In-Depth

NEWSLETTER OF THE NATIONAL ICE CORE LABORATORY — SCIENCE MANAGEMENT OFFICE

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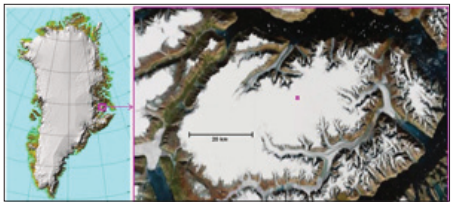

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Immerse yourself in ice

The U.S. Ice Drilling Program's "School of Ice"

By Linda Morris, Dartmouth Collge/U.S. Ice Drilling Program Office

Professor Lisa Bastiaans, Nassau Community College, gets her first exposure to an historic ice core. –Credit: Mike Lucibella

WHEN THE U.S. ICE DRILLING PROGRAM OFFICE (IDPO) was in need of a host site for its new "School of Ice" professional development workshop last June, Denver's National Ice Core Laboratory (NICL) was a natural choice. After all, where else but NICL's main storage freezer at -36 degrees C can people experience the extreme temperatures scientists are exposed to when studying climate history at the poles?

Last summer, twelve nationally selected professors from community colleges and universities serving large minority student communities got to walk in the shoes (bunny boots) of ice coring and drilling scientists/engineers as they kicked off a four day, residential learning program. [See related article on page 9 – *Empowering educators at the School of Ice*]

It's no secret that successful climate change education has hurdles to overcome. There's a dearth of scientifically sound information making it to teachers in a form they can easily utilize. There are common student misconceptions that undercut comprehension. There are conflicting public viewpoints being vociferously shared. And there is little funding to bring parties together to work on educational solutions. Yet progress is being made.

Responding to the challenge of enabling quality STEM (Science, Technology, Engineering and Math) education, Lockheed Martin awarded grant funding to Dartmouth's IDPO to design and deliver the first "School of Ice". IDPO's Director of Education & Public Outreach, Linda

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Immerse yourself in ice

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INSTAAR's Bruce Vaughn explains operations at the Stable Isotope Lab. –Credit: Shelly Sommer

Morris, worked with grant partner Jim Brey, Director at the American Meteorological Society's Education arm (AMS) in Washington, D.C. to craft the course.

Drawing from the expertise of a Leadership Team comprised of colleagues at University of Colorado Boulder's Institute of Arctic and Alpine Research (INSTAAR), the National Snow and Ice Data Center, NICL, CH2MHILL's Polar Field Services and Lockheed Martin's Antarctic Support Contract, the course incorporated in-person and video presentations by leading ice core scientists, field trips, hands-on activities and education sessions. Enhancing the science background knowledge of professors teaching introductory environmental or geoscience courses through AMS' college texts was a primary goal. Leaving them confident and empowered by the excitement of having (almost) "been there, done that" was the outcome.

One participant shared, "Seeing facilities and hearing from such a variety of experts was amazing! Especially appreciate hearing about not just the data but the field collection methods, lab data methods and complex field logistics. I feel like I have a true understanding of a variety of aspects of ice core research so I can teach my students the complete story."

On the Horizon: School of Ice 2016 is scheduled for May 22-26, 2016. As discoveries enabled by ice core research, especially recently published results from the long term West Antarctic Ice Sheet (WAIS) Divide deep drilling project, continue to emerge, it is more important than ever to make sure educators know the latest about these findings. Outreach efforts are underway to notify college professors at Minority-Serving Institutions nationwide of the opportunity to enhance their own teaching of climate science through participation in this in-depth course. Is this you, or do you have a colleague that qualifies? Information on course content is available from Linda Morris at linda.m.morris@dartmouth.edu. Application materials can be accessed online at http://goo.gl/forms/HvHqFjizVy or contact Elizabeth Mills at mills@ametsoc.org to receive them by email. Hope to see you there!

Geoff Hargreaves, NICL Curator, leads professors in safety training prior to core processing with PI Sarah Das. –Credit: Linda Morris

International research team drills new Greenland ice core through the Renland ice cap

Aerial view of the RECAP field camp located in the center of the Renland ice cap, Greenland. The drilling of the RECAP ice core itself took place inside of the large white tent. –Credit: Todd Sowers

ON JUNE 12, 2015, AN INTERNATIONAL RESEARCH TEAM led by the Niels Bohr Institute at the University of Copenhagen completed the drilling of a new ~100,000 year long ice core through the ice cap on the Renland peninsula in the Scoresbysund fjord in Eastern Greenland. The international project – called RECAP (REnland ice CAP project) – is a collaboration between scientists from Denmark's Centre for Ice and Climate at the University of Copenhagen, the U.S. (Penn State University and the University of Colorado), Germany's Alfred Wegener Institute (AWI), and Italy's University of Venice. The National Science Foundation's Division of Polar Programs funds the U.S. effort.

