

# In-Depth

NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

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## In this issue . . .

Upcoming Meetings .....	2
Ice Core Working Group Members .....	3
International Partnerships in Ice Core Sciences .....	4
Greenland NEEM Deep Ice Core .....	4
U.S. International Trans Antarctic Scientific Expedition .....	5
Norwegian/ U.S. Scientific Traverse in East Antarctica .....	6
Currently Funded Projects .....	7

## Message from the Director

Welcome to the 4th International Polar Year (IPY)! Over the next two years there will be intense focus on Polar research and several multi-institutional U.S. ice coring projects will be ongoing during IPY. These include the WAIS Divide Ice Core Project, U.S. ITASE, a Norwegian/ U.S. scientific traverse in East Antarctica, and a new U.S.-European deep ice core in Greenland. Brief descriptions about these projects are included in this issue of *In-Depth* and we hope to follow up with longer articles on each project in upcoming issues.

In other news, the international ice coring community has established the "International Partnerships in Ice Core Sciences" (IPICS) (see story page 4) whose charge is to promote ice coring projects through greater partnerships in logistics, technology and scientific collaborations between the 20 member nations. This is an important step for increased ice coring activities leading to a better understanding of the Earth's climate system. -MST ■

## International Polar Year 2007-2008

THE INTERNATIONAL POLAR YEAR 2007–2008 will be the largest internationally coordinated research program in 50 years. It will be an intensive period of interdisciplinary science focused on the Arctic and the Antarctic. The polar regions are especially important for the following reasons:

- They are presently changing faster than any other regions of the Earth, with regional and global implications for societies, economies and ecosystems. This change is particularly evident in widespread shrinking snow and ice.
- Processes in polar regions have a profound influence on the global environment, and particularly on the weather and climate system. At the same time, the polar environment is impacted by processes at lower latitudes. Examples include the

formation of the ozone hole and the accumulation of pollutants in the Arctic environment.

- The Arctic is home to more than 4 million people, and these communities face changes in their natural environment and in their natural resources and food systems — changes that are, for the most part, of a rapidity and magnitude beyond recent experience or traditional knowledge.



- Within the polar regions lie important scientific challenges yet to be investigated and unique vantage points for science. The regions beneath the polar ice sheets and under the ice-covered oceans remain largely unknown. Many of the new scientific frontiers in the polar regions are at the intersection of traditional scientific disciplines.

(continued on page 2)

## WAIS Divide Ice Core Project

### Project Overview

WAIS DIVIDE is a United States deep ice core project in West Antarctica funded by the National Science Foundation (NSF). The purpose of the project is to collect a 3,400 meter deep ice core from the flow divide (similar to a watershed divide) in central West Antarctica in order to develop records for the last 100,000 years of: global climate, the stability of the West Antarctic Ice Sheet (WAIS), and biological activity. The WAIS Divide ice core will provide Antarctic records of environmental change with the highest possible time resolution for the last ~100,000 years; it will be the Southern Hemisphere equivalent of the

Greenland GISP2, GRIP, and North GRIP ice cores. The most significant and unique characteristic of the WAIS Divide project will be the development of climate records with an absolute, annual-layer-counted chronology for the most recent ~40,000 years. In addition, due to the high snowfall rate, the WAIS Divide record will have only a small offset between the ages of the ice and the air trapped in the ice. The combination of high-time resolution and minimal age offset will allow us to study interactions between climate variations and atmospheric composition with a level of detail previously not possible in deep long Antarctic ice core records. The WAIS

(continued on page 3)



# In-Depth

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Masthead photos courtesy of  
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## Upcoming Meetings

### 15-20 April 2007

European Geosciences Union (EGU)  
General Assembly, Vienna, Austria  
<http://meetings.copernicus.org/egu2007/>

### 24-25 April 2007

Ice Core Working Group Annual  
Meeting, Irvine, CA  
nicl.smo@unh.edu

### 2-13 July 2007

Ice Cores and Climate Session of the  
IUGG, Perugia, Italy  
<http://www.iugg2007perugia.it/>

### 26-31 August 2007

10th International Symposium on  
Antarctic Earth Sciences, Santa Barbara,  
CA  
<http://isaes2007.geol.ucsb.edu/>

### 5-8 September 2007

West Antarctic Ice Sheet (WAIS)  
Workshop  
<http://igloo.gsfc.nasa.gov/wais/>

### 4-5 October 2007

WAIS Divide Ice Core Project Science  
Meeting, Lake Tahoe, NV  
<http://www.waisdivide.unh.edu/>

### 10-14 December 2007

AGU - Fall Meeting, San Francisco, CA  
<http://www.agu.org/meetings/>

## International Polar Year 2007-2008 *(continued from page 1)*

Six scientific themes provide a framework for IPY 2007–2008.

