Full Proposals for International Polar Year 2007-2008 Activities

Proposed IPY Activity Details

1.0 PROPOSER INFORMATION

(Activity ID No: 118)

1.1 Title of Activity
The Greenland Ice Sheet – Stability, History and Evolution

1.2 Short Form Title of Proposed Activity
The Greenland Ice Sheet – Stability, History and Evolution

1.3 Activity Leader Details
Dorthe Dahl-Jensen
University of Copenhagen
Denmark

1.4 Lead International Organisation(s) (if applicable)
NULL
NULL
NULL
NULL

1.5 Other Countries involved in the activity
Australia
Belgium
Canada
Denmark
France
Germany
Hungary
Iceland
Japan
Netherlands
Norway
Sweden
Switzerland
United Kingdom
USA
NULL

1.6 Expression of Intent ID #'s brought together in this proposed activity
561, 069, 187, 245, 334, 381, 581, 763, 765, 784, 933

1.7 Location of Field Activities
Arctic

1.8 Which IPY themes are addressed
1. Current state of the environment
2. Change in the polar regions
3. Polar-global linkages/tele-connections
4. Exploring new frontiers
5. The polar regions as vantage points

1.9 What is the main IPY target addressed by this activity
1. Natural or social science

2.0 SUMMARY OF THE ACTIVITY

The Greenland Ice Sheet offers outstanding opportunities for significant advances of our knowledge on its interaction with both past and present climate using its archive of palaeoclimatic information, observations and modelling respectively. In addition, it is a vantage point for studies of the underground, which is important for the stability and evolution of the ice sheet and for mapping of natural resources around Greenland. Stability of the Greenland Ice Sheet is directly related to climate change, ice dynamics, sea level change and change in fresh water supply to the ocean which effect the global thermohaline circulation.
Cryosphere Interactions in Greenland. A scientific program using surface traverses and field camps, will be initiated to collect a variety of data including GPS and geophysical data (magnetic, gravitational), seismic profiles, borehole logging and ice drilling along airborne profiles. The data will be combined with satellite data to determine the crustal structure in Greenland and history of the sub-ice bedrock and sediments. This knowledge is needed to map the heat flow and basal melt beneath the ice sheet - an important factor for assessing the stability of the Greenland ice sheet. In addition, detailed point measurements of the magnetic field at sea level and at a few km above sea level will be performed.
Evolution of the Greenland Ice Sheet. The build up of the Greenland Ice Sheet starting around 10 million years ago will be investigated by determining the timing of uplift of the coastal regions in Greenland. Field studies will be undertaken at two locations and models testing various scenarios will be implemented. The evolution of the ice sheet during more recent times also be investigated studies with the aid of models and the programs described below.
North Eemian Ice Core Project. The last interglacial was warmer than the Holocene, providing an analogy for an anthropogenically-warmed world. A deep ice core reaching back into the penultimate glacial period (the Saalean) is proposed to provide a much-needed North Atlantic Climate Record for bipolar studies. In addition, the Holocene period from this deep ice core will provide a better isotopic record of the present climate than those from other Greenland ice cores.
Stability of large ice streams and floating glaciers. During 2003 and 2004, there has been increased discharge from floating glaciers in northeast Greenland. The exact mechanism responsible for this breakout is not known: Changes in mass balance, decrease in sea ice extent, influx of Atlantic water and increased open-ocean wave energy will be investigated on the ice and in the ocean. The Jakobshavn Isbrae in west Greenland has also retreated dramatically since 1998, while its flow velocity has increased from 7 to 12 km/a. The dynamics of the ice stream will be investigated with techniques using borehole instrumentation reaching to the base of the ice stream. In addition, for both systems the role of basal melt, which can occur at a rate of up to several tens of meters per year, will be investigated using ice flow models.
Present stability of the Greenland Ice Sheet. Airborne measurements of interferometric synthetic aperture radar (InSAR), scanning laser ranging (lidar), and radio echo sounding (RES) will be used to determine the discharge of ice from outlet glaciers around the margin of the Greenland Ice Sheet, as well as selected ice margin areas. This will provide baseline measurements of the discharge all over Greenland, as well as allow detection of elevation changes by comparison to earlier airborne missions and satellites (CryoSat, ICESat). Weather and mass balance stations will be located on the ice in order to relate mass balance changes with climate and to investigate the ablation processes in detail. In addition, the RES profiles will be used to map the melting under the ice in north Greenland and under the fast moving glaciers and ice streams allowing inclusion

of basal melt in the mass balance of the ice sheet.

