In-Depth

NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

Vol. 4 Issue 2 • FALL 2009

International Greenland Ice Coring Effort Sets New Drilling Record in 2009

... page 2

Old Ice - Climate record from last 2.5 million years may sit at the surface of Allan Hills

... page 4

WAIS Divide Ice Core Project Update

... page 6

Message from the Director 2

Upcoming Meetings 3

Ice Core Working Group Members 4

Recently Funded Projects .. 7

National Science Foundation and U. S. Geological Survey Decision about Future NICL Management

Photo: National Ice Core Laboratory, NICL/USGS

AS A RESULT OF BROAD DISCUSSIONS between the National Science Foundation (NSF) and the U.S. Geological Survey (USGS) about how to manage NICL in the future and how NICL relates to various mission goals of each agency, the agencies have concluded that it will be better to dissolve the past relationship. This means that NSF will begin a process to develop a new management structure for NICL that will entail leadership from the academic community. USGS has indicated to NSF that they will not provide support for the partnership beyond September 2010 but that it would be possible, at NSF's expense, to have the NICL physical plant remain at the Denver Federal Center as well as arrange for current NICL staff to remain with the facility.

For over a year, NSF and USGS have been discussing various options for the operation and management of the NICL facility. The situation can be summarized as follows: While both agencies viewed NICL as an important research resource, significant differences between the NSF and USGS approaches to the leadership and management of the facility had emerged in the discussions. For example, NSF had indicated that a dedicated ice core scientist should head the facility, following the intended management approach when NICL was first established at the Denver Federal Center. In contrast, USGS had indicated that the facility would be best managed as part of a broader core repository function that incorporates permafrost and rock cores in addition to ice cores, with a single scientist or curator responsible for all components. An important factor in the USGS position is that ice core science as part of a broader effort in climate change science is reasonably within their mission responsibilities, but that, in a strict sense, ice core science as a separate activity is not central to current or anticipated USGS scientific directions. Because of this divergence of views, and after considerable internal discussions, the USGS informed NSF that it cannot justify a dedicated focus to ice core science and so it desires to phase out of the partnership.

NICL-SMO will keep the community informed on developments relating to the new management structure at NICL.

■

In-Depth

In-Depth is published semi-annually by the **National Ice Core Laboratory - Science Management Office (NICL-SMO)**.

We are interested in project stories and news from the ice coring community. Please contact us if you are interested in submitting a story or news item to *In-Depth*.

***In-Depth* Newsletter**
Mark Twickler (MST), Director
Joe Souney (JMS), Production/Editing

nicl.smo@unh.edu
(603) 862-1991
http://nicl-smo.unh.edu

University of New Hampshire
Institute for the Study of Earth, Oceans, and Space
Durham, New Hampshire 03824

Masthead photos courtesy of Lonnie Thompson and Michael Morrison.