1. Status: to determine the present environmental status of the polar regions;
2. Change: to quantify and understand past and present natural environmental and social change in the polar regions and to improve projections of future change;
3. Global linkages: to advance understanding on all scales of the links and interactions between polar regions and the rest of the globe, and of the processes controlling these;
4. New frontiers: to investigate the frontiers of science in the polar regions;
5. Vantage point: to use the unique vantage point of the polar regions to develop and enhance observatories from the interior of the Earth to the sun and the cosmos beyond;
6. The human dimension: to investigate the cultural, historical and social processes that shape the sustainability of circumpolar human societies and to identify their unique contributions to global cultural diversity and citizenship.

IPY 2007–2008 research activities were assembled from the ideas of researchers in more than 60 countries. A total of 228 projects have been endorsed by the ICSU/WMO Joint Committee for IPY 2007–2008. These projects have a strong interdisciplinary emphasis and address the six themes as well as education and outreach objectives. IPY projects will exploit new technological and logistical capabilities and strengthen international coordination of research. They aim to attract, engage and develop a new generation of researchers and raise the awareness, interest and understanding of polar residents, educators, students, the general public and decision makers worldwide. IPY projects will collect a broad-ranging set of samples, data and information which will be made available to an unprecedented degree.

IPY 2007–2008 aims to leave a legacy of enhanced observational systems, facilities and infrastructure. The observational networks to be established during IPY include integrated ocean observing systems in both the Arctic and Southern Oceans, coordinated acquisition of satellite data products from multiple space agencies and observational systems for astronomy, sun–earth physics, atmospheric chemistry, meteorology, ecosystems, permafrost, glaciers and geophysics. Many observing systems within IPY will be developed within the framework of existing international global observing systems.

The period from 1 March 2007 to 1 March 2009 will be exciting and historic. The International Polar Year 2007–2008 should significantly advance our ability to meet the major science challenges of the polar regions and generate a rich legacy, notably in a new understanding of polar processes and their global linkages at this critical time— for it is becoming ever clearer that we humans have to recognize and respond to the planetary limits of our behaviour. The polar regions provide a litmus test and the insight to help us do so.

*From:*

The scope of science for the International Polar Year 2007-2008, Executive Summary, February 2007. Produced by the ICSU/WMO Joint Committee for IPY 2007-2008.

[http://www.ipy.org/index.php?/ipy/detail/the\\_scope\\_of\\_science\\_for\\_the\\_international\\_polar\\_year/](http://www.ipy.org/index.php?/ipy/detail/the_scope_of_science_for_the_international_polar_year/)

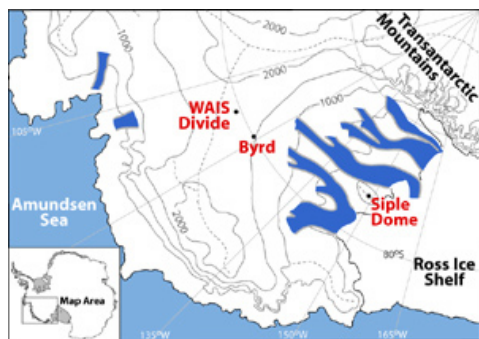
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For a list of NSF-funded IPY projects go to:  
[http://www.nsf.gov/od/opp/ipy/ipy\\_awards\\_0607.jsp](http://www.nsf.gov/od/opp/ipy/ipy_awards_0607.jsp)

## WAIS Divide Ice Core Project *(continued from page 1)*

Divide ice core is expected to produce the best atmospheric gas records of the past 100,000 years ever obtained. As such, the WAIS Divide ice core will enable detailed comparison of environmental conditions between the northern and southern hemispheres, and the study of greenhouse gas concentrations in the paleo-atmosphere, with significantly greater accuracy than is possible with any existing or planned ice core record.

The main objectives of this project are:

1. Develop the most detailed record of Greenhouse gases possible for the last 100,000 years
2. Determine if the climate changes that occurred during the last 100,000 years were initiated by changes in the northern or southern hemisphere
3. Investigate the past and future stability of the WAIS
4. Investigate the biology of deep ice



Site map showing the location of WAIS Divide.

Ice Coring and Drilling Services at the University of Wisconsin constructed a new deep drill (called the DISC [Deep Ice Sheet Coring] drill) for the WAIS Divide project. The DISC drill utilizes many technologies proven on Russian and European drills, as well as several new innovations. The drill was tested at Summit Greenland in summer 2006 and was very successful.

A seasonal field camp at WAIS Divide has been established. An arch facility to house the DISC drill and to handle the core has been constructed, and the pilot hole has been drilled and cased. In the past two field seasons more than 1,300,000 pounds

of cargo, passengers, and fuel have been flown to the WAIS Divide camp. During the upcoming 2007-2008 Antarctic field season construction of the arch facility will be completed, the DISC drill will be installed, and deep drilling will begin.