Detailed studies of the ice dynamics related to melt on an outlet glacier. Glaciological investigations from the ice divide to the margin along a transect east of Kangerlussuaq, West Greenland to determine the sensitivity of ice-marginal dynamics to changes in surface melt through the penetration of runoff to the glacier bed. Surface melt, refreezing, ponding and run off will be investigated and ice dynamic will be monitored. Ice-sheet and energy balance models will be used in conjunction with airborne and satellite data.
Response of the Greenland Ice Sheet to Global Warming. During the Holocene climatic optimum, 10 ka to 5 ka before the present time, Greenland experienced temperatures 2-3 deg C warmer than today. Since then, the ice sheet has readvanced up to 40-50 km. Indirect evidence of this retreat will be found by observing past sea level elevations at two sites along the southern half of the Greenland Ice Sheet.
Climate during the last thousand years. To study the climate during the last thousand years a series of shallow to intermediate length ice cores is needed. Many of the existing cores can be used if the sites are revisited and 100-m cores drilled there to prolong the existing records up to modern times. The deep ice core will also provide data from this climate period. In conjunction with some of these cores gases will be extracted from the firn in order to set up legacy of northern hemispheric trace gas concentration and its variations over time.
Detailed modelling of weather and climate over the Greenland Ice Sheet at present. A very high resolution regional atmospheric model (like HIRLAM) will be run in re-analysis and climate mode, providing both hindcasts and future predictions of atmospheric conditions relevant to mass balance and ice sheet modelling.

2.1 What is the evidence of inter-disciplinarity in this activity?
The program proposed here is highly interdisciplinary and involves collaboration between geologists, geophysicists, glaciologists, climate modellers, oceanographers, remote sensors, radio echo sounders and meteorologists in conjunction with airborne and satellite missions to address the stability and evolution of the Greenland Ice Sheet on the time scales from 10 million years before present to predictions for the coming 100 years.

2.2 What will be the significant advances/developments from this activity? What will be the major deliverables? What are the outputs for your peers?
1. International collaboration of a highly multi-disciplinary group of researchers. 2. Training of the next generation of polar researchers and engineers. 3. Traverse facilities on the Greenland Ice Sheet. 4. Advances of knowledge about the basically unknown crustal structure under the Greenland Ice Sheet. 5. Mapping of the area under the Greenland Ice Sheet at pressure melting point. 6. Advances in knowledge of the behaviour and interaction of fast-flowing tidewater glaciers, ice streams and land-terminating ice-masses in relation to climate changes. 7. Advances in mapping the ice discharge from the margin of the Greenland Ice Sheet and improved understanding of the meltwater contribution to volume changes of the Ice Sheet. This is very important knowledge for the validation of the Cryosat and IceSat program. 8. A deep ice core reaching back beyond the Eemian period to advance our knowledge of the North Atlantic climate and to provide needed data for a bipolar comparison.9. Providing essential data and models to understand how the Greenland Ice Sheet will react to predicted global warming. 10.Advancing our knowledge about future sea level changes.

