spheres

EDUCATION OUTREACH
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COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES

CIRES OUTREACH

Bringing science - and scientists - to the classroom

This Issue

On the cover: 5th grade students at Crest View Elementary in Boulder, Colorado, work through a science project developed by graduate student Phillip Taylor. CIRES

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PAT CORKERY/UNITED LAUNCH ALLIANCE

seventy percent

of U.S. adults think that we should teach children the causes, consequences, and potential solutions to global warming. *(Anthony Leiserowitz, Yale University)*

what is climate literacy?

A climate-literate person:

- **understands the essential principles of Earth's climate system**
- **knows how to assess scientifically credible information about climate**
- **communicates about climate and climate change in a meaningful way**
- **Can make informed and responsible decisions with regard to actions that may affect climate**

(Essential Principles of Climate Science)

50 percent

of the U.S. population lives within 50 miles of a coast.

(National Oceanic and Atmospheric Administration, Ocean Service)

97.4%

of climate scientists who publish in peer review journals affirm human activity is a significant contributing factor in changing mean global temperatures. *(EOS)*

$10,000 per flight

Cost of rerouting commercial polar flights to avoid serious space weather impacts on avionics and communications, according to 2003 Congressional testimony from United Airlines executives.

Working to create climate literate citizens

Climate science and climate change are everywhere these days. Yet the public is more confused than ever about climate change basics. A recent report shows that since 2008 the percentage of the public that says global warming is happening has dropped from 71 to 57 percent. That's in contrast to increased scientific consensus that the climate is changing.

Now, more than ever, society needs citizens who understand climate science and know how to apply that knowledge in their lives, careers, and communities.

The climate education community and climate scientists developed a coherent framework of "the big ideas," along with the fundamental concepts that underpin them, called the "Essential Principles of Climate Science." EPCS has been adopted by the U.S. Global Change Research Program, and is being used to guide new funding, new education projects, and communication efforts.

CIRES Education and Outreach has been a climate literacy partner from the beginning. It's not enough to know about climate science. Teachers, scientists, and communicators also need to know how to engage in communication as effectively as possible. CIRES Outreach projects for climate literacy include online courses, teacher workshops, scientist and communicator workshops, and digital collections of reviewed climate resources.

Learn more

about CIRES climate literacy programs for teachers, scientists, and communicators at cires.colorado.edu/education/outreach

Getting the tools

Many teachers would like to teach climate science, but are frustrated by the difficulty of finding high-quality teaching materials or by their own lack of background in the topic. CIRES Outreach is helping to meet this need, with funding from NASA and the National Science Foundation. The two projects below draw from the U.S. Global Change Research Program's framework, "Climate Literacy: The Essential Principles of Climate Science."

ICEE: Inspiring Climate Education Excellence

Many educators who teach climate and energy topics in the classroom go first to magazines, websites, and films to teach themselves climate science, ICEE is developing a suite of web-based modules to help teachers learn the "Essential Principles of Climate Science." A workshop to test modules with teachers is being planned for June 10-16, 2010, and a full online course will be available for those seeking more in-depth experience.

ICEE partners are the GLOBE project (Global Learning and Observations to Benefit the Environment) and the National Science Digital Library, NSDL, both located at the University Corporation for Atmospheric Research in Boulder, Colorado. Teachers who are preparing for the upcoming GLOBE Student Climate Research Campaign may use ICEE resources to learn more themselves before working with their students. NSDL will help to develop video-enhanced podcasts for teachers to use as part of their own self-directed learning.

to teach

"These frameworks are all really great ... and we need them, but what we really need is the curriculum and professional development to go with them."

Florida teacher commenting on the Climate Literacy Framework

"I have a strong basic understanding, but just need more data and evidence to share with students, and better inquiry-based activities to use in the classroom."

Colorado teacher responding to the ICEE needs assessment

CLEAN: Climate Literacy Energy Awareness Network

The CLEAN project with the help of CIRES Outreach is developing a collection of 500 "cream-of-the-crop" learning resources aligned with the Benchmarks for Science Literacy, the Excellence in Environmental Education Guidelines and ultimately the National Science Education Standards. To develop this collection, thousands of climate learning resources will be reviewed by a team of collectors, climate scientists, and educators. Those that meet the highest standards of quality and are aligned with the "Essential Principles" will be included in the collection. As part of the new digital science library, the CLEAN team will make climate and energy education resources more visible and useful for educators, and will build a community of people who are interested in these topics. The first set of resources will be reviewed during a "boot camp" meeting July 26-28, and the first set of reviewed resources will be available by November, 2010.

More CLEAN partners: NSDL, the education research and development program known as TERC, Carleton College, and the National Renewable Energy Laboratory

Future scientists test ocean-science savvy

What do you call a fish that spends most of its life in freshwater, but migrates to the open ocean to reproduce?

Being land-locked hasn't stopped Intermountain West students from answering questions like this in the regional contest of the National Ocean Sciences Bowl. And even though a trip to the finals, held annually in a coastal city, may be the first time students may have visited the ocean, they've repeatedly shown their ocean-knowledge prowess finishing near the top of the competition many years.

Since 1999, CIRES has sponsored the competition for top high school students from Colorado, South Dakota, Nebraska, Kansas, Wyoming, and Utah. The students compete in an ocean sciences-themed quiz contest at the University of Colorado at Boulder, now dubbed the Trout Bowl.

While there, students have the opportunity to get to know the campus and chat with CU students and researchers. This experience can lead to lasting confidence. "Participation in NOSB and the interaction with the volunteers, whether from CU, CIRES, NOAA, or elsewhere, boosted my confidence that I could succeed in math and science fields. It solidified my resolve to pursue a career in science," said Cassia Rye, now a Ph.D. student at the University of Nebraska.