### Project Organization

The Office of Polar Programs at the NSF funds the project with most of the science funding coming from the Glaciology Program managed by Julie Palais. Some additional science funding is provided by the Antarctic Organisms and Ecosystems Program. Logistical support is provided by NSF's Division of Antarctic Infrastructure and Logistics and is managed by Matthew Kippenhan at Raytheon Polar Services Company. The Science Coordination Office (SCO) coordinates the scientific goals of the project. The SCO is led by Kendrick Taylor (Chief Scientist; Desert Research Institute, University of Nevada-Reno) and managed by Mark Twickler (Institute for the Study of Earth, Oceans, and Space, University of New Hampshire).

### Contact Information

More information can be found at <http://www.waisdivide.unh.edu> or by contacting Kendrick Taylor (email: [kendrick.taylor@dri.edu](mailto:kendrick.taylor@dri.edu)). -JMS ■



Drilling the WAIS Divide pilot hole inside the arch facility. Photo: J. Souney

## Ice Core Working Group

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**Eric Saltzman**  
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**Ross Edwards**  
*Desert Research Institute*  
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**Lonnie Lane**  
*Jet Propulsion Laboratory*  
Technical

**Howard Conway**  
*University of Washington*  
Modeling

**Larry Wilen**  
*Ohio University*  
Physical Properties

**Karl Kreutz**  
*University of Maine*  
Stable Isotopes

**Eric Steig**  
*University of Washington*  
TBD

In 1986, the National Academy of Sciences recommended developing an Ice Core Working Group of representatives from institutions prominent in ice coring activities. The ICWG now provides guidance to NSF on the future directions for ice core research, on topics related to sample access, distribution, inventory, policy issues, and operation and maintenance of the NICL facility. Administered by the NICL-SMO, ICWG is organized around scientific disciplines, rather than institutions. Members are elected to a three year term, with the committee chair serving two years.

# International Partnerships in Ice Core Sciences (IPICS)



IN MARCH, 2004 THE NATIONAL SCIENCE FOUNDATION supported a workshop proposal submitted by National Ice Core Laboratory-Science

Management Office to gather the world's premier ice core scientists, engineers and drillers to establish a formal plan for utilizing the strengths and expertise of each nation to promote future ice core projects and to develop focused research objectives. This resulted in a four-element framework of projects that both extends the ice core record in time and enhances spatial resolution.

A follow up meeting in October, 2005, supported by the European Polar Consortium, advanced these objectives to develop a "Roadmap and Pathways to Implementation" of the four IPICS flagship projects. An official IPICS steering committee was also formed, which includes national representatives from Australia, Belgium, Brazil, Canada, China, Denmark, France, Germany, India, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Russia, Sweden, Switzerland, United Kingdom and the United States.

In the wake of the IPICS meetings, the future goals of ice core research have been outlined in four White Papers summarizing

the scientific objectives, as well as drilling and implementation plans. The programs outlined in the four IPICS White Papers that are to be tackled in the coming years are:

1. The oldest ice core: A 1.5 million year record of climate and greenhouse gases from Antarctica (a time period where Earth's climate shifted from 40,000 year to 100,000 year cycles)
2. The last interglacial and beyond: A northwest Greenland deep ice core-drilling project (a deep ice core in Greenland recovering an intact record of the last interglacial period) (see NEEM story below)
3. The IPICS 40,000-year network: A bipolar record of climate forcing and response
4. The IPICS 2k Array: A global network of ice core climate and climate forcing records for the last two millennia

A fifth, and critical, element of IPICS is the development of advanced ice core drilling technology. A technical white paper, entitled "Ice Core Drilling Technical Challenges" addresses this.

In March 2006, members from the twenty nations represented by the group developed an IPICS Mission Statement:

- Defining priorities for international ice core science for the next two decades
- Developing the identified priority projects, and any organizational structures needed to enable them.
- Acting as a voice that will promote ice core science, and the priority projects in particular to: funding and logistics agencies, international organizations, and other scientific communities.
- Providing a forum for coordination and exchange of information between ice core practitioners from different nations.
- Promoting the maintenance, enhancement and sharing of expertise and capability in ice core drilling, curation, analysis and other technical areas needed to carry out the priority projects.
- Encouraging the training of young ice core scientists needed to carry out the current priority projects and to develop the next generation of projects.