2.3 Outline the geographical location(s) for the proposed field work (approximate coordinates will be helpful if possible)

Locations	Coordindates
NEEM deep drilling site , NW Greenland	77.5N, 51W
Transect from Kangerlussuaq, W Greenland	67 N
The margin of the Greenland Ice Sheet. Airborne operations	
Airborne mapping of the Greenland Ice Sheet	
Studies of Jakobshavn Isbrae, W. Greenland	
Weatherstation sites, sites on the coast, Greenland	

Studies of floating glaciers, NE Greenland	
Traverse on the Greenland Ice Sheet	

2.4 Define the approximate timeframe(s) for proposed field activities?

Arctic Fieldwork time frame(s)	Antarctic Fieldwork time frame(s)
04/07 - 09/07	
04/08 - 09/08	
04/09 - 09/09	

2.5 What major logistic support/facilities will be required for this project?
Fixed wing transport aircraft
Ice drilling capability
Fixed wing geophysical aircraft
Snow terrain vehicles
Radars
Multi-instrumented platforms
Helicopters
Existing field stations

Further details – In addition to list above: New field stations, Fuel depots, Satelites, Ice Strengthened research ship. The logistics should be shared with other Greenland Ice Projects. It might be of benefit for IPY if an organisation (f. x. Danish Polar Center or VECO) chartered a number of aircrafts and helicopters and all actors had a meeting in 2006 to plan the logistics. In any case, many of the Greenland projects will need approval from DPC and the Greenland Home Rule for activities in the National Park.

2.6 How will the required logistics be supplied? Have operators been approached?

Source of logistic support	Likely potential sources	Support agreed
Consortium of national polar operators	Y	
Own national polar operator	Y	
Another national polar operator	Y	
National agency	Y	
Military support	Y	
Commercial operator		
Own support	Y	
Other		

2.7 If working in the Arctic regions, has there been contact with local indigenous groups or relevant authorities regarding access?

3.0 STRUCTURE OF THE ACTIVITY

3.1 Origin of the activity
This activity is the start of a new programme that will outlive IPY

3.2 How will the activity be organised and managed? Describe the proposed management structure and means for coordinating across the cluster
The activities under this cluster span from small to big projects. In addition, many of the projects have parts that naturally could belong to other clusters just as well. In order to manage the cluster we propose:

1. A steering committee for the cluster is formed with the aim of supporting the activities the science programs could mutually benefit from, such as:
Coordination of the logistics within the cluster and with other IPY clusters
Planning and coordination of outreach activities
Planning and coordination of educational activities
Planning and coordination of data management structure
Contact with JC and other clusters
Coordination of presentations of results of the IPY years at symposiums and meetings
2. The steering committee will be formed in 2006 when the funding for the individual projects becomes known.
3. We expect the individual projects to have steering groups especially related to the individual project.
4. We expect the funding of the cluster steering committee activities to be funded by individual nations, funding agencies. The EU Polar ERA net might be able to support some of the Steering Committee activities.

3.3 Will the activity leave a legacy of infrastructure and if so in what form?
1. Weather stations on the Greenland ice sheet 2. Drilling camp and possible core though the full interglacial in Greenland 3. Ice drilling technology 4. The next generation of polar researchers 5. Traverse facilities on the Greenland Ice Sheet 6. Long term monitoring systems of the fast-moving glaciers

3.4 Will the activity involve nations other than traditional polar nations? How will this be addressed?
The cluster does involve nations not traditionally involved in polar research, such as Hungary.

3.5 Will this activity be linked with other IPY core activities? If yes please specify
IPY project "State and Fate of the Cryosphere" (lead EoI-607), Jeff Key

IPY project "International Partnerships in Ice Core Science (IPICS)" (lead EoI-203), Ed Brooke
IPY project "Arctic Glaciers and Climate" (lead EoI-30, 654,756), Hans Oerlemans j.oerlemans@phys.uu.nl

IPY project “Mass Balance and Ice Dynamics” (lead EoI-418), Mark Fahnestock, mark.fahnestock@unh.edu APEX

3.6 How will the activity manage its data? Is there a viable plan and which data management organisations/structures will be involved?
The individual projects in this cluster will collect a variety of data from airborne, satellite, ice core, meteorological and seismic in addition to generating models and associated model outputs. Each project thus has different traditions for depositing its data. The steering committee will take an active role in creating efficient data management structures so the data will become available.

3.7 Data Policy Agreement
Will this activity sign up to the IPY draft Data Policy (see website)
Yes

3.8 How will the activity contribute to developing the next generation of polar scientists, logisticians, etc.?
PhD positions and Post Doc positions will be included in the budgets for the proposed activities. There is a great interest for young researchers to participate in polar projects and field work. We believe an essential part of the IPY program is to ensure there are funds available for young researchers in the programs.

