin as lecturer in palaeoecology. In 1988 he moved to Sweden with the award of a six year senior research council fellowship. During its tenure he made significant international contributions to the theory and practice of protecting forest biodiversity and providing goals for nature-near forest management. His research group was judged to have made one of the top contributions to forest research relevant for the next century during a millennial review by the Swedish Society of Foresters. He was selected as a Vega Medal lecturer by the Swedish Geographical Society in 1998.

In 1997 he was appointed as Danish State Geologist to head a new research department of Environmental History and Climate Change within the Ministry of Environment and he now leaves the Ministry in Copenhagen to join Liverpool University. His background is therefore a combination of teaching, research and governmental and industrial advisory work which is a powerful base from which to address current issues of climate change and land-use.

Richard has 91 refereed international publications. He has supervised 12 Ph.D. and numerous masters students. He has been a member of the Swedish Natural Science Research Council, the advisory boards of the Finnish Biodiversity Research Programme and the European Pollen Database. He has acted as an expert advisor to the European Union, the European Environmental Agency, the Danish Ministry of the Environment, the Swedish Nature Protection Agency and forest companies and organisations. He has co-ordinated and participated in several international and national projects and currently heads the EU-ESF EUROCLIMATE project DECVEG, in which eight European research groups study climate-vegetation impacts and interactions. He is a major partner in the EU-funded network EVOLTREE where his group will study ancient DNA of European trees.

## Organisers' Biographies

### Dr Markku Rummukainen

*Rosby Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden*

Markku Rummukainen has a Ph.D. in Meteorology and he is currently the Head of Rosby Centre, the 14-person strong regional climate modelling research unit of the Swedish Meteorological and Hydrological Institute in Norrköping, Sweden. He is also Docent (lecturer without being a regular faculty member) in meteorology at the University of Helsinki, Finland. In 2000-2003 he served as the Programme Director of the Swedish regional climate modelling programme, SWECLIM 1996-2003, a major national research network effort.

The Rosby Centre was established in 1997 as the core resource of SWECLIM. Since 2003, the Rosby Centre has belonged to the Research Department of SMHI. The efforts at the Rosby Centre include developing, evaluation and applying advanced regional climate modelling in areas such as climate change research, the results of which are used in, for example, impact research. The Rosby Centre work is driven both by scientific challenges and the needs of users such as other national authorities and enterprises, as well as the various county and local administrations. The results are extensively used in such national climate-related areas as public information, formulation of policies, and in discussing adaptation needs. The Rosby Centre is also involved in a number of collaborative national, European and international climate research projects.

Markku Rummukainen has also a background in stratospheric ozone research including measurement campaigns, monitoring, analysis and global modelling of the chemistry, dynamics and composition of the Middle Atmosphere.



### Dr Ian Snowball

*Quaternary Sciences, GeoBiosphere Science Centre, Lund University, Sweden*

Ian Snowball is a Senior Lecturer (Docent) in Quaternary Sciences at the GeoBiosphere Science Centre at Lund University, Sweden, which was established in 2003 after an amalgamation of the departments of Geology and Physical Geography/Ecosystem Analysis. He is also the head of its Palaeomagnetic and Mineral Magnetic Laboratory.

Raised in London UK, he obtained a Bachelor of Sciences degree in Physical Geography and Ecology from Loughborough University in 1984 and worked in the Department of Geophysics at Edinburgh University between 1985 and 1989. In 1990 he moved to Lund, Sweden and passed the examination for a Doctoral degree in Quaternary Geology in 1995.

His basic research has covered various aspects of climate and environmental change in North Western Europe during the last 50,000 years, including the reconstruction of glacial activity in northern Sweden, ocean circulation in the North Atlantic, past levels of solar activity and dynamics of the geomagnetic field.

Ian Snowball has contributed to the administration of several international research programmes, such as the International Geosphere-Biosphere Programme core project Past Global Changes (IGBP-PAGES), the Nordic Arctic Research Programme (NARP) and the European Science Foundation (ESF).



## Organisers' Biographies



### Dr Richard Jones

*Met Office, Hadley Centre, UK*

Richard Jones has worked at the Hadley Centre since 1990 where he developed the Met Office's regional climate model (RCM) and has subsequently managed the Hadley Centre's extensive regional modelling programme. This now includes a regional climate modelling system, PRECIS, designed to run on PCs and to provide detailed projections of climate change over any region of the globe. Results from this programme are now increasingly being used in climate impacts assessments, for example by the UK Climate Impacts Programme and by adaptation projects in India, China, Africa and South and Central America.

Central to this work is performing and guiding research into understanding regional climate change. Due to his experience, he has been involved with the Intergovernmental Panel on Climate Change for many years (as a lead author of the 2001 Third Assessment Report and currently with Assessment Report 4).



### Professor Keith Briffa

*Climatic Research Unit, University of East Anglia, Norwich, UK*

Keith Briffa was born in 1952 and is currently Deputy Director of the Climatic Research Unit at the University of East Anglia in Norwich, UK, where he has worked since 1977. His primary research interests are in the general area of late Holocene climate change, with a geographical emphasis on Europe and northern Eurasia. His specialism is dendroclimatology, the study of tree growth for the purposes of climate reconstruction. He has produced detailed reconstructions of individual summer temperature patterns across the Northern Hemisphere spanning some 600 years and a number of widely cited longer regional reconstructions of past climate variability (for example in Canada, Fennoscandia and Northern Siberia), often used by other researchers studying the changes in Hemispheric mean temperature through the last millennium.

Besides tree-ring research, his interests encompass the study of recent climate change based on instrumental records, and the theory and general application of various palaeoclimate data for describing 'natural' climate variability, its relationships with possible forcing factors and use for anthropogenic climate change detection.

For six years (1994-2000) he served on the Scientific Steering Committee (SSC) of the International Geosphere-Biosphere Past Global Changes programme (PAGES) and recently on the SSC of the UK NERC Rapid Climate Change programme (RAPID). He currently sits on the PAGES/CLIVAR Intersection committee and the SSC of the European Science Foundation's HOLIVAR programme.

He has co-ordinated several large EU-funded research projects and is currently joint co-ordinator (with Dr. Tim Osborn) of SOAP, a collaboration between eight European data and climate modelling groups in five countries, exploring the empirical evidence for climate changes and their links to possible forcing factors over the last 500-1000 years, and the realism with which these are simulated by two policy-relevant coupled ocean/atmosphere models developed in the UK and Germany.

He is an Associate Editor of the journals *The Holocene*, *Dendrochronologia*, and *Boreas*.

## Speakers' Biographies



### Professor Bert Bolin

*Department of Meteorology, University of Stockholm (MISU), Sweden*

Bert Bolin is a meteorologist and Professor emeritus of meteorology at the Meteorologiska institutionen (MISU), Stockholm University, Sweden.

He was a founding chair of the Intergovernmental Panel on Climate Change (IPCC), has been a member of the Scientific Advisory Board to the Swedish Government and Scientific Advisor to the Swedish Prime Minister and vice Prime Minister. He was also instrumental in the initial formulation of the World Climate Research Programme (WCRP) in the 1970's.

Bert Bolin has published more than 150 scientific papers and books, mostly concentrating on the subjects of meteorology and climate change and has received many awards and honours, including the OMI (Organisation Météorologique Internationale, Geneva) medal in 1981, the Carl-Gustaf Rossby Research Medal in 1984 and the Blue Planet Prize (Japan) in 1995, for his work in climate research.



### Professor Torben Røjle Christensen

*Department of Physical Geography and Ecosystems Analysis,  
GeoBiosphere Science Centre, Lund University, Sweden*

Torben Christensen is a Professor at Lund University, Sweden and currently (2004-2007) also part-time Professor at the Royal Swedish Academy of Sciences placed at the Abisko Scientific Research Station. His background is in environmental biology and Arctic biogeochemistry. His expertise is in Arctic and sub-arctic ecosystems, taiga and tundra. His research has focused on trace gas exchange of controlling variables, ground-based flux measurements (methane, carbon dioxide) and controlled environment studies.

Further keywords are carbon cycling response to climate change, climate feedbacks, vegetation changes and responses in ecosystem functioning in the past, current and future predictions. Within these research areas Torben Christensen has published 45+ original peer-reviewed articles and book contributions during the past 12 years.

He is co-chair of the Swedish National IGBP/WCRP Committee, chairman of the Feedbacks from Arctic Terrestrial Ecosystems (FATE) Working Group under the International Arctic Science Committee, member of the Scientific Steering Committee for IGBP-iLEAPS, member of Scientific Board for the Basic Ecological Research and Monitoring Programme at Zackenberg Research Station, NE Greenland and associate editor of *Biogeochemistry*.



### Dr Richard Jones

*Met Office, Hadley Centre, UK*

Richard Jones has worked at the Hadley Centre since 1990 where he developed the Met Office's regional climate model (RCM) and has subsequently managed the Hadley Centre's extensive regional modelling programme. This now includes a regional climate modelling system, PRECIS, designed to run on PCs and to provide detailed projections of climate change over any region of the globe. Results from this programme are now increasingly being used in climate impacts assessments, for example by the UK Climate Impacts Programme and by adaptation projects in India, China, Africa and South and Central America.