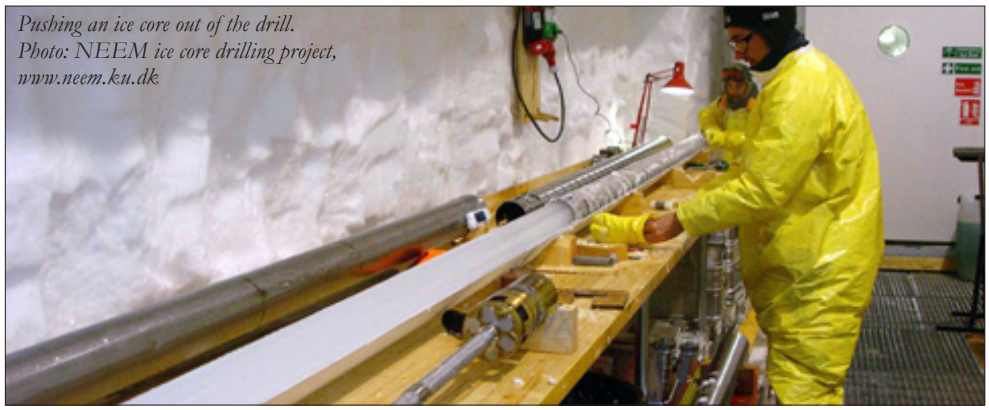
Message from the Director

As you can see from our cover story, the inter-agency agreement between NSF and USGS that provides management at NICL is not planned for renewal beyond the current fiscal year. The relationship between the agencies operating NICL is still strong and they are actively working towards infrastructure improvements at the facility. The Ice Core Working Group discussed the change in management at NICL and the Group endorses the concept of a University-based model for NICL management. These are exciting times and NICL-SMO will assist with all entities involved in this new venture for the ice coring community, which will hopefully be a smooth and seamless transition.

-MST ■

International Greenland Ice Coring Effort Sets New Drilling Record in 2009

Courtesy: *Press Release 09-158*, National Science Foundation



Pushing an ice core out of the drill. Photo: NEEM ice core drilling project, www.neem.ku.dk

A NEW INTERNATIONAL research effort on the Greenland ice sheet with the University of Colorado at Boulder as the lead U.S. institution set a record for single-season deep ice-core drilling this summer, recovering more than a mile of ice core that is expected to help scientists better assess the risks of abrupt climate change in the future.

The project, known as the North Greenland Eemian Ice Drilling, or NEEM, is being undertaken by 14 nations and is led by the University of Copenhagen. The goal is to retrieve ice from the last interglacial episode known as the Eemian Period that ended about 120,000 years ago. The period was warmer than today, with less ice in Greenland that led 5 meter (15-foot) higher sea levels than present--conditions similar to those Earth faces as it warms in the coming century and beyond, said CU-Boulder Professor Jim White, who is leading the U.S. research contingent.

> *"Every time we drill a new ice core, we learn a lot more about how Earth's climate functions. The Eemian period is the best analog we have for future warming on Earth."*

While three previous Greenland ice cores drilled in the past 20 years covered the last ice age and the period of warming to the present, the deeper ice layers representing the warm Eemian, and the period of transition to the ice age were compressed and folded, making them difficult to interpret, said White. Radar measurements through the ice sheet from above the NEEM site have indicated the Eemian ice layers below are thicker, more intact and likely contain more accurate, specific information, he said.

"Every time we drill a new ice core, we learn a lot more about how Earth's climate functions," said White. "The Eemian period is the best analog we have for future warming on Earth."

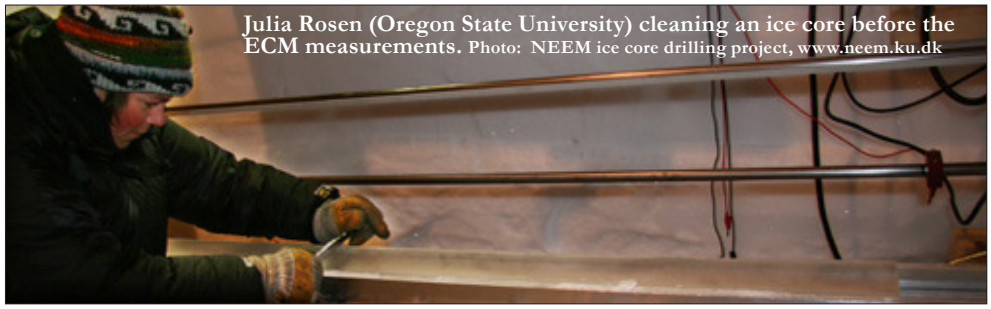
The NEEM project is led by the University of Copenhagen's Centre of Ice and Climate directed by Professor Dorthe Dahl-Jensen. The U.S. and Denmark are the two leading partners in this project. The U.S. effort is funded by the National Science Foundation's Office of Polar Programs.