While a previous Danish ice core was drilled from the Renland ice cap in 1988, it was not drilled at the optimum location on the ice cap and bedrock was not reached. Furthermore, the drilling technology used in 1988 produced low quality ice core with a small diameter (3-inch), permitting neither gas measurements nor continuous chemical impurity measurements. The poor core quality of the 1988 ice core was caused by the drilling setup being unable to support drilling in liquid, and without a liquid in the borehole to equalize pressure, the core quality deteriorates with depth. In contrast, the new wet-drilled RECAP ice core contains high-quality, 4-inch diameter ice all the way to bedrock that is suitable for gas measurements and continuous chemical impurity measurements.

The Renland ice cap is constrained by the surrounding topography and its eastern plateau reaches an elevation of 2340 meters at its summit, where the thickness of the ice cap is almost 600 meters and the accumulation rate is approximately 0.5 meter of ice equivalent precipitation per year. The RECAP drill site was strategically located in the center of the Renland ice cap where the ice is the deepest and the most uniform with depth.

The shallowness of the Renland ice cap means that it does not have a brittle ice zone in the Holocene ice like the Greenland ice sheet, and therefore the RECAP ice core has the potential to yield the first continuous Holocene profiles of gases and chemical impurities ever extracted from Greenland. Furthermore, because climatic conditions on the Renland ice cap are strongly influenced by the varying Arctic sea ice export along Greenland's east coast, the RECAP ice core is expected to improve our understanding of Eastern Greenland climatic conditions, including the export of sea ice from the Arctic Ocean, over the past ~100,000 years.

In late April and early May 2015, a 4-person Danish field team determined the exact location of the RECAP drill site using a ground based radar system provided by the Center for Remote Sensing of Ice Sheets (CReSIS) at the University of Kansas, USA. The drilling

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International research team drills new Greenland ice core

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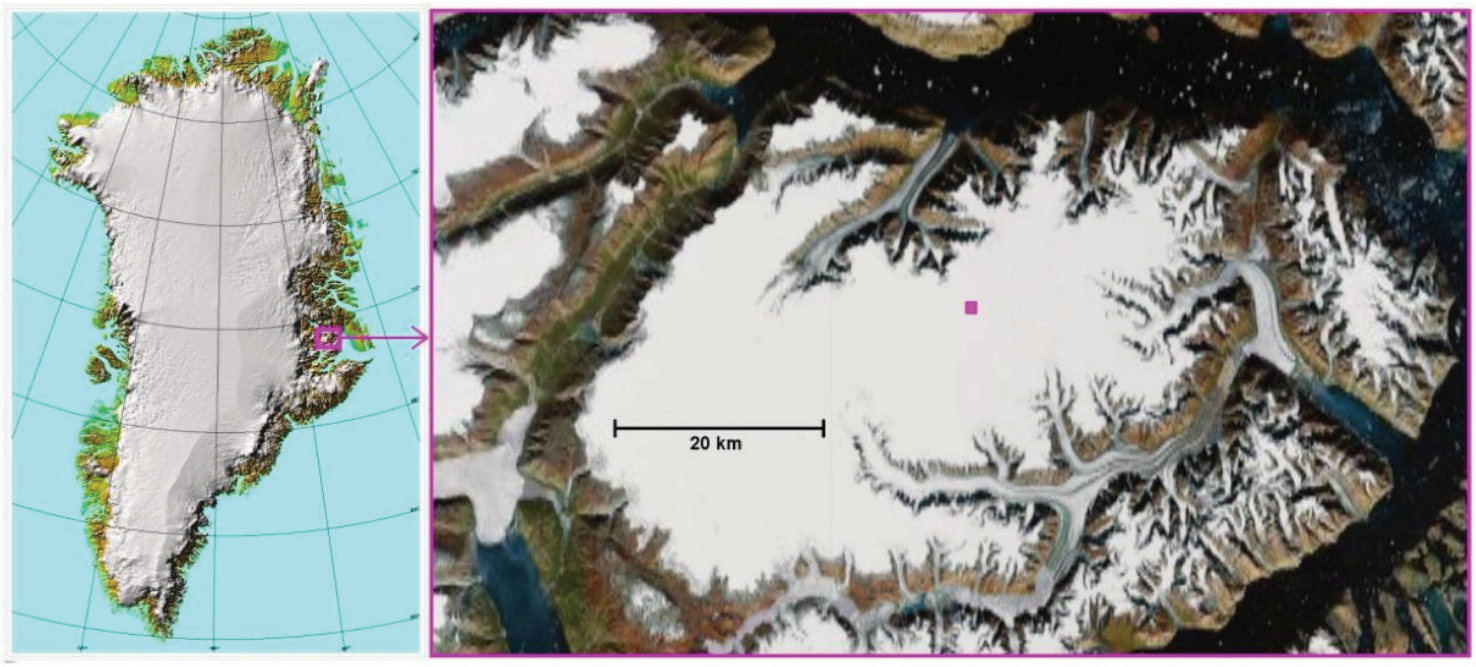