Central to this work is performing and guiding research into understanding regional climate change. Due to his experience, he has been involved with the Intergovernmental Panel on Climate Change for many years (as a lead author of the 2001 Third Assessment Report and currently with Assessment Report 4).



# Speakers' Biographies

## Professor Eelco J Rohling

*National Oceanography Centre, Southampton, UK*

Over the last 11 years, Prof. Rohling has supervised a total of nine (completed) and six (current) Ph.D. students. He is the current Chairman of IMAGES (International Marine Global Change Study); Vice-President of the EGU Division on Climate: Past, Present and Future (section Palaeoclimatology); editor of the new EGU-journal *Climate of the Past*; associate editor of *Palaeoceanography*; and editorial board member of *Geology*.

Prof. Rohling has published over 75 papers. His main research interests are: (1) High-resolution investigation of Neogene ocean/climate and sea-level changes, with emphasis on the Late Quaternary; (2) Theoretical and applied (integrated with proxy records) modelling of present-day and past states of circulation and property distribution; and (3) Theoretical and practical/analytical research on the use of conservative properties and stable oxygen isotopes to trace deep-water formation, advection and mixing processes in the modern ocean.



## Dr Jouni Räisänen

*Division of Atmospheric Sciences, University of Helsinki, Finland*

Jouni Räisänen was born in Helsinki, Finland in 1968. He got his Ph.D. in meteorology from the University of Helsinki in 1998. He worked for five years at Rossby Centre, Norrköping, Sweden before returning in 2003 to the University of Helsinki to take a position as a lecturer in meteorology.

He has a long experience in the analysis and intercomparison of global and regional climate change simulations and a special interest on the probabilistic interpretation of climate projections. He has published 25 peer-reviewed journal articles and is one of the lead authors of the chapter on regional climate changes in the IPCC 4th Assessment Report to be completed in 2007.



## Professor Hans von Storch

*Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany*

Hans von Storch is a director of the Institute for Coastal Research at the GKSS Research Centre (Germany) and Professor at the Meteorological Institute at the University of Hamburg in Germany.

His scientific interests are statistical analysis (especially transfer functions relating large-scale climate to local features, identification of modal structures in geophysical fields; data driven simulations), simulation of regional climates and pathways of matter, palaeoclimatic modelling, and transfer of knowledge from natural sciences to the public arena (in cooperation with social and cultural scientists).

He has published nine books and numerous articles and is in charge of a number of projects. He is member of the advisory boards of the journals: *Journal of Climate* and *Meteorologische Zeitschrift*, and *Annals of Geophysics*; and of the organisations Danmarks Klimacenter and Institut für Atmosphärenphysik (Kühlungsborn, Germany), and organiser of the GKSS School on Environmental Research. He is a member of the steering committee of the International Meeting on Statistical Climatology and of the committee for the Eduard Brückner award.



## Participants' Biographies



### Susanne Lildal Amsinck

*Department of Freshwater Ecology, NERI, Denmark*

Susanne Lildal Amsinck obtained her MSc degree in microbiology in 1998 at Aarhus University (Denmark) and has since been working in the Lake Group at the National Environmental Research Institute (Denmark). Her key research activity is the development and application of zooplankton-based (qualitative and quantitative) palaeoecological tools to investigate past conditions, changes and trends of freshwater and brackish lakes related to environmental and climate change.

In 2003, Susanne obtained her Ph.D. degree and now holds a 2-year post-doc position financed by the Carlsberg Foundation, focusing on illuminating the impact of climatically induced changes on biological structure in North-Atlantic lakes during the last 10,000 years. Susanne is also involved in university teaching (MSc and Ph.D. courses), studies of food-web interactions in sub-arctic and arctic freshwater lakes and participates in the projects EUROLIMPACS (<http://eurolimpacs.ucl.ac.uk>, funded by EU) and CARE (Comprehensive analysis of recovery of eutrophicated lakes, funded by the Finnish Scientific Research Council), both focusing on the effects of interactions between climate and human activities on freshwater ecosystems and encompassing detailed palaeolimnological investigations.

More recently, Susanne has been working on the implementation of the EU Water Framework Directive in Denmark and the Action Plan for the Aquatic Environment – Wetlands.



### Camilla Snowman Andresen

*Quaternary Sciences, GeoBiosphere Science Centre, Lund University, Sweden*

In 1998 Camilla Snowman Andresen finished her Masters thesis at the University of Copenhagen, which involved a study of the Intra-Allerød Cold Period on the basis of lake sediments from Jutland, Denmark. After working as a research assistant, she started her Ph.D. in 2000 at the University of Copenhagen and evaluated Holocene climate variability in the Denmark Strait region on the basis of a lacustrine record from southern Greenland and a marine record from the northwest Icelandic shelf.

She is skilled in numerous proxy methods such as pollen (University of Copenhagen), foraminifera studies (University of Lund), biogenic silica measurements (Danish National Environmental Research Institute), macrofossils (Geological Survey of Denmark and Greenland) and petrologic provenance studies (Lamont Doherty Earth Observatory of CU). Presently she has a two year post doc position in Lund participating in a Swedish Research Council funded project that aims to investigate late Quaternary coupling in climate between the northern and southern hemisphere. A number of terrestrial study sites have been chosen along a transect in the Atlantic Ocean (Southern Greenland, Iceland, Faeroe Islands, Azores, Tristan da Cunha, Grenada, Antarctic Peninsula) and Camilla S. Andresen investigates sediments from two lakes on the Faeroe Islands.

In the future she would like to continue working with investigations of patterns in climate variability during the Holocene on the basis of marine and lacustrine sediment stratigraphies.



### Jenny Brandefelt

*Department of Meteorology, Stockholm University (MISU), Sweden*

Jenny Brandefelt graduated at Stockholm University as a Master of Science in Meteorology 1998. She was enrolled as a Ph.D. student at the Department of Meteorology at Stockholm University (MISU) the same year. In June 2005, Jenny successfully defended her doctoral thesis, "Atmospheric circulation regimes and climate change". The primary focus of the work presented in the thesis is the response of the climate system to the enhanced greenhouse gas forcing. Her research deals with the interplay between the natural variability of the climate system and the changes forced by external factors.

Jenny is currently working at MISU, setting up a coupled global climate model (CGCM). The model is set up for use by Ph.D. students and others at MISU. Jenny is also planning to use this CGCM to study the natural variability of the climate system.

# Participants' Biographies

## Göran Broström

*Department of Meteorology, Stockholm University, Sweden*

Göran Broström received his Ph.D. at Göteborg University in 1997 working mainly on the oceanic carbon cycle, and earned the title Associate Professor (Docent) in 2004. He received a postdoctoral position at Massachusetts Institute of Technology (MIT) in 1998 where he stayed for 2 years and worked on the oceanic carbon cycle and biogeochemical modelling. In 2000 he returned to Göteborg, Sweden, where he held a 3 year position sponsored by the Knut and Alice Wallenberg foundation.

From May 2003 he has held a position as junior lecturer at the department of Meteorology, Stockholm University. His present research is devoted to the dynamics of the basin scale ocean circulation using numerical and analytical tools. It is expected that Göran's future work will be devoted to the large-scale ocean circulation dynamics and its coupling to the biogeochemical cycle.



## Kendrick Brown

*Geological Survey of Denmark and Greenland (GEUS), Denmark*

Kendrick Brown received a Ph.D. (2000) from the University of Victoria, School of Earth and Ocean Sciences, Canada. His dissertation focused on the origin, evolution, and dynamics of coastal temperate rainforests in western North America. He then completed two post-doctoral fellowships at the University of California, Davis (2000-2002) and Duke University (2002-2004) focusing on wetland restoration and aridity cycles in the Northern Great Plains respectively. He was awarded a European Union Marie Curie Fellowship (2005-2007) which is being held at the Geological Survey of Denmark and Greenland, Department of Quaternary Geology.

His current research focuses on European fire history reconstruction. Other research interests include examining post-glacial landscape and ecosystem evolution, development of climate transfer functions and spatio-temporal modelling of past climates, high resolution analysis of lake cores with emphasis on characterising short-term climate cycling, and evaluating the impacts of black carbon deposition on Greenland ice sheet margin melting.

Awards and recognitions in 2005 include an Editors' Choice feature in the journal Science and a National Geographic News article on centennial climate cycling.



## Erasmus Buonomo

*Met Office, Hadley Centre, UK*

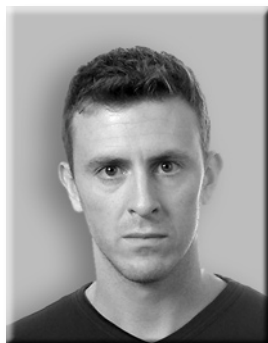
Erasmus Buonomo graduated in Theoretical Chemistry in 1992, at the University "La Sapienza" Rome, where he continued his studies working on the predissociation of ionic clusters, obtaining a Ph.D. in Physical Chemistry in 1996. His post-doctoral activities started with a one year project on the use of parallel computers for theoretical chemistry calculations at the computing centre of University "La Sapienza" Rome (CASPUR), after which he moved to University College London (UK) to work on a European Union funded project on astrochemistry. As a theoretical chemist, his research interests ranged from calculations of molecular interactions, inelastic molecular collisions, predissociation of molecules and clusters, the theory and computation of chemical reactive systems and the design and implementation of parallel software for computational chemistry.