Annual ice layers formed over millennia in Greenland by compressed snow reveal information on past temperatures and precipitation levels and the contents of ancient atmospheres, said White, who directs CU-Boulder's Institute of Arctic and Alpine Research. Ice cores exhumed during previous drilling efforts have revealed abrupt temperature spikes of more than 20 degrees Fahrenheit in just 50 years in the Northern

— continued on page 3

International Greenland Ice Coring Effort

— continued from page 2



Julia Rosen (Oregon State University) cleaning an ice core before the ECM measurements. Photo: NEEM ice core drilling project, www.neem.ku.dk

Hemisphere.

The NEEM team reached a depth of 1,758 meters (5,767 feet) in early August, where ice layers date to 38,500 years ago during cold glacial period preceding the present interglacial, or warm period. The team hopes to hit bedrock at 2,545 meters (8,350 feet) at the end of next summer, reaching ice deposited during warm Eemian period that lasted from roughly 130,000 to 120,000 years ago before the planet began to cool and ice up once again.

The NEEM project began in 2008 with the construction of a state of the art facility, including a large dome, the drilling rig for extracting three-inch in-diameter ice cores, drilling trenches, laboratories and living quarters. The official drilling started in June 2009. The United States is leading the laboratory analysis of atmospheric gases trapped in bubbles within the NEEM ice cores, including greenhouse gases like carbon dioxide and methane, said White.

"Evidence from ancient ice cores tell us that when greenhouse gases increase in the atmosphere, the climate warms," said White. "And when the climate warms, ice sheets melt and sea levels rise. If we see comparable rises in sea level in the future like we have seen in the ice-core record, we can pretty much say good-bye to American coastal cities like Miami, Houston, Norfolk, New Orleans and Oakland.

Increased warming on Earth also has a host of other potentially deleterious effects, including changes in ecosystems, wildlife extinctions, the growing spread of disease, potentially catastrophic heat waves and increases in severe weather events, according to scientists.

While ice cores pinpoint abrupt climate change events as Earth has passed in and out of glacial periods, the warming trend during the present interglacial period is caused primarily by human activities like fossil fuel burning, White said. "What makes this warming trend fundamentally different from past warming events is that this one is driven by human activity and involves human responsibility, morals and ethics."

> *"Evidence from ancient ice cores tell us that when greenhouse gases increase in the atmosphere, the climate warms. And when the climate warms, ice sheets melt and sea levels rise."*

Other nations involved in the project include the United States Belgium, Canada, China, France, Germany, Iceland, Japan, Korea, the Netherlands, Sweden, Switzerland and the United Kingdom.

Other CU-Boulder participants in the NEEM effort include INSTAAR postdoctoral researcher Vasilii Petrenko and Environmental Studies Program doctoral student Tyler Jones. Other U.S. institutions collaborating in the international NEEM effort include Oregon State University, Penn State, the University of California, San Diego and Dartmouth College.

For more information on the NEEM project, including images and video, visit http://www.neem.ku.dk/.

■

See U.S. funded NEEM investigators on page 5

Upcoming Meetings

14-18 December 2009
AGU Fall Meeting, San Francisco, CA
www.agu.org/meetings/

1-3 February 2010
Ice and Climate Change: A View from the South, Valdivia, Chile
www.cecs.cl/VICC2010/index.html

15-17 March 2010
AGU Chapman Conference on the Exploration and Study of Antarctic Subglacial Aquatic Environments (SAE), Baltimore, MD
www.agu.org/meetings/chapman/2010/ccall/

16-19 March 2010
2010 State of the Arctic Conference, Miami, FL
http://soa.arcus.org

3-6 August 2010
SCAR 2010 Open Science Conference, Buenos Aires, Argentina
www.scar.org/events/#31scarbuenosaires

5-10 September 2010
12th International Conference on the Physics and Chemistry of Ice, Sapporo, Japan
www.lowtem.hokudai.ac.jp/PCI-2010/

15-20 September 2010
International Symposium on Earth's Disappearing Ice, Byrd Polar Research Center, OH
www.igsoc.org/symposia/2010/ohio/