Left, map of Greenland, showing the location of the Renland ice cap. Right, satellite image of the Renland peninsula, which is almost entirely covered by the Renland ice cap. The dome of the eastern plateau of the Renland ice cap is marked with a purple square. –Source: http://recap.nbi.ku.dk/

equipment and ~11-person field crew were flown from Kangerlussuaq to Mestervig in Eastern Greenland via the U.S. 109th Air National Guard's ski-equipped LC-130 Hercules aircraft [*see ABC news story – VIDEO: New York Air Guard Unit is Lifeline for Scientists in Greenland and Antarctica*], and then from Mestervig to the RECAP drill site on Renland with the smaller AWI ski-equipped Basler DC-3 aircraft. Drilling of the RECAP ice core with the Danish Hans Tausen drill started on May 13, 2015, and was completed in record time one month later on June 12 at a depth of 584.11 meters when the drill reached the ground underneath the ice. The team then drilled down into the ground/sediment to get samples from below the ice.

The RECAP ice core was subsequently retrograded to AWI in Bremerhaven, Germany, where it was sub-sampled, with samples sent to laboratories at the Niels Bohr Institute, University of Venice, Penn State University, and the University of Colorado. U.S. efforts are focusing on gas concentrations and gas isotopes (PI Todd Sowers, Penn State University) and ice isotopes (PI James White, University of Colorado). Danish partners are also focusing on stable isotopes of ice and gas composition, as well as high-resolution chemistry. German partners are focusing on physical properties of the ice, line scanning, and dielectric properties to investigate the factors driving snow densification and ice core age model development.

For more information about RECAP, visit http://recap.nbi.ku.dk/

RECAP Chief Scientist Bo Vinther cuts a section of the freshly-drilled ice core. –Credit: Centre for Ice and Climate, University of Copenhagen

This research is supported by the National Science Foundation Division of Polar Programs under grant numbers 1304077 (Penn State University) and 1304109 (Univeristy of Colorado).

Upcoming Meetings

2015 AGU Fall Meeting
14-18 December 2015
San Francisco, California, USA
http://fallmeeting.agu.org/2015/

Scientific Drilling in the Polar Regions - AGU Town Hall Meeting
17 December 2016
AGU Fall Meeting, San Francisco, CA, USA
https://agu.confex.com/agu/fm15/meetingapp.cgi/Session/10019

Ice Core Young Scientists Workshop
6 March 2016
Hobart, Australia
http://www.pages-igbp.org/ini/end-aff/icys/overview

IPICS 2nd Open Science Conference
7-11 March 2016
Hobart, Australia
http://www.ipics2016.org/

Arctic Science Summit Week
12-18 March 2016
Fairbanks, Alaska, USA
https://assw2016.org/

European Geosciences Union General Assembly 2016
17-22 April 2016
Vienna, Austria
http://www.egu2016.eu/

Fourth International Summer School in Glaciology
7-17 June 2016
McCarthy, Alaska, USA
http://glaciers.gi.alaska.edu/courses/summer-school/2016

Desert Research Institute Press Release

Volcanic eruptions that changed human history

Researchers find new evidence that large eruptions were responsible for cold temperature extremes recorded since early Roman times

A freshly drilled ice-core from TUNU, Greenland containing a history of volcanic eruptions is pushed out of the core barell. –Credit: Olivia Maselli

July 8, 2015

RENO – It is well known that large volcanic eruptions contribute to climate variability. However, quantifying these contributions has proven challenging due to inconsistencies in both historic atmospheric data observed in ice cores and corresponding temperature variations seen in climate proxies such as tree rings.

Published today in the journal Nature, a new study led by scientists from the Desert Research Institute (DRI) and collaborating international institutions, resolves these inconsistencies with a new reconstruction of the timing and associated radiative forcing of nearly 300 individual volcanic eruptions extending as far back as the early Roman period.