In 2002 he switched to climate research by joining the Regional Climate Modelling group at the Hadley Centre, working mostly on the validation of the climate models. His current research activity is in the understanding of the physical mechanisms behind the modelled changes in a greenhouse-gas forced climate, focusing in particular on the precipitation processes.





# Participants' Biographies



## Simon Crooks

*Atmospheric, Oceanic and Planetary Physics, University of Oxford, UK*

Between 1997 and 2000 Simon studied for a B.Sc. in Mathematics at UMIST. Having gained a 1st Class Honours degree and achieving the highest mark amongst his peers on this degree course, he then studied for a MSc in Applied and Computational Mathematics at the Oxford Centre for Industrial and Applied Mathematics at the University of Oxford (2000-2001).

During this period Simon completed a dissertation entitled "The Solar Wind", in which he investigated the reasons for the high temperatures observed in the Sun's corona, and for an explanation of the reasons for the initial acceleration of the high speed solar wind. Having fuelled his interest in the physical application of mathematics, he went on to study for a D.Phil. in the physics department at Oxford (2001-2004). Simon investigated the solar influence on the Earth's climate, with a particular interest in the possible impacts of the Sun's 11-year cycle on temperatures in the lower and middle atmosphere. During his D.Phil., Simon developed as interest in time series analysis and signal-to-noise optimisation techniques.

Simon is now working as a Postdoctoral Research Associate at the University of Oxford, on the more general topic of detection and attribution of climate change.



## Anna Ekberg

*Department of Physical Geography and Ecosystems Analysis,  
GeoBiosphere Science Centre, Lund University, Sweden*

Anna Ekberg's research is mainly concerned with biosphere-atmosphere carbon (C) and nitrogen (N) exchange in different ecosystem types and climatic regions. As a Master's degree project (1997, Plant Ecology, Lund University, Sweden) she studied the effects of increased N deposition on the accumulation rate of organic material in a boreal mire. Wetland biogeochemistry has since been a major scientific interest of Anna's and in her Ph.D. project (1997-2001, Plant Ecology, Lund University, Sweden) she studied methane (CH<sub>4</sub>) exchange dynamics in boreal and arctic wetland ecosystems. The focus was on the relationship between vascular plant production and CH<sub>4</sub> production, consumption and emission.

Between 2002 and 2004, Dr. Ekberg was a Marie Curie postdoctoral fellow at the Max Planck Institute for Biogeochemistry in Jena, Germany. She continued working on C and N exchange in relation to the biotic and abiotic environment and investigated how fluxes are influenced by primary production, biodiversity and the occurrence of wild-fires. At present, Anna holds a postdoctoral fellow position in the Marie Curie Excellence Team on Exchange Processes in the Land Surface Atmosphere System at the Department of Physical Geography and Ecosystems Analysis, Lund University, Sweden.

A key objective of the team's research is to quantify biogenic volatile organic compound (BVOC) emissions and their environmental control in relation to photosynthesis and net surface-atmosphere carbon exchange. Biogenic particle formation is studied in relation to the BVOC emissions and leaf level as well as ecosystem flux data will be used to develop and test novel regional and global models. Anna is responsible for the leaf level measurements and has recently completed a first set of field experiments on a mire underlain by discontinuous permafrost in sub-arctic Sweden.



## Annica Ekman

*Department of Meteorology, Arrheniuslab, Stockholm University (MISU), Sweden*

Annica Ekman received her Ph.D. in June 2001 at the Department of Meteorology, Stockholm University (MISU), Sweden and has after that worked as a Wallenberg research fellow on sustainability and the environment at the Massachusetts Institute of technology (MIT) for 2.5 years. At present, she has a position as a researcher at MISU in Sweden.

Her thesis work was focused on sulphate aerosols and their effect on the European climate. Since then she has been studying the interaction of aerosols and convective clouds as well as general aerosol formation and dispersion in the upper troposphere. This work has involved collaboration with scientists from the Rossby Centre (Sweden), MIT (USA), CMM (Chile) and FMI (Finland).

Her major research interest is to examine how aerosols interact and affect the atmosphere in which we live from the aspects of both health and climate. These studies are conducted both on a local and regional scale as well as from a global point of view.

# Participants' Biographies

## Hayley Fowler

*Water Resource Systems Research Laboratory, School of Civil Engineering and Geosciences,  
University of Newcastle upon Tyne, UK*

Dr. Hayley Fowler is a senior research associate in the Water Resource Systems Research Laboratory, School of Civil Engineering and Geosciences at Newcastle University (UK), where she has worked since 2001. She graduated in 1996 with the top first in Physical Geography at Cambridge University, receiving a distinction in MSc Water Resource Systems Engineering at Newcastle University, before completing her Ph.D. on "The impacts of climatic change and variability on water resources in Yorkshire" in 2000.

Since then her research has concentrated on the impacts of climate change and climatic variability on drought and water resource reliability, the development of new downscaling techniques for climate change scenario construction using stochastic rainfall models, observed hydro-climatic variability in the UK, Europe and the Karakoram, and extreme rainfall and flood risk for present and future climates.

She leads the Newcastle involvement in the AquaTerra (FP6 Integrated Project) and FOOTPRINT (FP6 STREP) projects, coordinating the HYDRO sub-project within AquaTerra, and is involved in several UK Research Council and Environment Agency funded projects, specialising in the production of climate change scenarios and impact methodologies for hydro-climatological research.



## Thomas Giesecke

*Geological Survey of Denmark and Greenland (GEUS), Denmark*

Thomas Giesecke was born in Berlin (Germany) in 1972. He developed a strong interest in Landscape Ecology, which led him to study Geography. Thomas enrolled at Humboldt University Berlin in 1993 and chose Biology and Chemistry as minor subjects. Beside his studies of Geography, he developed an interest in limnology, and worked part time in a limnological research institute. During a one-year studentship at the University of Toronto (Canada) Thomas took the chance to study palaeoecology and became involved in research projects aiming at climate reconstructions in Ontario as well as in the reconstruction of Human activity in Switzerland. In his Masters project he studied the late Quaternary vegetation history, landscape development and historical human impact of a small catchment in eastern Germany, using pollen and geochemical analyses as well as historical and archaeological sources. For this work, which followed his own design, he was awarded the "Katharina-Heinroth-Preis".

Immediately after finishing his degree in Geography in 1999 he went to Uppsala University (Sweden) and started his investigations on the spread of spruce in Scandinavia. Thomas defended his Ph.D. in autumn 2004 and has been employed as part of a European Science Foundation endorsed project since spring 2005.

In pursuing his interest in pollen representation he became a member of the POLLANDCAL and the Pollen Monitoring Project networks. He is keen on new techniques that help quantifying past vegetation change and he is searching for a better understanding of factors determining past plant distribution, abundance and interaction on a sub-continental scale.



## Dan Hodson

*Department of Meteorology, University of Reading, UK*

After obtaining a Ph.D. in Theoretical Physics, Dan joined the Centre for Global Atmospheric Modelling at Reading in the UK, in 2001. For two years he worked on the EU Framework5 PREDICATE project – which examined the mechanisms and predictability of decadal fluctuations in Atlantic-European climate. He is now working as part of the European Union Framework6 DYNAMITE project, which seeks to quantify the strongly- and weakly-coupled processes underlying the natural variability of ENSO and NAO/AO.

Dan's main research interest is the impact and causes of variability of climate on decadal and multidecadal timescales, in particular how long timescale changes in the Atlantic ocean – including thermohaline circulation – may influence the global climate. He is also interested in the implications that such decadal signals may have for the predictability of future climate. Additionally he is trying to understand the role that global climate modes such as ENSO or the North Atlantic Oscillation play in (multi-decadal climate variability – specifically the possible interactions between ENSO, the NAO and the ocean thermohaline circulation.



## Participants' Biographies



Helen L Johnson

*Department of Meteorology, University of Reading, UK*

After an undergraduate degree in Physics and Meteorology at the University of Reading, UK (with a scholarship from the UK Met Office), Helen worked as a research assistant in the Physical Oceanography group at Massachusetts Institute of Technology (MIT), USA, for a year before returning to the University of Reading as a Ph.D. student. Advised by Prof. David Marshall, she developed a simple theory for the time-dependent response of the Atlantic overturning circulation to variability in the high-latitude North Atlantic.

As a postdoctoral research scientist at the University of Victoria, Canada, Helen then worked on turbulent ocean mixing and the dynamics of flow through straits, and gained experience in observational oceanography techniques and teaching. Currently a Royal Society University Research Fellow at the University of Reading,

Helen's overarching interest lies in understanding the ocean circulation, in particular the Atlantic's thermohaline circulation, and the role it plays in global climate variability and change. At present she is trying to understand the influence of high-latitude ocean dynamics and fresh water forcing on the overturning in the Atlantic, using simple theoretical ideas, finite element analysis and more conventional numerical models, and collaborations with observational oceanographers working in the Canadian Archipelago.