13-17 December 2010
AGU Fall Science Meeting, San Francisco, CA
www.agu.org/meetings/

Ice Core Working Group

Karl Kreutz, Chair
University of Maine

Murat Aydin
University of California-Irvine
Gases

Ian Baker
Dartmouth College
Physical Properties

Ryan Bay
University of California-Berkeley
Borehole Logging

Brent Christner
Louisiana State University
Biology

Todd Dupont
University of California-Irvine
Ice Sheet Modeling

Ross Edwards
Desert Research Institute
Ice Chemistry

Tom Neumann
University of Vermont
Surface Glaciology

Erin Pettit
University of Alaska-Fairbanks
Ice Flow Dynamics

Mark Skidmore
Montana State University
Biogeochemistry

Eric Steig
University of Washington
Isotopes

Stefan Vogel
Northern Illinois University
Sub-glacial Environments

Kendrick Taylor
Desert Research Institute
At Large

In 1986, the National Academy of Sciences recommended developing an Ice Core Working Group of representatives from institutions prominent in ice coring activities. 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.

Old Ice

Climate record from last 2.5 million years may sit at the surface of Allan Hills

By Peter Rejcek, Antarctic Sun Editor
Courtesy: ***The Antarctic Sun***, U.S. Antarctic Program

THE OLDEST ICE CORE retrieved from Antarctica — and the world — travels back about 850,000 years in time, revealing eight previous ice ages. It took the European Project for Ice Coring in Antarctica (EPICA) more than five field seasons to drill down 3,270 meters into the East Antarctic ice sheet.

Andrei Kurbatov and his colleagues believe that they can retrieve a nearly limitless supply of ice for climate research that dates back at least 2.5 million years — located right at the surface and retrievable in a single season.

The proverbial gold mine of old ice is located in a region called the Allan Hills Blue Ice Area, only about an hour's plane ride away from McMurdo Station , the hub of the U.S. Antarctic Program .

> *"The whole purpose of this project is to confirm that the ice is good for the reconstruction of climate."*

Snow covers most of Antarctica, but in blue ice areas, wind scours the snow from the surface. Sublimation — a process that turns snow immediately into water vapor in the air — takes care of the rest. Blue ice areas generally form where subglacial mountains obstruct ice flow, pushing the ice below to the surface. The surface ice closest to Allan Hills is the oldest ice and ages Benjamin Button-style farther away one moves horizontally.

"It's right on the surface, and if we sample it right, we should be able to complement existing ice core records," said Kurbatov, an assistant research professor at University of Maine's Climate Change Institute.

The first indication that Allan Hills held million-year-old ice actually came from meteorites collected there by scientists working on the Antarctica Search for Meteorites program for more than three decades, according to Kurbatov. Dating of the extraterrestrial rocks at the surface suggested an age of at least a million years. In addition, meteorite fragments buried in the ice just below the surface date back about 2.5 million years.

A millions of years old layer of ash buried just below the surface at Allan Hills. Photo credit: Andrei Kurbatov

Kurbatov said previous work by William McIntosh and Nelia Dunbar, with the New Mexico Bureau of Geology and Mineral Resources at New Mexico Tech , revealed an ash layer in the blue ice that turned out to be four million years old, further bolstering the idea that old ice was available for the picking without multi-million-dollar ice drilling operations.

"The whole purpose of this project is to confirm that the ice is good for the reconstruction of climate," Kurbatov explained. "Once we've done that, technically we could map this ice."

Kurbatov and his team will have two field seasons to collect samples from shallow ice cores and horizontal trenches using a machine developed and used by McIntosh and Dunbar about 10 years ago. The ice cutter — a four-wheeled, steel-framed contraption that sports two chainsaws at 45-degree angles — cuts a horizontal trench into the ice, pushed from behind like a lawnmower.