"Using new records we are able to show that large volcanic eruptions in the tropics and high latitudes were the dominant drivers of climate variability, responsible for numerous and widespread summer cooling extremes over the past 2,500 years," said the study's lead author Michael Sigl, Ph.D., an assistant research professor at DRI and postdoctoral fellow with the Paul Scherrer Institute in Switzerland.

"These cooler temperatures were caused by large amounts of volcanic sulfate particles injected into the upper atmosphere," Sigl added, "shielding the Earth's surface from incoming solar radiation."

The study shows that 15 of the 16 coldest summers recorded between 500 BC and 1,000 AD followed large volcanic eruptions – with four of the coldest occurring shortly after the largest volcanic events found in record.

This new reconstruction is derived from more than 20 individual ice cores extracted from ice sheets in Greenland and Antarctica and analyzed for volcanic sulfate primarily using DRI's state-of-the-art, ultra-trace chemical ice-core analytical system. These ice-core records provide a year-by-year history of

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Volcanic eruptions that changed human history

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atmospheric sulfate levels through time. Additional measurements including other chemical parameters were made at collaborating institutions.

"We used a new method for producing the timescale," explained Mai Winstrup, Ph.D., a postdoctoral researcher at the University of Washington, Seattle. "Previously, this has been done by hand, but we used a statistical algorithm instead. Together with the state-of-the-art ice core chemistry measurements, this resulted in a more accurate dating of the ice cores."

"Using a multidisciplinary approach was key to the success of this project," added Sigl.

In total, a diverse research group of 24 scientists from 18 universities and research institutes in the United States, United Kingdom, Switzerland, Germany, Denmark, and Sweden contributed to this work – including specialists from the solar, space, climate, and geological sciences, as well as historians.

The authors note that identification of new evidence found in both ice cores and corresponding tree rings allowed constraints and verification of their new age scale.

"With the discovery of a distinctive signature in the ice-core records from an extra-terrestrial cosmic ray event, we had a critical time marker that we used to significantly improve the dating accuracy of the ice-core chronologies," explained Kees Welten, Ph.D., an associate research chemist from the University of California, Berkeley.

A signature from this same event had been identified earlier in various tree-ring chronologies dating to 774-775 Common Era (CE).

"Ice-core timescales had been misdated previously by five to ten years during the first millennium leading to inconsistencies in the proposed timing of volcanic eruptions relative to written documentary and tree-ring evidence recording the climatic responses to the same eruptions," explained Francis Ludlow, Ph.D., a postdoctoral fellow from the Yale Climate & Energy Institute.

Throughout human history, sustained volcanic cooling effects on climate have triggered crop failures and famines. These events may have also contributed to pandemics and societal decline in agriculture-based communities.

A scientist is measuring the electrical properties – a measure of the volcanic acidity content of the ice layers – in the field. –Credit: Michael Sigl

Together with Conor Kostick, Ph.D. from the University of Nottingham, Ludlow translated and interpreted ancient and medieval documentary records from China, Babylon (Iraq), and Europe that described unusual atmospheric observations as early as 254 years before Common Era (BCE). These phenomena included diminished sunlight, discoloration of the solar disk, the presence of solar coronae, and deeply red twilight skies.

Tropical volcanoes and large eruptions in the Northern Hemisphere high latitudes (such as Iceland and North America) – in 536, 626, and 939 CE, for example – often caused severe and widespread summer cooling in the Northern Hemisphere by injecting sulfate and ash into the high atmosphere. These particles also dimmed the atmosphere

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Volcanic eruptions that changed human history

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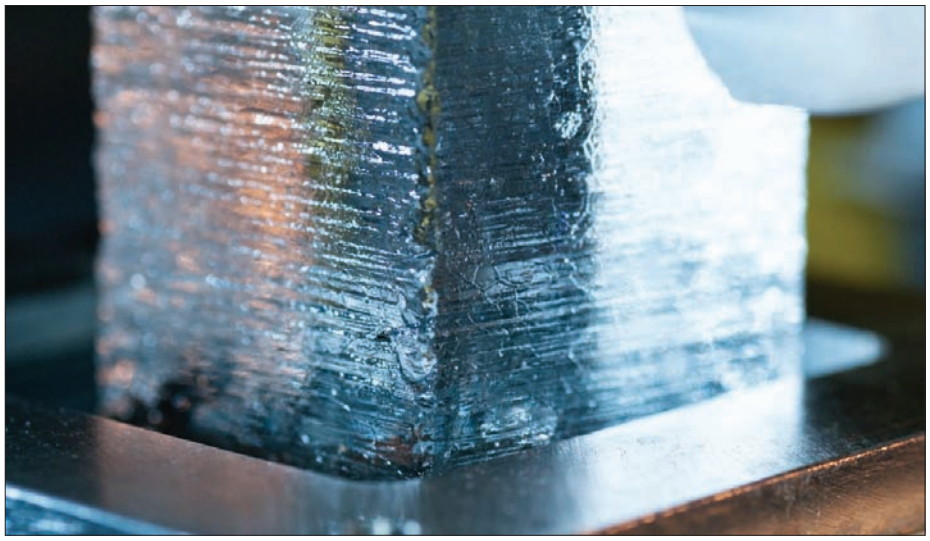