Erik Kjellström

*Rosby Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden*

Dr. Erik Kjellström finished his Bachelor degree in meteorology at Stockholm University in 1992. After the completion of his Ph.D. in 1998 in Chemical Meteorology at Stockholm University he received a fellowship from the Knut and Alice Wallenbergs Foundation and spent one year as a post-doctoral fellow in Environmental and Sustainability Studies at Massachusetts Institute of Technology in Cambridge, USA.

During his Ph.D. studies, the post-doc time, and for an additional three years after the return to Sweden and the Stockholm University, he worked in the field of Chemical Meteorology with studies relating to dispersion modelling and the atmospheric part of the biogeochemical cycles of Sulphur and Carbon. In 2003 he joined the Rosby Centre at SMHI and the scope of his work shifted into regional climate modelling.

At the Rosby Centre he is working on the evaluation of regional climate-modelling experiments. The research includes analysis of the simulated climates both in historical time periods and in present-day conditions as well as projections for future time periods. His research interests include changes not just in mean conditions, but also in the variability around the mean, including extremes.



Lone Liboriussen

*Department of Freshwater Ecology, National Environmental Research Institute, Denmark*

Lone Liboriussen has a degree in Biology and since 1998 has been working with shallow lake systems. She was awarded her Ph.D. in Biology from the University of Aarhus (Denmark) in April 2003 for the thesis "*Production, regulation and ecophysiology of periphyton in shallow freshwater lakes*". Her key research areas are periphyton (attached algae communities) and primary production in shallow lakes – with special emphasis on the effects of resources, grazing and physical conditions on the distribution, regulation and ecophysiology of primary producers and the benthic-pelagic coupling within different lake types.

Since 2003 she has been working in the 'Lake Group' at the National Environmental Research Institute (NERI) in Denmark, where much of her research has been on the effects of climate change on lake ecology. She is involved in the Danish cross-disciplinary climate research project CONWOY ([www.conwoy.ku.dk](http://www.conwoy.ku.dk)) and in the European Union funded climate change EUROLIMPACS project ([www.eurolimpacs.ucl.ac.uk](http://www.eurolimpacs.ucl.ac.uk)), being one of the key persons in the design, establishment and management of a long-term climate-warming mesocosm experiment.

## Participants' Biographies

### Hans Linderholm

*Physical Geography, Göteborg University, Sweden*

Hans Linderholm (Ph.D. in 2001 at Stockholm University) is employed at the Department of Earth Sciences, Göteborg University. He also has a position as a visiting scientist at the Laboratory for Climate Studies, National Climate Centre, Beijing, China.

Using tree-ring data he is attempting to reconstruct regional climate change and variability, especially in Fennoscandia and China, for the last 1000 years. The focus is on reconstructing past changes in temperature and precipitation (including floods and droughts), and on better understanding the effect of large scale atmospheric circulation on local and regional climates. He is also studying the ecological effects of climate change, such as changes in growing season length, and the effects of global warming on sensitive forest ecosystems. From 2005 to 2008, he will hold a position as a Research Fellow funded by the Swedish Research Council.

He is the principal investigator of a project in China (funded by the Swedish International Development Cooperation Agency) where past climate variability, with focus on the Asian monsoon, in the Shaanxi Province is studied. He has collaborated extensively with research colleagues in Europe and Asia, and future plans include projects in Russia and South America. He was contributing author to a chapter (14) in the recent Arctic Climate Impact assessment (ACIA)-report.



### Sirpa Rasmus

*Department of Physical Oceanography, Finnish Marine Research Institute, Finland*

Sirpa Rasmus has studied Geophysics, Physics, Mathematics and Environmental Sciences at the University of Helsinki, and obtained her M.Sc in Geophysics in 1999. She worked on her Ph.D at the University of Helsinki Snow and Ice Graduate School, and later on a personal grant.

She finished her Ph.D, entitled "Snow pack structure characteristics in Finland – measurements and modelling" in 2005. In her work she presented measurements on snow pack structure conditions in different parts of Finland. The observations were used to validate a Swiss SNOWPACK-model. The model was used together with the regional climate model outputs to estimate possible future snow conditions in Finland. During her research she also collaborated with plant ecologists and reindeer researchers in a variety of winter ecological projects.

At the moment she is working as a scientist at the Finnish Institute of Marine Research, studying cloud forcing in Antarctica. Her main research interest is in the coupling of local climate, snow conditions and vegetation. She is interested in studying how possible climate change affects the snow pack structure and over-wintering conditions of plants. She is planning an interdisciplinary project on snow-vegetation interaction in boreal coniferous forests in collaboration with researchers with the same interests in other countries.



### Sune Olander Rasmussen

*Ice and Climate Research, Niels Bohr Institute, University of Copenhagen, Denmark*

Sune Olander Rasmussen works as a Ph.D. student in the Ice and Climate Research Group of the University of Copenhagen. He graduated as a MSc in Geophysics in February 2002 and was employed as a research assistant until starting his Ph.D. studies in May 2003. Funded through a grant from the Carlsberg Foundation to the Copenhagen Ice Core Dating Initiative, he has worked mainly on issues relating to the dating of the NorthGRIP ice core, including resolution enhancement of data, method development for manual and semi-automatic counting of annual layers, and time series analysis of ice core records. He has participated in the NGRIP deep drilling programme as a field party member and Field Operations Manager in Kangerlussuaq, Greenland, and has been visiting the British Antarctic Survey in Cambridge for 3 months.

Future projects focus on methods for computer-aided dating of ice cores based on multi-parameter data sets and correlation of the ice core chronologies with tree ring chronologies and other palaeoclimate records.





## Participants' Biographies



### Maria Russo

*Met Office, Hadley Centre, UK*

Maria Russo graduated in Physical/Inorganic Chemistry from the University of Palermo (Italy) in June 1998, with a mark of 110/110 cum laude and a degree Thesis on modelling of surface processes and catalytic hydrogenation reactions. As an undergraduate she was awarded a grant under the European Erasmus exchange scheme, which she spent as a visiting student at University College London (95/96).

From September 1998 to September 2001 she continued her studies as a postgraduate student at University College London, focusing on computational and experimental investigation on the structure and bonding of heavy metal complexes. In June 2000 she was the recipient of the Glaxo-Wellcome travel award, and in August 2000 she was awarded a prize for the best talk at the University of London Annual Symposium for Postgraduates in Inorganic Chemistry. She obtained a Ph.D. qualification in December 2002.

In May 2002 she made a change in her career and joined the Hadley Centre for Climate Predictions and Research, where she is currently employed to work in the "Regional Climate modelling" group. Her work focuses on extending and developing capabilities for marine climate modelling on the regional scale, while also interacting with scientists, policy-makers and the general public to promote and facilitate the correct use of this new type of data.



### Sarah Watkins

*Geography Department, Lancaster University, UK*

Sarah Watkins was awarded a degree in Geophysical Sciences from Southampton University in 1995. She then moved to Reading University, where she gained a Masters degree in Weather, Climate and Modelling, studying the climate of the Eocene for her dissertation.

After Reading University, she worked as a research assistant at the Climate Research Unit (CRU), University of East Anglia (UEA) until September 1999. Whilst at CRU her research involved statistical downscaling of climate model data to a regional scale as part of the MEDALUS project and also modelling of future, long-scale climate change and sea-level rise. In October 1999, she began a Ph.D. in the School of Environmental Sciences at UEA, entitled "Geological ground-truthing of modelled iceberg trajectories in the North Atlantic: present day and Last Glacial Maximum", supervised by Prof. Barbara Maher and Prof. Grant Bigg.

Since completing her Ph.D. she has worked on various projects within the Department of Geography at Lancaster University. One of her recent highlights was presenting her Ph.D. research at the House of Commons during UK Science Week 2004. Her research interests remain much the same as when starting out at university – principally the reconstruction of past climatic and oceanic conditions.



### Hiro Yamazaki

*Atmospheric, Oceanic and Planetary Physics, University of Oxford, UK*

Hiro Yamazaki obtained his B.Eng. and M.Sci degrees in Tokyo, and his Ph.D degree at the University of Toronto in 2000. He then started to work as a post-doc at the Department of Physics, University of Oxford. He initially joined the Geophysical and Planetary Fluid Dynamics Group, and has been developing numerical and laboratory models of Jovian and Saturnian atmospheres. His main model has been a general circulation model (GCM), based on the Unified Model of the UK Met Office. He also carried out a laboratory simulation of the Jovian and Saturnian jets, using the world's largest rotating tank in France.

Recently, he also joined the Climate Modelling Group at the same department to help develop distributed computing software for the ClimatePrediction.net project. The project also employs the Unified Model to predict Earth's climate change until 2050, using the idle CPUs that are available over the Internet.

In January 2006, he is expected to embark on the GCM simulation of climate evolution in the last 1000 years as the leading GCM modeller of the EU's Millennium project. His interest extends to hardware for automated observations, numerical methods for fluid dynamics, and Cosmos in Chaos in nonlinear dynamical systems.



# Speakers' Abstracts

## **To use scientific knowledge on climate change in politics**

*Bert Bolin*

*Department of Meteorology, University of Stockholm (MISU), Sweden*

The assessment by the Intergovernmental Panel on Climate Change (IPCC) of the climate change issue has provided a detailed and authoritative analysis of what we do know and what we still are uncertain about regarding the ongoing change of the global climate. The global mean temperature has so far increased by  $0.7 \pm 0.2$  °C, which cannot be explained unless the contributions due to human emissions are included. A large majority of the scientific community therefore accepts the notion that a human induced climate change is on the way. Some still maintain an opposite view, but their scientific arguments are generally inconclusive.