— continued on page 5

Old Ice

— continued from page 4

The scientists will date the core mainly using a novel technique comparing the stable isotope ratio of Argon-38 and Argon-40 gas bubbles trapped in the ice, developed by colleague Michael Bender at Princeton University . The gas measurements allow the scientists to date the ice based on decay of the argon.

"It will probably be one of the best dates available to us," Kurbatov said.

If the ice proves viable — samples contain the same sort of properties as ice cores such as trapped gas and dust particles that provide information about past climate — Kurbatov said the Allan Hills could prove to be a "climate park" where investigators can request ice of varying ages for an experiment.

"The problem with ice core records, it's never enough ice [for research]," he said, though stressed that ice cores remain the "gold standard" for climate research. "Ice cores are a crucial part of the Antarctica science program."

A machine is used to cut a horizontal trench through the ice. Photo credit: Bill McIntosh and Nelia Dunbar

Leigh Sterns pulls an instrument behind a snowmobile to map the Allan Hills Blue Ice Area in 2004. Andrei Kurbatov and colleagues will return to the area during the 2009-10 field season to determine the feasibility of recovering ice that is 2.5 million years old. Photo credit: Andrei Kurbatov

But the blue ice at Allan Hills does offer a sort of proxy time machine for climate far beyond what's available today from ice cores. Based on climate records from ocean sediment cores, which can contain tens of millions of years of history, scientists know that ice ages used to wax and wane on a roughly 40,000-year cycle. About a million years ago, that became a 100,000-year cycle.

No one really knows why. And sediment cores don't really offer the sort of resolution — the finer details — that researchers need to tease out an answer. That keystone could be right underfoot in the blue ice at Allan Hills.

"You have everything that was in the atmosphere. You preserve it like an archive," Kurbatov said. "That's why we really want to get this old ice, and see if it can show us something interesting."

NSF-funded research in this story: Andrei Kurbatov and Paul Mayewski, University of Maine, Award No. 0838843 ; and Michael Bender, Princeton University, Award No. 0838849 .

North Greenland Eemian Ice Drilling (NEEM) - U.S. Investigators

Project	Investigator	Institution	NSF Award Number
Biomass Burning, Dust, Sea Salt, Volcanic & Pollution Aerosols in the Arctic during the Last 2 Millennia: High Resolution Aerosol Records from NEEM & an Array of Archived Ice Cores	McConnell, Joseph	Desert Research Institute	0909541
Collaborative Research: The NEEM Deep Ice Core	Baker, Ian Brook, Edward Severinghaus, Jeffrey Sowers, Todd White, James	Dartmouth College Oregon State University Scripps Institution of Oceanography Pennsylvania State University University of Colorado at Boulder	0806339 0806414 0806377 0806407 0806387
IPY: Collaborative Research: The NEEM Deep Ice Core	Laird, Claude White, James	University of Kansas/CReSIS University of Colorado at Boulder	0632105 0632222
Microbiological and geochemical studies along the new Greenland NEEM core: from authenticity to microbial diversity and activity	Miteva, Vanya	Pennsylvania State University	0909323

WAIS Divide Ice Core Update

Participants of the 2009 WAIS Divide Science Meeting, held at Scripps Institution of Oceanography, La Jolla, CA from 1-2 October. Photo credit: Sylvain Masclin.

THE WEST ANTARCTIC ICE SHEET (WAIS) Divide camp opened for the 2009/10 season on Nov-2 (local time). After a 5.5-hour direct flight from McMurdo Station via Basler aircraft, the camp put-in team, led by camp manager Theresa "T" Tran, arrived to WAIS Divide after 10 days of weather delays. The on-site temperature was -49 degrees C.

The arch at WAIS Divide as first seen by this season's put-in crew. The core-handling (drilling) side of the arch is in the foreground (background). Photo credit: RPSC.

The 2009/10 field season marks the third season of deep drilling for the WAIS Divide Ice Core Project. We will resume drilling at 1514 meters depth and the goal for the season is to reach 2,600 meters depth, which will bring us back in time to approximately 22,000 years BP. In addition, we had ~930 meters of brittle and ductile ice drilled during the 2008/09 season stored in the basement of the arch that needed to be shipped back to McMurdo at the beginning of this field season for subsequent shipment back to the U.S.