Ice impurities are simultaneously analyzed at the Desert Research Institute's Ultra-Trace Chemistry Laboratory while continuously melting the ice section on a heated melter plate. – Credit: Sylvain Masclin

over Europe to such an extent that the effect was noted and recorded in independent archives by numerous historical eyewitnesses.

Climatic impact was strongest and most persistent after clusters of two or more large eruptions.

The authors note that their findings also resolve a long-standing debate regarding the causes of one of the most severe climate crises in recent human history, starting with an 18-month "mystery cloud" or dust veil observed in the Mediterranean region beginning in March, 536, the product of a large eruption in the high-latitudes of the Northern Hemisphere.

The initial cooling was intensified when a second volcano located somewhere in the tropics erupted only four years later. In the aftermath, exceptionally cold summers were observed throughout the Northern Hemisphere.

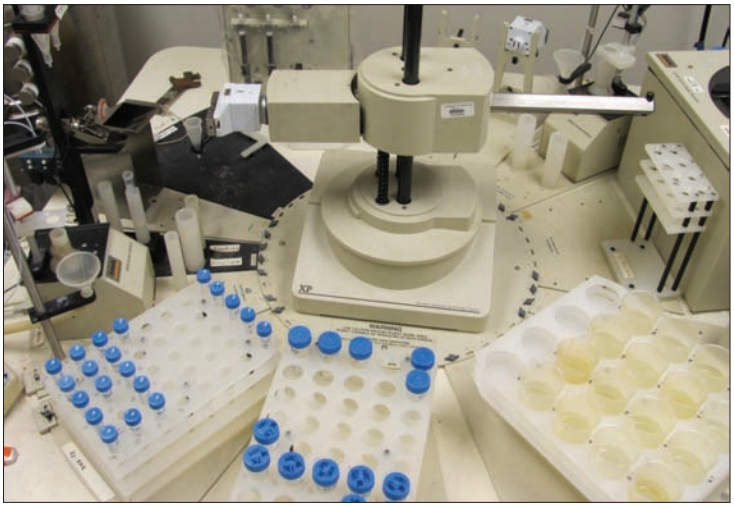
This pattern persisted for almost fifteen years, with subsequent crop failures and famines – likely contributing to the outbreak of the Justinian plague that spread throughout the Eastern Roman Empire from 541 to 543 CE, and which ultimately decimated the human population across Eurasia.

"This new reconstruction of volcanic forcing will lead to improved climate model simulations through better quantification of the sensitivity of the climate system to volcanic influences during the past 2,500 years," noted Joe McConnell, Ph.D., a DRI research professor who developed the continuous-flow analysis system used to analyze the ice cores.

"As a result," McConnell added, "climate variability observed during more recent times can be put into a multi-millennial perspective – including time periods such as the Roman Warm Period and the times of significant cultural change such as Great Migration Period of the 6th century in Europe."

This reconciliation of ice-core records and other records of past environmental change will help define the role that large climatic perturbations may have had in the rise and fall of civilizations throughout human history.

"With new high-resolution records emerging from ice cores in Greenland and Antarctica, it will be possible to extend this reconstruction of volcanic forcing probably all the way back into the last Ice Age," said Sigl.



Preparation of ice core samples for 10Be analysis using dedicated chemistry robot at Space Sciences Laboratory, University of California, Berkeley. –Credit: James McCarthy

This research was largely funded by the U.S. National Science Foundation's Polar Program; with contributions from additional funding agencies and institutions in Belgium, Canada, China, Denmark, France, Germany, Iceland, Japan, Korea, The Netherlands, Sweden, Switzerland, and the United Kingdom.