For more information on IPICS and the White Papers please visit the IPICS website at: <http://www.pages-igbp.org/science/initiatives/ipics/index.html> or contact the Chairs of the IPICS Steering Committee: **Ed Brook**, University of Oregon  
**Eric Wolff**, British Antarctic Survey  
-MST ■

## The Greenland NEEM Deep Ice Core

THE NEEM (NORTH EEMIAN) PROJECT is a new, 3km long, deep ice core in northern Greenland. This ice core will help us understand past environments and climates, and by improving that understanding, better enable us to predict the conditions of future climates. Specific goals include obtaining a record of the climate of last interglacial period, called the Eemian, in Greenland. This period was several degrees C warmer than today, and is our best analog for a potentially warmer future climate. This core and the attendant radar mapping will also provide constraints on the size of the Greenland ice sheet at that time, when sea level was many meters higher than today. Greenland ice contributed significantly to that higher sea level, as it may also contribute to higher sea level in the coming centuries. This core will also provide additional records of abrupt climate

change, a common occurrence in the North Atlantic region in times of large, continental ice sheets, but one that has also occurred in the current warm period. The NEEM core should reveal if abrupt climate change occurred in the warmer Eemian period. It will also add to the understanding of the geographic extent and timing of past abrupt climate changes observed in other Greenland ice cores. From such information will hopefully come better predictive power for future abrupt climate shifts. This core will also add to the growing store of knowledge about how alterations of climate and the environment by humans fit within the context of natural climate change. NEEM is an international effort, led by the glaciology group at the University of Copenhagen. Fifteen countries have expressed a desire to participate. The US team currently consists of scientists from The University

*(continued on page 5)*

## The Greenland NEEM Deep Ice Core *(continued from page 4)*

of Colorado and The University of Kansas. Scientists from these institutions are responsible for core collection and radar surveys. In the coming years, we hope to add scientists from CRREL/Dartmouth, Oregon State University, the Desert Research Institute, Pennsylvania State University, The University of California at San Diego, and the US Geological Survey. This US group will have central roles in all of the main scientific goals of NEEM.

NEEM will provide opportunities for international teams of teachers and students to work along side an international group of scientists on the ice in structured educational activities.

It will provide material for polar science courses for college undergraduates and graduate students. It will provide opportunities for undergraduates to experience ice core research, and for graduate students to work in other countries around the world. And it will provide scientific findings that will be used by professional media outreach groups to publicize the importance of polar research, the International Polar Year, and deep ice cores. Finally, the data and interpretations generated by this project will address questions about the nature of climate and climate change that are of both direct and immediate scientific interest, and direct and immediate policy interest.

This project is a genuine collaboration between nations in the spirit of the International Polar Year: it is an important endeavor that no single nation acting alone could achieve. This research addresses ICSU IPY Framework Report Theme 2, to quantify and understand past and present natural environmental change in the polar regions. It contributes to Theme 3, advancing the understanding of the links and interactions between the polar regions. This project addresses the recommendations articulated in National Research Council's "Vision for the International Polar Year 2007-8" to provide an assessment of polar environmental change through studies of the past environment, to create datasets for future investigations, to conduct investigations contributing to the prediction and consequences of rapid change, to excite and engage the public, and to develop the next generation of scientists. This project is an initiative of the new International Partnerships in Ice Core Sciences, and a key part of the ICSU-WMO approved IPY activity: "The Greenland Ice Sheet – Stability, History, and Evolution".

-- James White, Institute of Arctic and Alpine Research, University of Colorado

## U.S. International Trans Antarctic Scientific Expedition

### Project Overview

THE INTERNATIONAL TRANS ANTARCTIC SCIENTIFIC EXPEDITION (ITASE) is a multi-national (20 nations), multi-disciplinary field research program focused on understanding the recent environmental history of Antarctica and the Southern Ocean through overland traverses of Antarctica. ITASE is focused on collecting records of environmental change, primarily through ice cores and related glaciological observations, covering the last 200+ years to allow examination of the modern anthropogenic era (aka last 100 years) plus at least the previous 100 years of naturally forced climate.

The United States contribution to ITASE (U.S. ITASE) completed its first phase of traverses over the course of 4 field seasons from 1999-2003. U.S. ITASE Phase 1 focused on a series of traverses extending over much of West Antarctica and a portion of East Antarctica. At the completion of Phase 1, U.S. ITASE had completed >5000 km of over snow traverses conducting field

experiments and observations involving ice coring, ice dynamics and surface glaciology, geophysics (deep and shallow radar soundings), and atmospheric chemistry in order to understand annual to multi-centennial scale climate variability.

U.S. ITASE Phase 2 activities are focused on a series of scientific traverses, over the course of two field seasons, in the region of Taylor Dome (Northern Victoria Land) to the South Pole. The first season (2006-2007) of Phase 2 activities was just completed. Ten ice cores, totaling more than 460 meters of ice, were collected across the traverse along with snowpit samples and surface snow samples. Deep radar sounding (to determine ice sheet thickness, internal layer structure, and bedrock topography), shallow radar sounding (for studies of firn stratigraphy and to look for crevasses), high-precision GPS surveys (to determine mass balance, ice flow direction and speeds, and ice surface topography), and high-resolution ice core density measurements were also conducted along the traverse route.

### Project Organization

U.S. ITASE is funded by the Glaciology Program (Julie Palais) of the Office of Polar Programs at the NSF. The Science Management Office (SMO) at the University of Maine coordinates the science and logistics organizations. Paul Mayewski leads the U.S. ITASE SMO and is also the Chair of ITASE.