After waiting in McMurdo for 16 days due to bad weather at WAIS Divide (and occasionally McMurdo), the first crew of core handlers, led by Bruce Vaughn, and drillers, led by Jay Johnson, arrived to WAIS Divide on Nov-25 and began packing up the ice in the storage basement and preparing the drill.

The ice that wintered over in the storage basement appears to be in remarkable shape. The green mesh-netting on the core has made a very slight impression in the ice, but can easily be pulled away. "It would not be a stretch to say this is the best preserved ice through the brittle zone I have ever seen," reports Vaughn.

The core handling team worked non-stop since arriving to camp and by the evening of Dec-7 had successfully shipped all of the ice in the storage basement back to McMurdo. The core handling team is now setting up the logging stations and preparing to receive ice core from the drillers.

The ice core storage basement at the end of the 2008/09 season, with ~930 meters of ice in it waiting to be returned to the U.S. for analysis. Photo credit: Jay Johnson, IDDO.

The drillers have been busy preparing the entire arch for drilling. For example, the drill slot was broadened; the casing was modified to better drain drill fluid into the hole and drip pans were extended; 3,800 meters of cable has been spooled onto the winch, and the tedious termination of the cable is underway.

The goal is to start drilling by Dec-11, which would put us only ~1 week behind schedule. If the season runs to Jan-23, this would give us

— continued on page 7

WAIS Divide Ice Core Update

— continued from page 6

34 drilling days (accounting for normal holidays) to achieve our goal of getting to 2,600 meters depth.

In other project news, the third annual WAIS Divide Science Meeting was held on October 1-2 in La Jolla, CA and hosted by Scripps Institution of Oceanography. Sixty-eight people attended the meeting and nineteen science talks and twenty posters were presented. The presentations and poster abstracts from the meeting are available within the password-protected data area section of the project web site (www.waisdivide.unh.edu) for funded PIs, Co-PIs, and graduate students.

While in La Jolla, the WAIS Divide Executive Committee convened an open meeting on Sep-30 and discussed, among other topics, the issue of replicate coring. Two options for replicate coring were presented by Ice Drilling Design and Operations (IDDO): (1) an active replicate coring drill that can replicate at any depth without the use of a whipstock; and (2) a passive replicate coring drill that utilizes a non-removable whipstock allowing only the bottom-most ice to be replicated. The Executive Committee strongly favored the active drilling method because it will allow the most interesting sections of the core to be replicated and because it also meets all of the science requirements of the project. Subsequently, the WAIS Divide Executive Committee asked IDDO to proceed with the development and fabrication of the active replicate coring drill.

The following table lists the anticipated long-term schedule for the project.

	Antarctica	**NICL**
2009/10:	Core to 2,600 meters	
2010:		CPL from 580 to 2,100 m (to ~13,000 years BP)
2010/11:	Core to 3,415 meters (stop 50 meters above bed, which is 3,465 m)	
2011:		CPL from 2,100 to 3,415 m (to ~100,000 years BP)
2011/12:	Borehole logging, Replicate coring	
2012/13:	Borehole logging, Replicate coring	
2013/14:	Close camp, move drill	