3.9 How will this activity address education, outreach and communication issues outlined in the Framework document?
The subject of the cluster, “Stability of the Greenland Ice Sheet,” has big public interest. How will the Greenland Ice Sheet develop in the future and how did it look in the past? Combined with

polar expeditions and deep ice core drilling, we believe we have the potential to produce important education and outreach programs.

1. The group contains several talented public communicators.
2. Home pages will be developed on national basis.
3. Media can be invited to visit the field camps.
4. The cluster steering committee will coordinate the activities.
5. Several of the involved nations have funded projects for professional development of web-portals to The stability of the Greenland Ice Sheet.
6. As mentioned above, it is important for us that funds are included in the project for PhD students and Post Docs.

3.10 What are the proposed sources of funding for this activity?
Funds will be obtained for each sub-component from national operators as well as from international funding sources such as the EU. Coordination of funding and project logistics between nations will be required.

3.11 Additional Comments
The major parts of the projects have already been endorsed by national IPY committees. Right now most of us are waiting for IPY funds to be released by our national funding bodies. It is our hope that most of the funding will be in place by the beginning of 2006 and the cluster steering committee will wait until this time for the first meeting. There will be members from all projects (and hopefully all nations) in the steering committee.

4.0 CONSORTIUM INFORMATION

4.1 Contact Details

Lead Contact
Prof Dorthe Dahl-Jensen
Niels Bohr Institute
University of Copehagen University of Copenhagen, Juliane Maries Vej 30
2100 OE
Denmark

Tel: +45 35 32 05 56 (or +45 35 32
Mobile: N/A
Fax: Fax +45 35 36 53 57
Email: ddj@gfy.ku.dk

Second Contact
Prof Prasad Gogineni
Center for Remote Sensing of Ice Sheets
The University of Kansas The University of Kansas, 2335 Irving Hill Road, Lawrence, Kansas 66045-7612
USA

Tel: +1 785 864-7734
Mobile: N/A
Fax: +1 785 864-7789
Email: pgogineni@ku.edu

4.2 Other significant consortium members and their affiliation

Name	Organisation	Country
Mary Albert	CRREL	USA
Andreas Ahlstrøm	Oersted Institute, DTU	Denmark
Nobuhiko Azuma	Technological University of Nagaoka	Japan
Mark Battle	Dep.of Phys. and Astro., Bowdoin College	USA
Johan M. Bonow	Stockholm University	Sweden
David Braaten	Kansas University	USA
Alexander Braun	Department of Geomatics Engineering	Canada
Ed Brook	Oregon State University	USA
Gereon Budeus	AWI, Bremerhaven	Germany
Carl Egede Bøggild	GEUS	Denmark
Gary D Clow	USGS, Denver	USA
Beata Csatho	Ohio State University	USA
Mark Curran	University of Tasmania	Australia
Trine Dahl-Jensen	GEUS	Denmark
Mark Fahnestock	U New Hamphire	USA
Michel Fily	LGGE, Domaine Universitaire	France
Yoshiyuki Fujii	National Institute of Polar Res.	Japan
Carol Finn	USGS	USA
Hubertus Fischer	AWI, Bremerhaven	Germany
Rene Forsberg	Danish National Space Center	Denmark
Georgina Fotopoulos	University of Calgary	Canada
Martin Funk	ETH, Zurich	Switzerland
Thomas Funck	Danish National Space Center	Denmark
Hubert Gallee	LGGE, Domaine Universitaire	France
Christophe Genthon	LGGE, Domaine Universitaire	France
Jereon van Gool	GEUS	Denmark
Kumiko Goto-Azuma	National Institute of Polar Research	Japan
Paul F. Green	Geotrack International	Australia
Preben Gudmandsen	Danmarks Tekniske Universitet	Denmark
Oli Gudmundsson	University of Copenhagen	Denmark
Edmond Hansen	Norsk Polar Institute	Norway
Margareta Hansson	Stockholm Universitet	Sweden
Ebbe Hartz	Oslo University	Norway
Scott Hensley	Jet Propulsion Lab	USA
Georg Heygster	U. Of Bremen	Germany
Bryn Hubbard	University of Aberystwyth	United Kingdom
Phillipe Huybrechts	Vrijie Universiteit Brussel	Belgium
Robert Jacobel	U New Hamphire	USA
Peter Japsen	GEUS	Denmark
Anna B.O. Jensen	Denmarks Technical University	Denmark
Sigfus Johnsen	U. Of Copenhagen	Denmark
Ian Joughin	University of Washington	USA
Jean Jouzel	LSCE, Sacley	France
Eigil Kaas	Danish Meteorological Institute	Denmark
Janos Kiss	St. Olaf College, Budapest	Hungary
Sepp Kipfstuhl	AWI, Bremerhaven	Germany