Source: http://www.dri.edu/news/dri-news-and-press-releases/5102-volcanic-eruptions-that-changed-human-history

New program directors within Division of Polar Programs

Dr. Thomas Wilch appointed Antarctic Earth Sciences Program Director

Dr. Thomas Wilch has joined the Antarctic Sciences Section as Program Director for Antarctic Earth Sciences (AES). He replaces Dr. Mark Kurz, who managed the AES program from April 2013 to September 30, 2015. Dr. Wilch has worked on a variety of Antarctic research projects, including two that focus on using volcanic records to reconstruct the history of the Antarctic ice sheet and on the multi-national ANDRILL project, which drills deep into Antarctic sediments to study glacial history and predict future climates. He comes to NSF from Albion College in Albion, Michigan, where he is Chairman of the Department of Geologic Sciences. A Quaternary geologist, he specializes in glacial geology, physical volcanology, and paleoclimate history. He holds a M.S. in Quaternary Studies from University of Maine, Orono, Maine, and a Ph.D. in Geology from the New Mexico Institute of Mining and Technology, Socorro, New Mexico.

Dr. Christian Fritsen appointed Program Director for Antarctic Organisms and Ecosystems

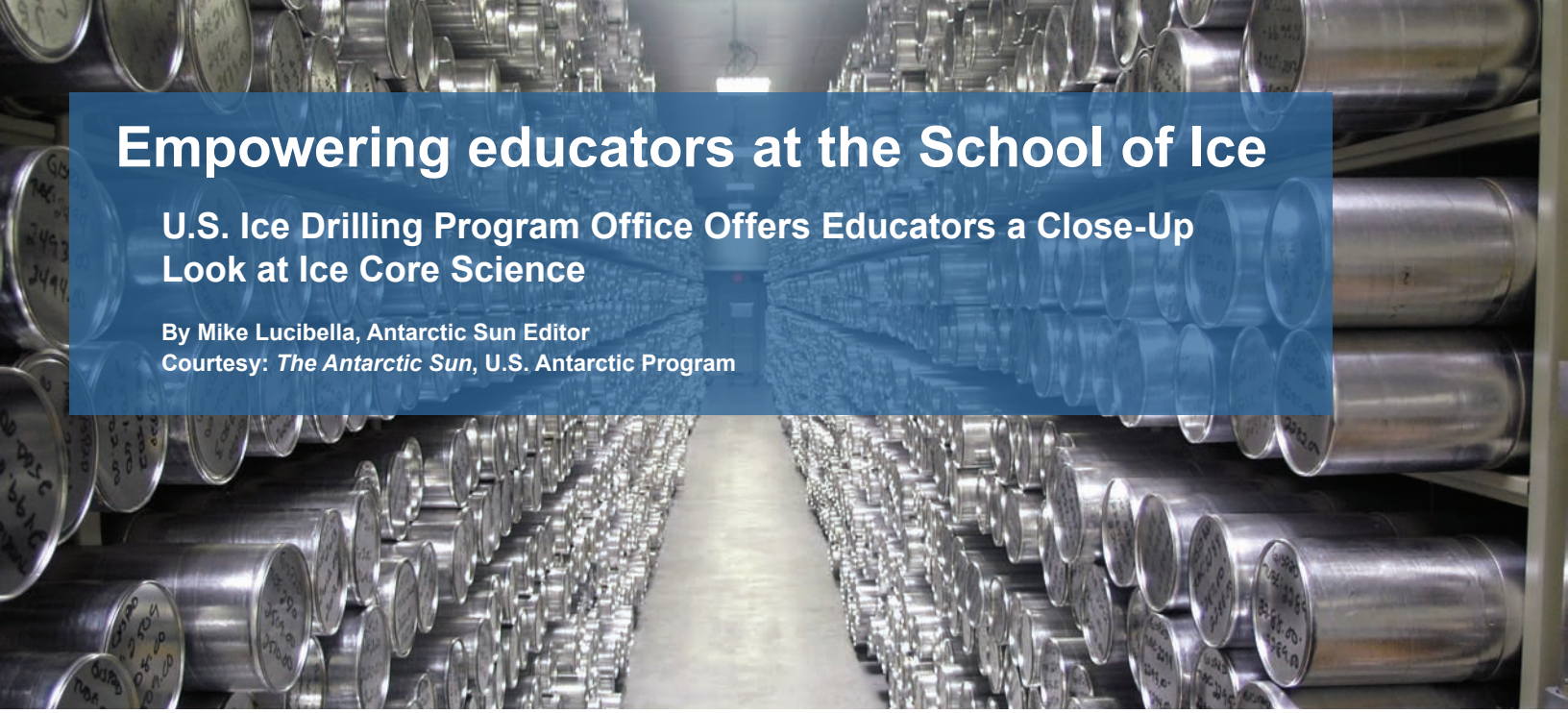
Dr. Christian Fritsen has assumed the responsibilities of Program Director for the Antarctic Organisms and Ecosystems Program in the Antarctic Sciences Section of the Division of Polar Programs. Dr. Fritsen is a Research Professor in the Division of Earth and Ecosystem Sciences at the Desert Research Institute. He also served as DRI's Vice President for Academic and Faculty Affairs, is a member of the graduate faculty in Hydrology and Environmental sciences at the University of Nevada, Reno, and has served as Director of both the Nevada Space Grant Consortium and Nevada NASA Experimental Program to Stimulate Competitive Research. Dr. Fritsen earned his Bachelor's degree from Montana State University in 1990 and a doctorate in the biological sciences, with an emphasis in oceanography, from the University of Southern California in 1996. Dr. Fritsen succeeds Dr. Charles Amsler, a rotator from the University Of Alabama at Birmingham. Dr. Amsler returned to his university at the end of July.