There is, however, still a significant uncertainty about the sensitivity of the climate system to the disturbances that human activities on the Earth bring about. Nor are we able to spell out in more detail what the characteristics of this change might be, or how quickly, where and to what extent it will have a major impact on our well-being. In general, the impact of a forthcoming climate change is uncertain. It is of course most essential to analyse these uncertainties more carefully, but there are in any case reasons that justify early actions. The main theme of my presentation here is to bring home the message that even though the climate change issue is fraught with uncertainty, a number of quite firm conclusions can be drawn. These should serve as a basis for action. Uncertainties should of course be fully recognised but must not be the main message. The final judgement about the urgency remains, however, a political issue and will necessarily to some extent be subjective.

Examples will be given that illustrate how selective, but still of course basic and robust, features of the ongoing change of climate might be brought together to provide a simple picture of the key issue. These should be brought into focus for consideration by the public and by politicians.

## **Towards a comprehensive understanding of land-atmosphere interactions in the sub-Arctic**

*Torben R. Christensen*

*Department of Physical Geography and Ecosystems Analysis, GeoBiosphere Science Centre, Lund University, Sweden*

According to recent major international assessments such as ACIA (the Arctic Climate Impact Assessment), the Arctic will see significant climate change within coming decades. Arctic land areas are influencing and interacting in many ways with the climate system. Snow cover and the associated effects of albedo are an obvious component of these interactions where the vegetation composition and the position of the tree-line also play important roles. But the carbon cycle of these natural ecosystems has also attracted an increasing amount of attention during recent years. Particular emphasis has been on measuring land-atmosphere exchanges of trace gases such as CO<sub>2</sub> and CH<sub>4</sub>. These greenhouse gases have in their land-atmosphere exchanges the potential for strongly influencing the further development of climate. However, if the carbon budget of the Arctic landscape as a whole is to be studied the immediate atmospheric exchanges are only one part of the story. Lateral transport of dissolved organic carbon and sedimentation in lakes are factors that also are important for a true catchment scale budget.

Here we try to evaluate the information available on all components of the carbon cycling in two examples of composite Arctic landscapes, the Torneträsk region in northern Sweden and the Zackenberg valley in NE Greenland. Many components of the carbon cycling are associated with huge uncertainties, and the budgets presented will merely be pointing these out as subjects of further studies, as opposed to arguing that we present final budgets for the landscapes.

## **What can we use a global climate model for?**

*Richard Jones  
Met Office, Hadley Centre, UK*

A global climate model (GCM) is a mathematical representation of the climate system based on the physical properties of its components, their interactions and feedback processes. Most models account for the most important physical processes; in some cases chemical and biological processes are also captured. Many GCMs represent well the broad features of current climate, and most can reproduce the observed large-scale changes in climate over the recent past, so can be used with some confidence to give predictions of the response of climate to current and future human activities.

Climate models have developed over the past few decades as computing power has increased. During this time, models of the main components – atmosphere, ocean, land and sea ice – have gradually been integrated and coupled together, and representations of the carbon cycle and atmospheric chemistry are now being introduced. Currently the horizontal resolution of a typical GCM is about 250 km in its atmospheric component and about 125 km in its oceanic component. Hence GCMs make projections at a relatively coarse resolution and cannot represent the fine-scale detail that characterises the climate in many regions of the world, especially in regions with complex orography or heterogeneous land surface cover or coastlines. As a result, GCMs cannot access the spatial scales that are required for climate impact, and adaptation studies though GCMs can be used in various ways to provide broad scale climate change information. This talk will present a description of the components of a climate model, their interaction and what we can use the model for.

## **Centennial-scale climate cooling with a sudden cold event around 8,200 years ago**

*Eelco J. Rohling and Heiko Palike  
National Oceanography Centre, Southampton, UK*

The extent of climate variability during the current interglacial period, the Holocene, is still debated. Temperature records derived from central Greenland ice cores show one significant temperature anomaly between 8,200 and 8,100 years ago, which is often attributed to a meltwater outflow into the North Atlantic Ocean and a slowdown of North Atlantic Deep Water formation. This anomaly provides an opportunity to study such processes with relevance to present-day freshening of the North Atlantic. Anomalies in climate proxy records from locations around the globe are often correlated with this sharp event in Greenland. But the anomalies in many of these records span 400 to 600 years, start from about 8,600 years ago and form part of a repeating pattern within the Holocene.

More sudden climate changes around 8,200 years ago appear superimposed on this longer-term cooling. The compounded nature of the signals implies that far-field climate anomalies around 8,200 years ago cannot be used in a straightforward manner to assess the impact of a slowdown of North Atlantic Deep Water formation, and the geographical extent of the rapid cooling event 8,200 years ago remains to be determined.

# Speakers' Abstracts

## **Anthropogenic climate change versus natural variability: a probabilistic view on the next few decades**

*Jouni Räisänen*

*Division of Atmospheric Sciences, University of Helsinki, Finland*

If present model- and observation-based estimates of the sensitivity of the climate system are correct, anthropogenic increases in greenhouse gas concentrations are likely to lead to large changes in the global climate during the next hundred years and beyond. Anthropogenic climate changes are, however, accompanied by natural climate variability, which may either amplify or suppress them. Part of the natural variability is forced by variations in solar output and volcanic activity, but a substantial part of it is associated with the internal dynamics of the climate system.

As far as century-scale changes in the global mean temperature are considered, natural variations of climate will very likely be small compared to the greenhouse gas-induced warming. On the other hand, natural variability is expected to be more important in relative terms in the near future, when anthropogenic changes are still weaker. In addition, natural variability increases towards smaller geographic scales, so that the climate of any given location varies more than the global mean climate. Finally, most other climate variables, such as precipitation, are relatively less sensitive to anthropogenic forcing and/or more strongly affected by natural variability than temperature.

In my talk, I will explore these issues by using a multi-model ensemble of climate change simulations. Such an ensemble implicitly includes the uncertainties due to both internally-generated natural variability and differences between climate models in their response to anthropogenic forcing. The resulting probabilistic estimates of near-term climate change already suggest a high probability of warming in northern Europe in the next few decades. However, forecasts for precipitation change are more uncertain than those for temperature change and, for both variables, changes in seasonal means are more uncertain than those in the annual means.

## **Determining the added value of Regional Climate Modelling**

*Hans von Storch and Frauke Feser*

*Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany*

Limited area models of the atmosphere are used to describe the regional climate. To do so they are exposed along the lateral boundaries and in some cases on large scales in the interior, to a given sequence of coarser resolution dynamical states of the atmosphere. These coarser resolution states originate either from global re-analyses (in the case of reconstruction of past regional weather) or from global climate simulations (often scenarios of anthropogenic climate change).

Since both the global re-analyses and the global simulations also provide a description for the interior of the limited area model, albeit coarser, the question is which added value the limited area model is providing. An obvious answer is that stationary conditions related to the topography and other physiographic detail will be described better; however, this added value may also possibly be achieved by a much simpler and cheaper geo-statistical post-processing.

We suggest that the added value is associated with those spatial scales at which the coarse resolution re-analysis system or global simulation model (which operate often on grid with a mesh size of 200 km and more) has little skill – which is of the order of a few grid lengths (i.e., often less than 800 km or so). At these shorter spatial scales many relevant (transient) weather phenomena take place.

We have developed a system of digital filters which allows us to separate the different scales – the large scales adequately described by the global systems, and the regional scales presumably better described by the limited area model. A comparison with regional re-analyses demonstrates that added value emerges only for the regional scales, while the description of the large scales suffers from some deterioration. The result is considerably improved if a large-scale constraint is introduced, while conventional forcing only along the lateral provides little added value.

It is emphasised that this assessment may depend to some extent on the specific measure adopted. Other measures may identify other added values. Thus, more research on the added value is needed.

## **Use of zooplankton-based palaeoecological methods to trace climate-driven changes in aquatic ecosystems**

*Susanne Lildal Amsinck*

*Department of Freshwater Ecology, NERI, Denmark*

Global warming is expected to alter the hydrology, chemistry and biology of lakes, rivers and wetlands and their interactions. However, the interactions both within and between the systems are extremely complex, and the consequences of the changes are difficult to determine. As many freshwater bodies are used as drinking water reservoirs and for agricultural irrigation and fishery, the need for knowledge about the impact of global warming on these ecosystems is acute.

In addition, once the climatic forcing on these ecosystems is clarified, effective scenario models useful in future environmental management and restoration can be established. Lake sediments offer an excellent potential for studying environmental changes such as climate change. This is due to the fact that past changes both within the lake and in the surrounding catchment are trapped in lake sediments through chronological accumulation of biological remains identifiable to species level (e.g. zooplankton, phytoplankton, chironomids). The great advantage of using this sedimentary archive rather than conventional methods based on snapshot sampling is that it provides an accurate tool for assessment of, for instance, community structure, due to its integration of spatial and seasonal species heterogeneity and year-to-year variations.