### Contact Information

More information about U.S. ITASE can be found at <http://www2.umaine.edu/USITASE/> or by contacting Paul Mayewski or Ann Zielinski. -JMS ■

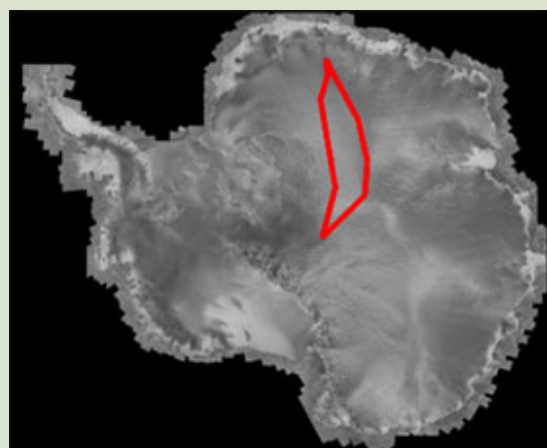


## Norwegian-United States IPY Scientific Traverse: Climate Variability and Glaciology in East Antarctica

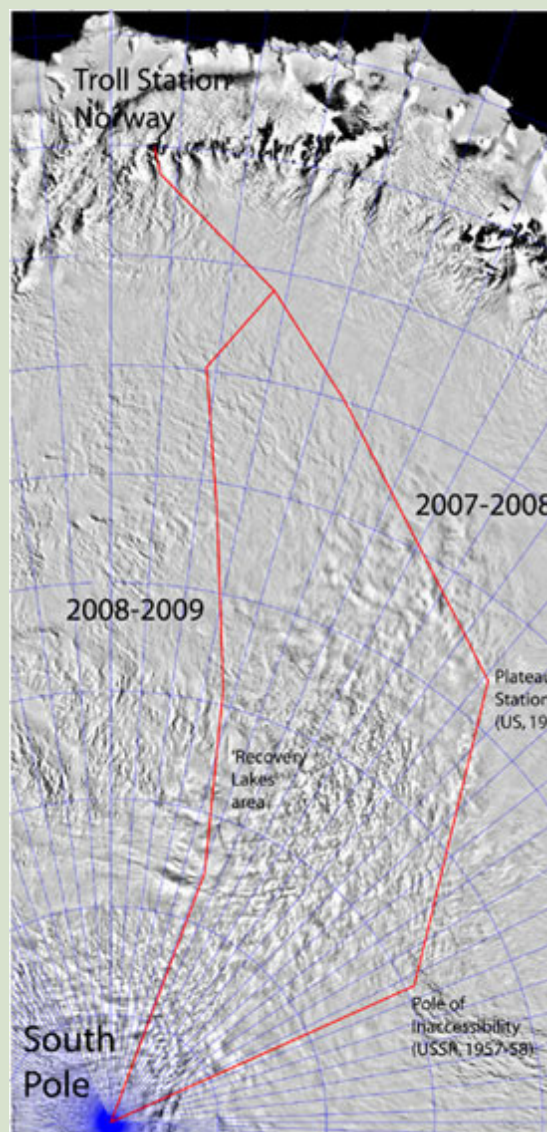
A NEW ICE CORING PARTNERSHIP between the U.S. and Norway will enable scientific investigations along two overland traverses in East Antarctica: one going from the Norwegian Troll Station (72° S, 2° E) to the United States South Pole Station (90° S, 0° E) in 2007-2008; and a return traverse starting at South Pole Station and ending at Troll Station by a different route in 2008-2009. The project will investigate climate change in East Antarctica, with the goals of understanding climate variability in Dronning Maud Land of East Antarctica on time scales of years to centuries, and determining the surface and net mass balance of the ice sheet in this sector to understand its impact on sea level. The project will also investigate the impact of atmospheric and oceanic variability, and human activities, on the chemical composition of firn and ice in the region. It will revisit areas and sites first explored by traverses in the 1960's, for detection of possible changes and to establish benchmark datasets for future research efforts.

The results of this study will add to understanding of climate variability in East Antarctica and its contribution to global sea level change. The project includes international exchange of graduate students between the institutions involved and international education of undergraduate students. It involves extensive outreach to the general public both in Scandinavia and North America through the press, television, science museums, children's literature, and web sites. Active knowledge sharing and collaboration between pioneers in Antarctic glaciology from Norway and the US, with the international group of scientists and students involved in this project, provide a unique opportunity to explore the changes that half a century have made in climate proxies from East Antarctica, scientific tools, and the culture and people of science. The project is relevant to the International Polar Year (IPY) since it is a genuine collaboration between nations: the scientists involved have complementary expertise, and the logistics involved rely on assets unique to each nation. It is truly an endeavor that neither nation could accomplish alone. This project is a part of the Trans- Antarctic Scientific Traverse Expeditions - Ice Divide of East Antarctica (TASTE-IDEA), and the International Partnerships in Ice Core Sciences (IPICS), both of which are part of IPY. More information can be found at <http://traverse.npolar.no>