Dr. Diane McKnight appointed Program Director for Arctic System Science Program

Dr. Diane McKnight, of the University of Colorado, has been appointed as a program director in the Arctic Sciences Section in the Division of Polar Programs. Dr. McKnight's primary assignment is to join Dr. Neil Swanberg in managing the Arctic System Science (ARCSS) Program. She began her service at NSF on June 15, 2015. Dr. McKnight comes to NSF from the University of Colorado where she holds an appointment as Professor of Civil, Environmental, and Architectural Engineering and a Fellow of the Institute of Arctic and Alpine Research. She also served as founding director of the Center for Water, Earth Science and Technology. Dr. McKnight is a hydrologist who studies coupled ecological, biogeochemical and hydrologic processes in lakes, streams, and watersheds, primarily in polar and mountain regions. She is also a member of the National Academy of Engineering and a Fellow of both the American Geophysical Union and the American Association for the Advancement of Science.

Dr. Michael E. Jackson appointed Program Director for Antarctic Research Facilities and Special Projects

Dr. Michael E. Jackson has joined the Antarctic Sciences Section of the Division of Polar Programs as Program Director for Antarctic Research Facilities and Special Projects. Dr. Jackson comes to NSF from Trimble Navigation where he was responsible for the hardware and software portfolio for the geosciences including seismic, geodetic, atmospheric and space weather activities. Before his tenure with Trimble, Dr. Jackson was the co-PI and Director of the UNAVCO-led Plate Boundary Observatory and later the San Andreas Fault Observatory at Depth components of EarthScope. Prior to EarthScope Dr. Jackson was the Network Operations Manager at the UNAVCO facility. He has chaired and participated in numerous review panels for the NSF, USGS, NOAA, and NASA. He has authored over 60 articles and abstracts on tectonics, volcanology, atmospheric water vapor, and technological innovations. Dr. Jackson holds a B.S. in geology from the University of New Mexico, as well as a Masters in geological sciences and a Ph.D. in geophysics, both from the University of Colorado.



Empowering educators at the School of Ice

U.S. Ice Drilling Program Office Offers Educators a Close-Up Look at Ice Core Science

By Mike Lucibella, Antarctic Sun Editor
Courtesy: *The Antarctic Sun*, U.S. Antarctic Program

Rows of insulated tubes store ice cores dating back hundreds of thousands of years at the National Ice Core Laboratory's freezer archive. –Credit: National Ice Core Laboratory

TO THE CASUAL OBSERVER, mid-June may not seem like the ideal time to explore the science of ancient ice. However, last month, as the hot sun beat down outside, a dozen geoscience professors donned boots and thick red parkas to brave sub-zero freezers and learn the secrets embedded in ice many thousands of years old, from the coldest places on Earth.

The U.S. Ice Drilling Program Office (IDPO), funded by the National Science Foundation, brought a dozen college professors to the Denver area for an up-close look at the important role that ice cores play in paleo-climate science. Dubbed "The School of Ice," the inaugural four-day workshop infused the most up-to-date ice science into the course materials for the American Meteorological Society's (AMS) Climate Studies Course. Climate scientists shared how the chemical composition of tiny air bubbles and other indicators trapped in ancient ice helps them model future climate changes.

"It's really important that we get that science out to people like these professors," said Linda Morris, the director of education and public outreach for the U.S. Ice Drilling Program based at Dartmouth College. "Ice cores are a pristine archive of really valuable data."

The workshop featured a mix of site visits, hands-on activities and lectures from some of the nation's top ice and climate scientists. The group toured the vast ice core archives stored in the freezers at the National Ice Core Laboratory in Lakewood, Colo., visited the isotope lab at the University of Colorado-Boulder's Institute of Arctic and Alpine Research and spent a day at the Antarctic Support Contract office in Centennial, Colo., learning about the complex logistics needed to extract and transport polar ice cores from some of the planet's most remote locations.