Calvin Klatt	NRCan	Canada
Gerhard Krinner	LGGE, Domaine Universitaire	France
Tina Larsen	GEUS	Denmark
Antony Long	University of Durham	United Kingdom
Martin Luthi	University of Alaska	USA
Søren Madsen	Jet Propulsion Lab	USA
Douglas Mair	University of Aberdeen	United Kingdom
Patrick Wu. S. Marshall	University of Calgary	Canada
Valerie Masson-Delmotte	Lab. des Sciences du Climat et de l'Envir.	France
Joe McConnell	Dessert Research Institute	USA
David Meldrum	Scottish Association for Marine Science	United Kingdom
Heinz Miller	Alfred-Wegener-Institute, Bremerhaven	Germany
Glenn Milne	University of Durham	United Kingdom
Hideaki Motoyama	NIPR	Japan
Robert Mulvany	BAS	United Kingdom
Allan Aasbjerg Nielsen	Denmarks Technical University	Denmark
Troels Nielsen	GEUS	Denmark
Peter Nienow	University of Edinburgh	United Kingdom
Tony Payne	University of Bristol	United Kingdom
Lars Whilliam Petersen	Danish Meteorological Institute	Denmark
Ole Rasmussen	Danish Meteorological Institute	Denmark
Thorkild M. Rasmussen	GEUS	Denmark
Dominique Raynaud	LGGE, Domaine Universitaire	France
Catherine Ritz	LGGE, Domaine Universitaire	France
David Roberts	University of Durham	United Kingdom
Paul Rosen	Jet Propulsion Lab	USA
Niels Reeh	Oersted Institute, DTU	Denmark
Jakob Schwander	University of Bern	Switzerland
Martin Sharp	University of Alberta	Canada
Andrew Shepherd	University of Cambridge	United Kingdom
Michael Sideris	University of Calgary	Canada
Martin Siegert	University of Bristol	United Kingdom
C.K. Shum	Ohio State University	USA
N. Sneeuw	University of Calgary	Canada
Peter Stauning	Danish Meteorological Institute	Denmark
Konrad Steffen	CIRES, U. Of Colorado	USA
Bernhard Steinberger	Norwegian Geological Survey	Norway
Árný Sveinbjörnsdóttir	University of Iceland	Iceland
Eric Steig	University of Washington	USA
Jørgen Peder Steffensen	U. of Copenhagen	Denmark
Ken Taylor	University of Nevada	USA
Thorsteinn Thorsteinsson	National Energy Authority	Iceland
Leif Toudal	Oersted Institute, DTU	Denmark
Martin Truffer	University of Alaska Fairbanks	USA
John Yackel	University of Calgary	Canada
Ces van der Veen	Ohio State University	USA
Stefan Vogel	Ohio State University	USA

Peter Voss	Danish National Space Center	Denmark
Jurgen Watermann	Danish Meteorological Institute	Denmark
Jemma Wadham	University of Bristol	United Kingdom
Peter Wadhams	University of Cambridge	United Kingdom
Roderik van de Wal	Utrecht University	Netherlands
Jim White	University of Colorado	USA
Jeremy Wilkinson	Dunstaffnage Marine Laboratory	United Kingdom
Eric W Wolff	British Antarctic Survey	United Kingdom