-- Mary Albert, Dartmouth College/ Cold Regions Research and Engineering Laboratory



*Image of Antarctica. The traverse route is shown in red.  
Image courtesy of: Jan-Gunnar Winther*



*Close up image of the traverse route.  
Image courtesy of: Jan-Gunnar Winther*

## National Science Foundation Projects Related to

### Ice Cores or Ice Core Data

A search on the NSF webpage led to a compiled list of projects related to ice core research which are listed below. To learn more about any of the projects below, go to the NSF Award Search page (<http://www.nsf.gov/awardsearch/>) and type in the Award Number. Future issues of *In-Depth* will contain new projects related to ice core sciences. If you have a project that was omitted from this listing, please let us know and we will add it to the next issue of *In-Depth*.

Title of the Funded Project	Investigator	NSF Award Number
6th International Ice Drilling Technology Workshop	Fitzpatrick, Joan	0552340
A Science Management Office for the United States Component of the International Trans Antarctic Expedition (US ITASE SMO) - A Collaborative Program of Research from Taylor Dome to South Pole	Mayewski, Paul	0440679
A Tropical Perspective on 20th Century Climate Change from Ice Core Histories and Glacier Area and Volume Measurement from the Quelccaya and Coropuna Ice Caps in the Southern Andes	Thompson, Lonnie	0318430
Acquisition of an X-ray Diffractometer	Engelbrecht, Johann	0521619
Acquisition of High-Precision Mass Spectrometers for Noble Gas Isotopes as Environmental Tracers	Severinghaus, Jeffrey	0521642
Acquisition Proposal for Cold Chambers and Associated Equipment to Complete a Subzero Science and Engineering Facility at Montana State University	Adams, Edward	0521360
Assessing and extending the N <sub>2</sub> O record in the Vostok ice core	Sowers, Todd	0338145
Atmospheric Input of Bioavailable Iron and Phosphorus to Arctic during the Past Century from Greenland Ice Cores	Edwards, Peter	0520556
Borehole Optical Stratigraphy: Ice Microphysics, Climate Change, and the Optical Properties of Firn	Waddington, Edwin	0335330
Climate and Ice-Core Records: Quelccaya and Kilimanjaro	Hardy, Douglas	0402557
Climatology, Volcanism, and Microbial Life in Ice with Downhole Loggers	Price, P. Buford	0440609
Collaborative Research: SGER: Ice Core Paleoclimate Record from Mt. Waddington, British Columbia Coast Range	Clark, Douglas Steig, Eric	0629497 0630178
Collaborative Research: A Synthesis of Rapid Meltwater and Ice Discharge Changes: Large Forcings from the Ice with Impacts on Global Sea Level and North Atlantic Freshwater Budget	Alley, Richard Box, Jason Das, Sarah Fahnestock, Mark Joughin, Ian Truffer, Martin	0531211 0531306 0531345 0531250 0531270 0531075
Collaborative Research: A Unique Opportunity for In-Situ Measurement of Seasonally-Varying Firn Densification at Summit, Greenland	McConnell, Joseph Waddington, Edwin	0352511 0352584
Collaborative Research: An Isotope MIF Study of Volcanic Events in Greenland Ice Cores	Cole-Dai, Jihong Thiemens, Mark	0612461 0612422
Collaborative Research: Combined Physical Property Measurements at Siple Dome	Alley, Richard Wilen, Larry	0440447 0439805
Collaborative Research: Constructing an Ultra-high Resolution Atmospheric Methane Record for the Last 140,000 Years from WAIS Divide Core.	Brook, Edward Sowers, Todd	0538578 0538538
Collaborative Research: Corewall - Integrated Environment for Interpretation of Geoscientific Data from Sediment and Crystalline Cores	Higgins, Sean Ito, Emi Jenkins, Christopher Leigh, Jason	0601883 0602121 0601978 0602117
Collaborative Research: Deciphering the Deep Ice and the Ice-water Interface over Lake Vostok Using Existing Radar Data	Matsuoka, Kenichi Studinger, Michael	0538674 0537752