- WAIS Divide Science Coordination Office (SCO)
www.waisdivide.unh.edu

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

The table below shows projects related to ice core research that have been funded by the National Science Foundation (NSF) since the last issue of *In-Depth* was published. To learn more about any of the projects listed below, go to the NSF Award Search page (http://www.nsf.gov/awardsearch/) and type in the NSF Award Number. If you have a newly-funded NSF 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	Award Number
A Chemical History of Anthropogenic Input to the Atmosphere throughout the Industrial Era	Bond, Tami	0852775
Applying Ice Cores, Instrumental Climate Records and Climate Modeling Towards a Mechanistic Understanding of Antarctic Climate Variability on Interannual to Multidecadal Time Scale	Deser, Clara	0838871
Biomass Burning, Dust, Sea Salt, Volcanic & Pollution Aerosols in the Arctic during the Last 2 Millennia: High Resolution Aerosol Records from NEEM & an Array of Archived Ice Cores	McConnell, Joseph	0909541
Collaborative Research: A "Horizontal Ice Core" for Large-Volume Samples of the Past Atmosphere, Taylor Glacier, Antarctica	Brook, Ed Severinghaus, Jeffrey	0838936 0839031
Collaborative Research: Antarctic Climate Reconstruction Utilizing the US ITASE Ice Core Array (2009- 2012)	Mayewski, Paul Steig, Eric	0837883 0837988
Collaborative Research: Cosmogenic Radionuclides in the Deep WAIS Divide Core	Caffee, Marc Welten, Kees	0839042 0839137
Collaborative Research: Development of High-Resolution Biomass Burning Records for Tropical South America from Andean Ice Cores	Eglinton, Timothy Thompson, Lonnie	0921197 0921509

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

Title of the Funded Project	Investigator	Award Number
Collaborative Research: Exploring A 2 Million + Year Ice Climate Archive-Allan Hills Blue Ice Area (2MBIA)	Bender, Michael Kurbatov, Andrei	0838849 0838843
Collaborative Research: Greenland Ice Sheet Snow Accumulation Variability: Filling Knowledge and Data Voids	Box, Jason Forster, Richard	0909469 0909499
Collaborative Research: Integrated High Resolution Chemical and Biological Measurements on the Deep WAIS Divide Core	McConnell, Joseph Priscu, John Saltzman, Eric	0839093 0839075 0839122
Collaborative Research: Norwegian-United States IPY Scientific Traverse: Climate Variability and Glaciology in East Antarctica	Steig, Eric	0963924
Collaborative Research: P2C2--Ice Core Paleoclimate Records from Combatant Col, British Columbia, Canada	Clark, Douglas McConnell, Joseph Pettit, Erin Steig, Eric	0902392 0902734 0903124 0902240
Collaborative Research: The impact of bromine chemistry on the isotopic composition of nitrate at Summit, Greenland	Dibb, Jack Hastings, Meredith Huey, Greg	0908588 0909374 0908186
Continued Core Atmospheric and Snow Measurements at the Summit, Greenland Environmental Observatory	McConnell, Joseph	0856845
Developing a Glacial-Interglacial Record of delta-13C of Atmospheric CO2	Brook, Ed	0839078
International Research Fellowship Program: Inferring Changes in Ice-Sheet Flow and Accumulation	Koutnik, Michelle	0853407
Is There Cosmogenic Radiomethane in Polar Firn?	Severinghaus, Jeffrey	0806450
Major Ion Chemical Analysis of Brittle Ice in the WAIS Divide Ice Core	Cole-Dai, Jihong	0839066
Microbiological and geochemical studies along the new Greenland NEEM core: from authenticity to microbial diversity and activity	Miteva, Vanya	0909323
MRI: Acquisition of a Mass Spectrometric System for Determination of Biogeochemical Fluxes Between the Atmospheric and Marine Environment	Knopf, Daniel	0923038
MRI: Acquisition of an Ultra High Performance Liquid-Chromatography Tandem Mass-Spectrometer for a Multi-user Core Mass-Spectrometry Facility	Logue, Brian	0922816
P2C2: Dynamical Climate Reconstruction Using Paleoclimate Data and Ensemble State Estimation	Hakim, Gregory	0902500
Record of the 17O-excess of H2O in the WAIS Ice Core	Steig, Eric	0837990
Understanding the Physical Properties of Northern Greenland Near-Surface Snow: A Spatial Variability Study	Hawley, Robert	0909265

This material is based upon work supported by the National Science Foundation under Award Number ANT-0635515. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.