This poster presents a selection of different zooplankton-based palaeoecological methods that have proven useful for obtaining valuable knowledge and hitherto hidden patterns of biological changes and lake responses associated with climate change, additional to other environmental changes (e.g. eutrophication, acidification, fish introductions, heavy metal pollution). Furthermore, future potentials and perspectives for the use of zooplankton-based ecological investigations are addressed.

## **Rapid Holocene climate changes in the North Atlantic based on lake sediments from the Faroe Islands**

*Camilla S. Andresen*

*GeoBiosphere Science Centre, Quaternary Sciences, University of Lund, Sweden*

Holocene records from two lakes on the Faroe Islands were investigated to determine regional climatic variability. Two different geomorphologic located lakes were chosen: the fairly wind-exposed Lake Starvatn on Streymoy and the more sheltered Lake Lykkjuvötn on Sandøy. Sediment cores were analysed for content of biogenic silica, organic carbon and clastic material and magnetic susceptibility.

In addition, a new qualitative proxy for past lake ice cover and wind activity was developed using the flux of clastic grains that are larger than 255 µm. Both long-term and short-term climatic developments were fairly similar between the two lakes, suggesting a response to a regional climate signal. The long-term climate development is characterised by early Holocene rapid warming followed by Holocene climatic optimum conditions ending around 8300 cal. yr BP. A more open landscape as evidenced from increased sand grain influx in the period 8300-7200 cal. yr BP could reflect the aftermath of the 8200 cal year BP event, although the event itself is not detected in either of the two lake records. From around 7200 cal. yr BP the Mid Holocene climate deterioration is observed and from 4200 cal. yr BP climate deteriorated further. Superimposed on the long term climate variability is a series of short scale events, which are also rather similar in both lake records.

A comparison between these events and marine records north and south of the Faroe Islands suggest that the Holocene was characterised by periodic incursions of polar sea ice laden waters to more southern Atlantic regions.

# Participants' Abstracts

## **The sensitivity of the Northern Hemisphere stationary wave pattern to the background state**

*Jenny Brandefelt*

*Department of Meteorology, Stockholm University, Sweden*

The spatial patterns of the response to an enhanced greenhouse gas (GHG) forcing simulated by coupled global climate models (CGCMs) differ substantially. We hypothesise that the differences are partially explained by inter-CGCM differences in zonal mean properties of the atmospheric flow. The focus is set on the Northern Hemisphere winter. The sensitivity of the stationary wave pattern (SWP) to changes in the zonal mean wind and tropopause height is studied using a global three-level quasi-geostrophic model. The changes in the zonal mean wind and tropopause height are defined to be similar to those found in CGCMs in response to enhanced GHG forcing.

The SWP in the three-level model is sensitive to these changes. The magnitude of the sensitivity is comparable to the magnitude of GHG induced changes in the SWP in CGCMs. The changes in the SWP are associated with substantial changes in the storm track activity. The balance for the time mean barotropic state is diagnosed. This balance is dominated by linear advection of barotropic relative vorticity and planetary vorticity. The changes in the SWP are primarily explained by a change in the balance between barotropic relative and planetary vorticity advection. Changes in transient and baroclinic processes are of smaller magnitude than the changes in barotropic advection.

## **The sensitivity of the oceanic current system in the Nordic Seas to increased freshwater forcing**

*Göran Broström*

*Department of Meteorology, Stockholm University, Sweden*

Today, the main circulation pattern in the Nordic Seas/Arctic Ocean is characterised by warm water that enters the Nordic Seas as a buoyant current along the Norwegian coast. Arguably, it is the density difference (and wind forcing) that drives the warm water across the Scotland-Faroe-Iceland ridge. In the Nordic Seas/Arctic Ocean the water is made heavier by cooling to the atmosphere, and buoyant by precipitation (or freshwater flux). Today, the cooling effect is strongest and there is net production of dense water in the Nordic Seas. It has for some time been speculated that an increased freshwater forcing in polar areas may lead to more buoyant water, which in turn may influence the forcing mechanism that drives warm buoyant water into the Nordic Seas.

In a set of numerical experiments utilising an idealised geometry reflecting the conditions in the Nordic Seas, we have studied the response of the current system to an increased freshwater forcing. The experiments, which are fully three dimensional and resolve sloping topographic boundaries, show that the Nordic Seas/Arctic Ocean system may be more stable to freshwater perturbations than earlier studies have indicated.

## **A 4,500-year record of aridity cycles on the Northern Great Plains, USA**

*Kendrick Brown*

*Geological Survey of Denmark and Greenland (GEUS), Denmark*

High-resolution analyses of a late-Holocene core from Kettle Lake, North Dakota, reveal coeval fluctuations in loss-on-ignition carbonate content, percentage of grass pollen, and charcoal flux. These oscillations are indicative of climate-fuel-fire cycles that have prevailed on the Northern Great Plains (NGP) for most of the late Holocene. High charcoal flux occurred during past moist intervals when grass cover was extensive and fuel loads high, whereas reduced charcoal flux characterised the intervening droughts when grass cover and hence fuel loads decreased, illustrating that fire is not a universal feature of the NGP through time but rather oscillates with climate. Spectral and wavelet analyses reveal that the cycles have a periodicity of ~160 years, though secular trends in the cycles are difficult to identify for the entire Holocene since the periodicity in the early Holocene ranged between 80-160 years. Although the cycles are evident for most of the last 4,500 years, their occasional muting adds further to the overall climatic complexity of the plains.

These findings clearly show that the continental interior of North America has experienced short-term climatic cycles accompanied by a marked landscape response for several millennia, regularly alternating between dual landscape modes. The documentation of cycles of similar duration at other sites in the NGP, western North America, and Greenland suggests some degree of regional coherence to climatic forcing. Accordingly, the effects of global warming from increasing greenhouse gases will be superimposed on this natural variability of drought.



# Participants' Abstracts

## **A preliminary investigation on the causes of the increase of extreme precipitation over Europe for the future climate**

*Erasmus Buonomo*  
*Met Office, Hadley Centre, UK*

Changes in extreme precipitation over central and northern Europe simulated from Regional Climate models for the future, greenhouse-gas-forced scenario, predict a widespread increase in precipitation for all seasons (see e.g. Frei *et al.*, 2005, results from the EU funded project PRUDENCE).

Possible causes for the increased extreme precipitation can be approximately partitioned into changes of large scale circulation, where global changes in redistribution of energy are the main components of the predicted changes and warming, where the local increase of surface temperature and moisture are the most important factors in determining the changes. The possibility to drive a regional climate model with boundary conditions in which the two effects are separated will allow the evaluation of the contributions of two effects to the simulated changes.

Recently, a limited area model version of HadAM3P centred over Europe (HadAM3P-Eur) and a new approach in experimental design, which allows the separation of the local drivers from the large scale circulation, have been developed at the Hadley Centre (Rowell and Jones, 2005). Model integrations which separated the effects of the two drivers have been performed using this approach (Rowell and Jones, 2005), with boundary conditions constructed from present climate and A2 scenarios.

A preliminary analysis of extreme precipitation indices obtained from these simulations and their relation with other physical quantities will be presented at the meeting.

## **An update on the detection and attribution of observed climate change.**

*Simon Crooks*  
*Atmospheric, Oceanic and Planetary Physics, University of Oxford, UK*

The detection and attribution of observed climate change plays a central role in climate research. Climate change is said to be detected if observed changes were inconsistent with what climate models said would happen in the absence of any external influences, while attribution is concerned with attributing the observed change to specific causes. To date, detection and attribution studies have focused primarily on attempting to quantify the observed global-average surface temperature response to individual external forcing factors (such as greenhouse gas emissions and natural changes in the solar luminosity) using very large-scale information (e.g. greater than 5000 km) obtained from climate model simulations.

The formal detection and attribution methodology will be briefly discussed alongside some examples of a new variant of the formal methodology, whereby spatial patterns of temperature response to individual external forcing agents are derived from model simulations which have been forced by external influences. The derivation of these spatial patterns will be explained, and it will be shown how, by utilising information on much smaller spatial scales than those used in the formal analysis, they can be used to facilitate the detection and attribution of observed climate change.

Moreover, it may be discussed how the development of this pattern-based variant of the formal methodology may allow us, as climate scientists, to move beyond examining global average quantities to assessing the attribution of quantities on sub-global scales, or on scales of more immediate concern to people, such as the impact of climate change at a regional level.

# Participants' Abstracts

## **Marie Curie Team on Exchange Processes in the Land Surface – Atmosphere System**

*Anna Ekberg, Almut Arrneth, Sean Hayward*

*Department of Physical Geography and Ecosystems Analysis, GeoBiosphere Science Centre, Lund University, Sweden*

Biogenic emissions of volatile organic compounds (BVOCs) contribute significantly to the total amount of atmospheric reactive carbon. The extremely diverse emissions of plant volatiles (methane excluded) are on the order of 1000 Tg yr<sup>-1</sup>, which has been estimated to account for over 90% of all VOCs entering the atmosphere, including anthropogenic emissions. These BVOCs have a major impact on the climate since they control the oxidising capacity of the atmosphere by reacting with, for example, the hydroxyl radical and with ozone. The atmospheric lifetime of other important greenhouse gases, such as methane, are therefore indirectly influenced by the BVOCs. They may also contribute to the formation of tropospheric ozone and biogenic aerosols, organic particles with the capacity to alter the radiative forcing of the atmosphere or to interact with cloud formation.