## National Science Foundation Projects Related to Ice Cores or Ice Core Data

Title of the Funded Project	Investigator	NSF Award Number
Collaborative Research: Digital Optical Imaging of Ice Cores for Curation and Scientific Applications	Alley, Richard McGwire, Kenneth	0229609 0230149
Collaborative Research: Dynamics and Climatic Response of the Taylor Glacier System	Cuffey, Kurt	0125579
Collaborative Research: Fabric and Texture Characteristics of Micro-Physical Processes in Ice	Waddington, Edwin Wilén, Larry	0136047 0135989
Collaborative Research: Firn structure, interstitial processes and the composition of firn air at Summit, Greenland	Albert, Mary Battle, Mark Severinghaus, Jeffrey	0520445 0520460 0520564
Collaborative Research: Gases in Firn Air and Shallow Ice at the Proposed WAIS Divide Drilling Site	Battle, Mark Brook, Edward Saltzman, Eric Severinghaus, Jeffrey Sowers, Todd White, James	0440509 0440615 0440602 0440701 0440759 0440498
Collaborative Research: Laboratory Studies of Isotopic Exchange in Snow and Firn	Albert, Mary Neumann, Thomas	0337304 0338008
Collaborative Research: Magnetic Properties of Greenland and Antarctic Ice Cores	Biscaye, Pierre Kent, Dennis	0424931 0424940
Collaborative Research: Multiple-isotope Analysis of Nitrate and Sulfate in the West Antarctic Ice Sheet Divide Ice Core	Steig, Eric Thiemens, Mark	0538049 0538520
Collaborative Research: New insights into the Holocene methane budget from dual isotope systematics and a high resolution record of the inter-polar gradient	Brook, Edward Sowers, Todd	0520523 0520470
Collaborative Research: Norwegian-United States IPY Scientific Traverse: Climate Variability and Glaciology in East Antarctica	Albert, Mary Hamilton, Gordon Liston, Glen McConnell, Joseph Neumann, Thomas Scambos, Ted	0538495 0538422 0537532 0538416 0538185 0538103
Collaborative Research: Particulate Organic Carbon in the Air and Snow at Summit, Greenland	Bergin, Michael Dibb, Jack Schauer, James	0425471 0425406 0425399
Collaborative Research: Physical Properties of the WAIS Divide Deep Core	Alley, Richard Cuffey, Kurt	0539578 0539232
Collaborative Research: Radical Chemistry over Sunlit Snow at Summit, Greenland	Blake, Donald Brooks, Steven Dibb, Jack Huey, L. Lefer, Barry Stutz, Jochen	0612426 0612568 0612075 0612387 0612136 0612279
Collaborative Research: Rapid Climate Change due to Sea Ice Dynamics in the North Atlantic and Arctic Oceans	Bitz, Cecilia Tziperman, Eli	0502204 0502482
Collaborative Research: Science Coordination for Summit Station, Greenland	Dibb, Jack Bales, Roger	0455299 0455623
Collaborative Research: Stable Isotopes of Ice in the WAIS Divide Deep Ice Core	Cuffey, Kurt Steig, Eric White, James	0537661 0537930 0537593
Collaborative Research: Western Divide West Antarctic Ice Cores (WAISCORES) Site Selection	Conway, Howard	0087345



## National Science Foundation Projects Related to Ice Cores or Ice Core Data

Title of the Funded Project	Investigator	NSF Award Number
Comprehensive Biological Study of Vostok Accretion Ice	Rogers, Scott	0536870
Core Measurements at Summit, Greenland Environmental Observatory	Bales, Roger	0336450
Detection of Crystal Orientation Fabrics near the Ross/Amundsen Sea Ice-flow Divide and at the Siple Dome Ice Core Site using Polarimetric Radar Methods	Raymond, Charles	0440847
Developing Dry Extraction of Ice Core Gases and Application to Millennial-Scale Variability in Atmospheric CO <sub>2</sub>	Brook, Edward	0337891
Dry Valleys Late Holocene Climate Variability	Kreutz, Karl	0228052
Evolution of Biogenic Exopolymer Concentrations and Interaction with Physical Structure in Arctic Sea Ice	Krembs, Christopher	0221055
Formaldehyde Desorption and Production from Ice Surfaces	Tan, David	0537789
Glaciological Characteristics of the Ross/Amundsen Sea Ice-flow Divide Deduced by a New Analysis of Ice-penetrating Radar Data	Raymond, Charles	0338151
High Resolution Radar Profiling of Firn Stratigraphy in East Antarctica: The ITASE II Traverse from Victoria Land to South Pole Station	Arcone, Steven	0440533
Histories of accumulation, thickness and WAIS Divide location from radar layers using a new inverse approach	Waddington, Edwin	0440666
Ice Coring and Drilling Services	Bentley, Charles	0003289
Ice Dynamics and Surface Glaciology along US ITASE Traverse Routes in East Antarctica	Hamilton, Gordon	0440792
Interpretation of the High Resolution, Multivariate Mt. Logan (Yukon Territory) Ice Core - A Record of North Pacific Climate and Atmospheric Chemistry	Mayewski, Paul	0612400
Investigation of Climate, Ice Dynamics and Biology using a Deep Ice Core from the West Antarctic Ice Sheet Ice Divide	Taylor, Kendrick	0440817
Investigation of the Glacial History of the Siple Coast Using Radar-Detected Internal Layers and the Ice Core from Siple Dome	Conway, Howard	0229490
Investigation of the Stratigraphy and Time Scale of the WAIS Divide Ice Core Using Electrical Methods	Taylor, Kendrick	0440819
Isotopic composition of HNO <sub>3</sub> and NO <sub>x</sub> at Summit Greenland	Steig, Eric	0454803
ITR/SI+AP: A Mobile Sensor Web for Polar Ice Sheet Measurements	Gogineni, S. Prasad	0122520
Laboratory Studies of Photochemistry in Antarctic Snow and Ice	Anastasio, Cort	0230288
Major Ion Chemistry of WAIS Divide Ice Core	Cole-Dai, Jihong	0538553
Methyl chloride and methyl bromide in Antarctic ice cores	Saltzman, Eric	0338359
Microbial Activity in Solid Ice: Implications for Modifying the CO <sub>2</sub> Record in Ice Cores	Skidmore, Mark	0525567
Microbial Observatory: Linking Microbial Diversity With Biogeochemical Studies Throughout the Deep Greenland Ice Sheet	Brenchley, Jean	0347475
Modeling Seasonal and Regional Patterns of Abrupt Climate Change	White, James	0519512
Nitrogen and oxygen gas isotopes in the Siple Dome and Byrd ice cores	Severinghaus, Jeffrey	0440975
Nitrogen and Oxygen Gas Isotopes in the WAIS Divide Ice Core as Constraints on Chronology, Temperature, and Accumulation Rate	Severinghaus, Jeffrey	0538657
Observations, Reanalyses and Ice Cores: A Synthesis of West Antarctic Climate	Reusch, David	0636618