The IDPO helps coordinate the short and long-term planning of U.S. ice coring operations in both the Northern and Southern hemispheres. The IDPO and AMS designed the workshop to help college professors who may not have much experience with ice cores better understand how researchers use cores to understand Earth's ancient climate.

The workshop expands on the AMS's Climate Studies Course, a comprehensive bundle of materials for college professors to teach climate science in their classrooms. To bring about the School of Ice, Morris at the IDPO partnered with James Brey at the AMS, who had organized a number of similar courses and workshops on a range of Earth science topics.

"The AMS education program has always gone directly to the scientists for content for our courses," Brey said. "This is why you have to bring the folks who are going to be teaching the materials in contact with experts."

Lockheed Martin funded the program through its philanthropic outreach program.

The professors selected for the School of Ice all come from minority-serving institutions, colleges and universities whose students are

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Empowering educators at the School of Ice

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largely made up of African-Americans, Hispanics, Native Americans and other underrepresented groups.

"We need to build that pipeline of underrepresented groups in the workforce, because it is a major source of talent that is not being tapped very well," Brey said. "The numbers of those students that go into earth science is very, very small."

South Texas College, where Mario Lopez teaches, is one such institution. Located about ten miles from the Rio Grande, a large proportion of South Texas College students are Hispanic and many are first generation college students.

"Being able to engage the students requires being able to think about what they would be interested in," Lopez said. "This workshop has introduced me to some neat ways to do that."

He added also that in order to best serve his students, workshops like the School of Ice let him learn the latest climate science directly from the researchers performing the experiments.

"Being kind of isolated from the climate research community where I live and work, it's really important to be able to build a network to stay connected with that field," Lopez said.

Mixed in with their technical lectures, the visiting professors learned experiments for students to try in their lab sessions. They sawed through artificial ice cores to extract colored marbles representing the chemical isotopes in ancient air, watched pooling water from a melting ice cube atop a small sand pile simulate the planet's rising oceans should the continental ice sheets thaw, and observed oozing putty mimic the flow of glaciers.

"There's a lot that I can take back into my classroom," said Shea Rose, a geoscience professor at the University of West Georgia. "I teach introductory level and upper level, and really I've found something for all of those levels in the workshop."

This material is based upon work supported by the National Science Foundation under Cooperative Agreement No. PLR-1327315 to Dartmouth, and sub awards to University of New Hampshire, University of Wisconsin and Colorado School of Mines which support the work of the Ice Drilling Program Office (IDPO).

[See related article on page 1 - *Immerse yourself in ice*]

Luke Trusel of the Woods Hole Oceanographic Institute describes to School of Ice participants how he and his colleagues store and process ice cores at the National Ice Core Laboratory. –Credit: Mike Lucibella

Richard Nunn, the assistant curator at the National Ice Core Laboratory, slices up recently acquired ice core samples. –Credit: Mike Lucibella

School of Ice participants get a taste of what it's like to work in the field by donning buckets to simulate the white-out conditions of an Antarctic blizzard while visiting the Antarctic Support Contract offices in Denver. – Credit: Mike Lucibella

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
Collaborative Research: Allan HILLs Englacial Site (AHILLES) Selection	Conway, Howard Spaulding, Nicole	1443260 1443461
Collaborative Research: Characterization of Upstream Ice and Firn Dynamics affecting the South Pole Ice Core	Hawley, Robert Koutnik, Michelle	1443341 1443471
Collaborative Research: Ice sheet sensitivity in a changing Arctic system - using Geologic data and modeling to test the stable Greenland Ice Sheet hypothesis	Briner, Jason Johnson, Jesse Morlighem, Mathieu Steig, Eric Young, Nicolas	1504267 1504457 1504230 1503281 1503959
Collaborative Research: Inert Gas and Methane Based Climate Records throughout the South Pole Deep Ice Core	Brook, Ed Severinghaus, Jeff Sowers, Todd	1443472 1443710 1443464
Collaborative Research: Window into the World with 40,000-year Glacial Cycles from Climate Records in Million Year-old Ice from the Allan Hills Blue Ice Area	Brook, Ed Higgins, John Mayewski, Paul	1443276 1443263 1443306

The U.S. National Ice Core Laboratory (NICL) is a facility for storing, curating, and studying meteoric ice cores recovered from the glaciated regions of the world. It provides scientists with the capability to conduct examinations and measurements on ice cores, and it preserves the integrity of these ice cores in a long-term repository for current and future investigations. NICL is funded by the National Science Foundation Division of Polar Programs and operated by the U.S. Geological Survey. Scientific management is provided by the University of New Hampshire.

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**

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Masthead photos courtesy of Lonnie Thompson and Michael Morrison