A chief objective of the research in the Marie Curie Team on Exchange Processes in the Land Surface – Atmosphere System is to quantify BVOC emissions and their environmental control in relation to photosynthesis and net surface-atmosphere carbon exchange, and in view of the formation of biogenic aerosol. Leaf level as well as ecosystem BVOC flux data will be utilised to develop and test novel regional and global routines that incorporate process-based leaf BVOC production models into the dynamic vegetation/terrestrial carbon cycle model LPJ-GUESS, aiming to investigate the interacting role of atmospheric CO<sub>2</sub> concentration, temperatures and vegetation cover on emissions.

During the growing season 2005, a first set of BVOC and particle formation field measurements have been conducted in a sub-arctic wetland to provide original information from ecosystems that have previously been overlooked in that respect, despite them undergoing rapid changes due to their sensitive response to changing air temperatures. The field site is a mire underlain by discontinuous permafrost located near Abisko in northern Sweden (68°21'N, 19°00'E). In the MCT ELSA poster we present first results from leaf-level measurements concentrating on photosynthetic carbon assimilation and isoprene emissions from two of the dominating species present on the wetter parts of the mire: *Eriophorum angustifolium* and *Carex rostrata*.

## **Effects of aerosol concentration and composition on convective cloud development**

*Annica Ekman*

*Department of Meteorology, Arrheniuslab, Stockholm University (MISU), Sweden*

Aerosols influence convective clouds, because they serve as cloud condensation nuclei or ice nuclei. At the same time, deep convection is one of the major sinks of atmospheric aerosols through wet scavenging. The interactions between aerosol and cloud processes are determined not only by surface properties of aerosols but also by cloud dynamics and microphysics. To understand these direct or indirect effects of aerosols on deep convection is very important to atmospheric chemistry and global change studies.

To address these issues, we have used a 3-D cloud-resolving model including interactive dynamics, cloud and aerosol microphysics, gaseous and aqueous chemistry, heterogeneous chemistry, and radiation. Initialised with observational data over northern Europe, a number of model runs – with a 200 by 200 by 25 km domain, and various different settings in physics and chemistry as well as aerosol profiles – have been carried out.

The sensitivities of deep convection related physics and its impact on various aerosol profiles will be discussed and related to atmospheric climate research in general.

## **Changing rainfall patterns and implications for flood risk in the UK: dramatic increase in climatic variability or the first indications of climate change?**

*Hayley J. Fowler*

*Water Resource Systems Research Laboratory, School of Civil Engineering and Geosciences,  
University of Newcastle upon Tyne, UK*

Increasing flood risk is now recognised as an important threat from climate change, with recent repeated severe flooding in the UK and Europe causing major loss of property and life. There has been intense public debate on the apparent increased frequency of extreme weather events, focusing attention on a perceived increase in rainfall intensities. Climate model future simulations predict increases in the frequency and intensity of heavy rainfall in the high latitudes under enhanced greenhouse conditions, projections consistent with recent increases in rainfall intensity seen in the UK and worldwide. We may therefore expect an increase in the future risk of flooding.

Using a statistical method called regional frequency analysis, we examined 204 rainfall records across the UK in nine homogeneous climatic regions for evidence of change in extreme events. Our research shows significant changes in both the timing and occurrence of extreme rainfall events over the past decade. The magnitude of multi-day extreme rainfall has increased two-fold over parts of the UK since the 1960's, with intensities previously experienced every 25 years now occurring at six-year intervals. Changes in timing are also apparent, with extreme events now predominating in autumn months. Observed patterns of change are very similar to those projected by regional climate models for the end of the 21st century, with the latest climate model predictions from HadRM3H suggesting increases of 30% in the magnitude of multi-day rainfall events over parts of the UK. These climatic changes may result from persistent atmospheric circulation anomalies, and will have severe implications for design and planning practices in flood control.

## **Which climate parameters are responsible for observed changes in Holocene vegetation composition?**

*Thomas Giesecke*

*Geological Survey of Denmark and Greenland (GEUS), Denmark*

Holocene climate reconstructions designed to estimate annual mean temperatures generally indicate temperature changes of about 2 Kelvin over the course of the Holocene. While such changes in mean annual temperature must have had profound effects at tree lines, they should have had little effect at lowland sites away from ecotone boundaries.

However, many Holocene vegetation reconstructions from mid-latitudes show significant changes in vegetation composition. Often, these changes are interpreted to be caused by migrational lags or human interaction, but many are ascribed to changing climate parameters. Holocene changes in effective moisture are likely another important cause for vegetation changes. However, the distribution of precipitation throughout the year or the timing and frequency of late and early frosts may have played an even more important role in shaping the vegetation composition of mid-latitude biomes. Although such frequency and distribution of stochastic climate parameters are of major importance for forestry and agriculture they are little discussed as drivers of Holocene vegetation change.

The above ideas on changes in frequency and distribution of climate parameters are illustrated on examples from central Sweden.

## **Climate response to a multidecadal warming/cooling of the North Atlantic Ocean**

*Daniel Hodson and Rowan Sutton*

*Department of Meteorology, University of Reading, UK*

Understanding the factors that cause climate to vary on multidecadal timescales is a key challenge in climate science. Observational records show that during the twentieth century sea surface temperatures in the North Atlantic Ocean exhibited prominent multidecadal variations. The amplitude of these variations was large by comparison with interannual variability, and it has been suggested that variations in the Atlantic Ocean northward heat transport, associated with the Thermohaline Circulation, may have been responsible.

Such multidecadal sea surface temperature variations are likely to have an impact on climate. However, thus far the evidence for such an impact is mainly circumstantial, being derived from observations and showing correlation rather than causality. In order to assess the climate impacts of such multidecadal changes in the Atlantic Ocean we have carried out experiments in which an Atmosphere Global Circulation Model is forced with idealised multidecadal patterns of sea surface temperature.

Here we present the result from these experiments for northern summertime climate, and show through quantitative comparisons between the model results and observations, that multidecadal variations in the Atlantic Ocean were an important driver of variations in the summertime climate of both North America and western Europe during the twentieth century. These findings advance understanding of past climate changes, and also have implications for future decadal climate predictions.

# Participants' Abstracts

## **Influence of the Arctic on the Atlantic Thermohaline Circulation and Climate**

*Helen L. Johnson*

*Department of Meteorology, University of Reading, UK*

The thermohaline overturning circulation transports approximately 1PW of heat northwards in the Atlantic basin, and as such has an important influence on European climate. Some recent coupled climate model experiments suggest that this circulation could change abruptly as a result of anthropogenic climate change. The deep water formation regions in the Labrador and Nordic Seas play a key role in the dynamics. Surface density here is affected not only by local meteorological forcing but also by the outflow of fresh water from the Arctic Ocean. Using numerical models, observations and dynamical theory I am trying to understand what determines the flow of fresh water from the Arctic to these sinking regions, via Fram Strait and the Canadian Archipelago, and what effect this freshwater has on the thermohaline overturning circulation in the Atlantic.

To represent more faithfully the complicated bathymetry and small-scale flow structures in the high-latitude North Atlantic a finite element numerical model will be used, with a dynamically adaptive, unstructured mesh. Along with theoretical studies of nonlinear flow through idealised narrow channels, and measurements made from moored instruments in the Canadian Archipelago, this will enable us to build up a physical understanding of the processes and feedbacks involved, and how these might change in the future.

## **Two projections of regional climate change in Europe during 1961-2100**

*Erik Kjellström*

*Rosby Centre, Swedish Meteorological and Hydrological Institute (SMHI), Sweden*

The Rosby Centre regional climate model, RCA3, is used for regionalisation of two global climate change projections for the time period 1961-2100. The radiative forcing of the climate system is based on observed concentrations of greenhouse gases until 1990 and on two different emission scenarios from the IPCC special report on emission scenarios for the remaining time period. The evolution of climate change during the period is investigated. Long-term averages as well as measures of the variability around these averages are presented for a number of variables including precipitation and near-surface temperature. It is shown that the changes in variability sometimes differ from the changes in averages. For instance, in northeastern Europe the increase in wintertime temperatures is followed by an even stronger reduction in the number of very cold days in winter. This kind of performance of the climate system implies that methods of inferring data from climate change projections to other periods than those actually simulated have to be used with care, at least when it comes to variables that are expected to change in a non-linear way.

Further, it is shown how the climate is projected to change already in the first decades of the 21st century. Also, it is noted that the differences between the two emission scenarios remain modest until the final decades of the century confirming the picture given by GCMs.

Finally, the two projections are put into perspective of previous simulations at the Rosby Centre by comparing the climate change signal for the last three decades of the 21st century.