## National Science Foundation Projects Related to Ice Cores or Ice Core Data

Title of the Funded Project	Investigator	NSF Award Number
Operation and Maintenance of the U.S. National Ice Core Laboratory	Hinkley, Todd	0223387
Optical Imaging Support for the National Ice Core Laboratory	McGwire, Kenneth	0637004
Paleo Records of Biotic and Abiotic Particles in Polar Ice Cores	Priscu, John	0440943
Paleoatmospheric Krypton and Xenon Abundances from Trapped Air in Polar Ice as Indicators of Past Mean Ocean Temperature	Severinghaus, Jeffrey	0538630
Photochemical Formation of Oxidants and Destruction of Organic Compounds in the Snowpack at Summit, Greenland	Anastasio, Cort	0455055
Preparation for a Deep Ice Coring Project in West Antarctica	Taylor, Kendrick	0230396
Radar Studies of Internal Stratigraphy and Bed Topography along the US ITASE-II Traverse	Jacobel, Robert	0440304
Reconstructing Late Holocene Volcanic Aerosol Fluxes from Greenland Ice Cores Collected by the PARCA Project	Mosley-Thompson, Ellen	0352527
Reconstructing Monsoon and Climate Variability from Naimona'nyi Ice Cores, Southwest Himalayas	Thompson, Lonnie	0502476
REU Site: Summer Fellowships in Biogeochemistry and Climate Change at the University of California, Irvine	Moore, Jefferson	0453495
Science Coordination Office for Summit, Greenland Environmental Observatory (Cooperative Research with the University of New Hampshire)	Bales, Roger	0453758
Science Management of the National Ice Core Laboratory	Twickler, Mark	0635515
SGER: High Resolution Radar Mapping of Ice Thickness and Near-Surface Layers in Northeast Greenland	Laird, Claude	0608181
SGER: An Exploratory Look at Stable Isotopes in an Ice Core from Flade Isblink	White, James	0604924
Solar Activity during the Last Millennium, Estimated from Cosmogenic in-situ <sup>14</sup> C in South Pole and GISP2 Ice Cores	Lal, Devendra	0538683
Space-time models, methods, and applications	Craigmile, Peter	0604963
Spatial Variability in Firn Properties from Borehole Optical Stratigraphy at the Inland WAIS Core Site	Waddington, Edwin	0538639
Stable Isotope Studies at East Antarctic US ITASE Sites	Steig, Eric	0440414
The Antarctic Glaciological Data Center: Continued Data Collection and Management for Antarctic Glaciology	Scambos, Ted	0338134
The Ice Age Large-format Film	Kempf, Donald	0552481
The Microstructural Location and Effects of Impurities in Polar Ice Cores	Baker, Ian	0440523
The Physical Properties of the US ITASE Firn and Ice Cores from South Pole to Taylor Dome	Meese, Debra	0538494
Trace and Ultra-Trace Chemistry Measurements of the WAIS Divide Ice Core	McConnell, Joseph	0538427
U.S.-France Cooperative Research: Nitrogen and Sulfur Cycles in Antarctica Inferred from Concentration and Isotopic Measurements	Thiemens, Mark	0128971
US ITASE Glaciochemistry Phase 2: East Antarctica	Mayewski, Paul	0439589

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