## **Effects of global warming on shallow freshwater lakes – a long-term experimental study**

*Lone Liboriussen*

*Department of Freshwater Ecology, National Environmental Research Institute, Denmark*

It is expected that climate warming will strongly impact shallow freshwater lakes and in-lake processes. Climate warming is hypothesised to make turbid nutrient-rich shallow lakes more turbid, while clear less nutrient-rich lakes may become turbid or stay clear; however, the specific effects and mechanisms involved remain to be elucidated. In a long-term (> 2 years) factorial mesocosm experiment we try to elucidate some of the climate-warming effects that may occur in shallow, nutrient-rich, phytoplankton-dominated lakes and less nutrient-rich, plant-dominated lakes. The experiment combines three temperatures (in situ reference temperature, ICPP climate scenario A2 and scenario A2+50% modelled for year 2071-2100) with two nutrient levels in 24 mesocosms (volume ~ 2800 l). In the mesocosms natural communities of bacteria, algae, smaller animals and submerged plants have been established and a fixed number of fish (sticklebacks) introduced.

Throughout the experiment we follow the chemical and physical conditions closely, just as the structure and the dynamics of the biological communities are monitored frequently. Preliminary results from the experiment will be presented.

## **Late Holocene climate variability in Fennoscandia and China inferred from tree rings**

*Hans Linderholm*

*Physical Geography, Göteborg University, Sweden*

Climate is naturally variable, influenced by a range of external and internal factors. Although the knowledge of the climate system is constantly increasing, we still need to gain better understanding of it as a whole. This is imperative when assessing the anthropogenic influence on present climate and predicting future climate change. One of the principal ways to increase such knowledge is to study past variations in climate. Instrumental observations, in general, only are available for assessing climate changes (regional to global) in the last 100–150 years. Therefore, to get further back in time, we have to rely on other data sources, e.g. climate proxies such as tree rings, to provide information about climate variability on different time scales.

Results from three studies, in which tree-ring data were utilised to reconstruct past climates, are presented here. They were carried out at the Regional Climate Group, Göteborg University and the National Climate Center, Chinese Meteorological Administration. Tree-ring data from the central Scandinavian Mountains provided information about local summer temperature variability for the past 3.6 millennia. In China, the growth pattern of trees growing in the semi-arid province of Shaanxi was used to reconstruct the frequency of local droughts and floods in the past 500 years. While tree-ring data from a single site may contain climate information that is regionally valid, several sites are needed to understand climate variability on a larger spatial scale. In the last study, a network was used to reconstruct Fennoscandian summer temperatures for the last 1600 years.

## **Interactions between snow and vegetation in boreal coniferous forests**

*Sirpa Rasmus*

*Department of Physical Oceanography, Finnish Marine Research Institute, Finland*

The interaction between snow cover and vegetation in Finnish boreal coniferous forests is studied in this project in an interdisciplinary way. The aim of the study is to better understand how the forest structure affects the forest microclimate, and through this the snow amount and snow pack structure in different parts of the forest. The effect of the short vegetation under the snow cover on the snow is also studied. The functional traits of the plants, which make them adapted to snow or make them avoid snowy conditions, are looked for. The changes in snow amount and structure, which are connected to climate warming and are critical to plant over-wintering and start of the growth season, are studied by field experiments. It is necessary to understand better the interactions between snow and vegetation, so that the effects of warming winters on boreal coniferous forests can be understood.

The study will be carried out during years 2006-2008. The field measurements will be done in two forests in Southern Finland. They will consist of forest microclimatic measurements, snow pack structure observations, and observations of photosynthesis of the plants under the snow cover, as well as other plant ecological measurements. During the research the use of different snow distribution models in the forests will also be studied, and the study will contribute to snow pack structure modelling in the forests. The coupling of regional climate model outputs to snow pack structure modelling will also help to understand possible changes in future winter conditions.



# Participants' Abstracts

## **The construction of the Greenland Ice Core Chronology 2005 (GICC05) across the late glacial oscillation**

*Sune Olander Rasmussen*

*Ice and Climate Research, Niels Bohr Institute, University of Copenhagen, Denmark*

The poster presentation focuses on the making of the GICC05 time scale in the period 7.9 – 14.85 ka before present, including the Bølling, Allerød, Younger Dryas, and Early Holocene periods.

High resolution Continuous Flow Analysis (CFA) impurity records have been obtained from the NGRIP ice core, providing a data set where annual layers can be identified from several independent data series in section from the Bølling interstadial to the Early Holocene. Several investigators have identified and counted annual layers using up to 7 parallel data series containing an annual signal.

Based on the combined GRIP and NGRIP CFA data sets, the presented time scale covers the period from the 8.2 ka cold event to the Younger Dryas – Preboreal transition, in the GICC05 dated to 11,784 b2k (before the year A.D. 2000) with an estimated maximum counting error of 69 years. The transition date has thus been moved 100–200 years back in time relative to the existing GRIP, NGRIP, and GISP2 time scales. The Dye 3 record has been tied to the GRIP and NGRIP records using ECM data, making the three records available on a common time scale down to the Younger Dryas – Preboreal transition.

Before the Holocene, the timescale is based on NGRIP data alone, and continues back through the late glacial oscillation into the Oldest Dryas, just prior to the onset of the Bølling interstadial, which begins at 14,773 b2k (maximum counting error 156 years). The estimated maximum counting uncertainty is about 3% for this part of the time scale.

Examples of the dating will be presented and the uncertainties of the time scale will be discussed.

## **Development of a coupled Regional Climate Model for Europe**

*Maria Russo*

*Met Office, Hadley Centre, UK*

The motivation behind this project arises to target a specific need to understand and assess the effects of climate change on the regional scale. The Hadley Centre has long been engaged in the development of high-resolution regional atmospheric models [1, 2] which have helped to unravel important mechanisms acting on the local scale. A simple 2-D barotropic tide and surge model is also used, in conjunction to the atmospheric model, to make projections of local sea-level rise and extreme events [3].

In an attempt to improve our understanding and modelling of the North-West European seas, we aim to develop a fully coupled regional climate model. In the first stage we are using 3-D lateral boundary conditions from our global coupled model (HadCM3) to run a one-way nested, high-resolution, baroclinic shelf-seas model, forced at the surface by air-sea fluxes from the Hadley Centre regional atmospheric model, and freshwater runoff from a newly-developed, grid-to-grid routing model.

Our aim is:

- to gain a better knowledge of the dynamics and circulation of the North-West Europe shelf-seas, and understand the factors and mechanisms controlling it;
- to estimate the impacts of climate change on coastal areas with particular interest to sea-level rise, storm surges, and coastal flooding;
- to provide improved quality data of marine climate projections to policy makers and to the scientific community (particularly for estuary and coastal defences, and for ecosystem and fisheries modelling).

[1] Jones *et al*, *Q. J. R. Meteorol. Soc.*, 1995, **121**, 1413-1449

[2] Jones *et al*, *Q. J. R. Meteorol. Soc.*, 1997, **123**, 265-292

[3] Lowe *et al*, *Phil. Trans.*, 2005, **363**, 1313-1328

# Participants' Abstracts

## **North Atlantic ocean circulation during the Last Glacial Maximum: a combined modelling and magnetic sediment proxy study**

*Sarah Watkins*

*Geography Department, Lancaster University, UK*

Formation of North Atlantic Deep Water (NADW) drives the ocean thermohaline circulation, transporting heat from the subtropics to high latitudes. Controversy exists over the ocean circulation during glacial stages. Some geological and modelling studies suggest decreased NADW and increased formation of deep water in the Southern Ocean during the Last Glacial Maximum (LGM); others indicate similar, or higher, rates of NADW advection compared with present.

Here, we test LGM ocean simulations, comprising a 'northern-' and 'southern-sinking state', by comparing the iceberg trajectories produced by each state with reconstructed patterns and sources of LGM ice-rafted debris. Fuzzy c-means cluster analysis of selected diagnostic magnetic parameters (measured on > 130 deep-sea LGM sediment samples) was used to characterise the sediment and identify the main controls on sedimentation across the North Atlantic.

The ice-rafted debris distributions and provenances match the iceberg trajectories of the 'southern-sinking state', indicating that deep water formation at the LGM occurred dominantly in the Southern Ocean.

## **The Millennium simulation of the past climate**

*Y. Hiro Yamazaki*

*Atmospheric, Oceanic and Planetary Physics, University of Oxford, UK*

Here I provide a brief summary of the numerical simulations of the "Millennium" project, which attempts to reconstruct the climate evolution of the last 1000 years.

In 2006, the European Union will start a new project called "Millennium" to collect new proxy data of various kinds on European climate change, and to run a series of GCM simulations. The numerical model to be employed is known as the HadCM3 variant of the Unified Model. The UM was originally developed at the UK Met Office for operational weather forecasting, and HadCM3 is the variant which has been enriched at the Hadley Centre specifically for simulation of the climate change at a modest horizontal resolution of 3.75 times 2.5 degrees to cover the entire globe. Yet, the long-term integration is a challenge for both computational and scientific reasons.

We will build a new Linux cluster and run the simulations to quantify the degree of natural variability of climate evolution. We will also evaluate the impact of proposed scenarios of solar, volcanic and other natural forcings upon the Little Ice Age, Mediaeval Warming and other episodic events, which have been suggested by the proxy data.

We will also employ the computing resources that became available by the ClimatePrediction.net (CPDN) project. CPDN has unleashed the power of idle CPUs at homes and offices on the Internet, and has already evolved to outperform the world's fastest super-computers.