Winning regional teams travel to the national competition where they compete for scholarships and trips to oceanographic research institutions. Not only is it good fun, it helps prepare a future generation of scientists. "I had already decided on a science career before NOSB," said Hannah Wallace, now a biological engineering student at CU, "but focusing on the biology topics solidified my biology foundation for college."

So what kind of fish practices the aforementioned lifestyle? Catadromous.

CIRES

High school students ponder a question at the 2009 regional competition of the National Ocean Sciences Bowl in Boulder, Colorado.

Living with a star

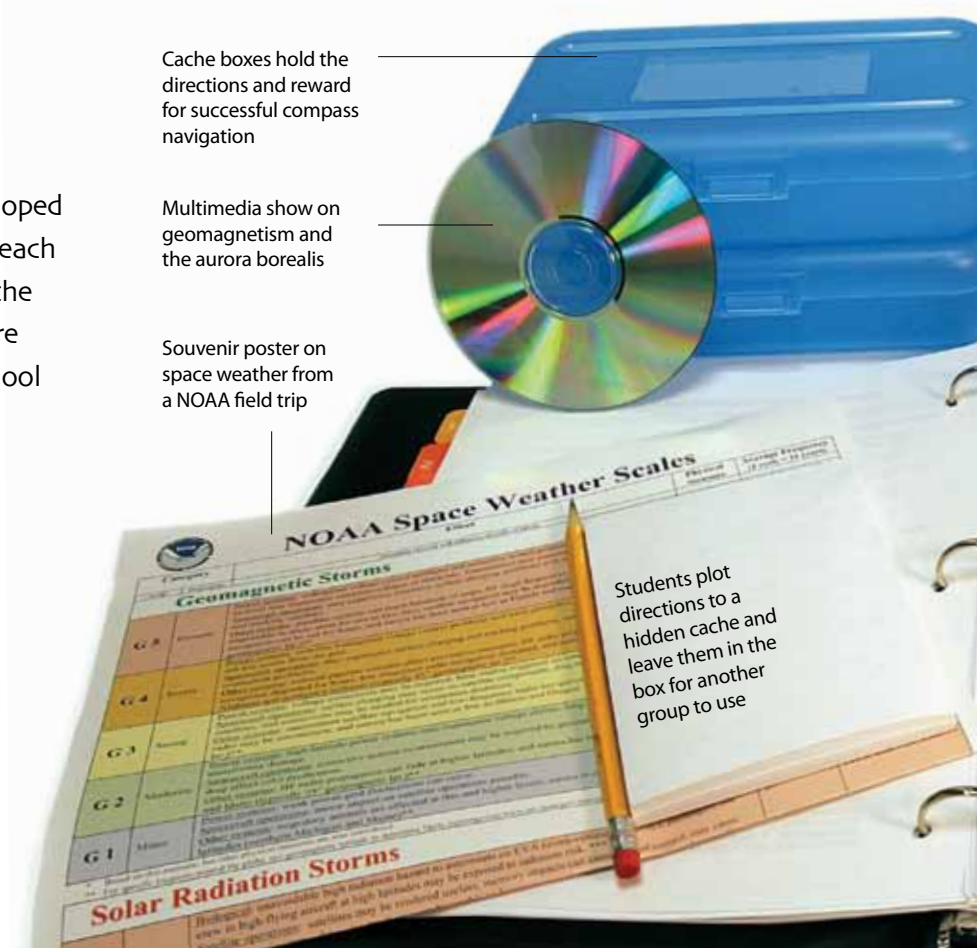
CIRES works with scientists and a new satellite to improve teachers' and students' understanding of the dynamic Sun

Imagine you are piloting an aircraft, and receive word you must alter your flight plan to avoid an extreme solar event, or your company's production line suddenly shuts down as a power transformer 1,000 miles away sustains damage following a massive solar storm. Society is increasingly vulnerable to solar flares and the effects of solar weather: Our navigation, communication, and information systems all rely on a smooth flow of data from satellites and power from the grid.

"We are used to hearing that we live with a star, but we actually live within the Sun's outer atmosphere," said Sarah Gibson, a scientist with the National Center for Atmospheric Research High Altitude Observa-

Solar science in a box

CIRES Outreach developed this classroom kit to teach the fundamentals of the Earth's magnetosphere as part of an after-school enrichment program.



tory. People are affected by space weather just as we are affected by weather on the surface of the Earth, Gibson said during a workshop for journalists.

"Understanding solar variability is crucial," added space scientist Judith Lean of the Naval Research Lab. "Our modern way of life depends upon it."

CIRES Outreach is working on two projects to help people learn the modern importance of space weather, and to understand the basics of the Sun-Earth connections.

The first involves the Solar Dynamics Observatory (SDO) launched successfully February 11 from NASA's Kennedy Space Center in Cape Canaveral, Florida. The NASA mission, to study solar variability, will "revolutionize our view of the Sun" said Lika Guhathakurta of NASA headquarters.

Tom Woods, lead scientist in charge of the Extreme Ultraviolet Variability Experiment (EVE) instrument on the SDO, said that the "trickle" of data scientists now get about the Sun is about to turn into a firehose of information streaming back to Earth every day.

CIRES Outreach works with the team that built EVE, which will measure variability in the extreme ultraviolet portion of the solar spectrum. Extreme ultraviolet radiation from the Sun ionizes the Earth's upper atmosphere, affecting satellites, radio communication, and GPS navigation.

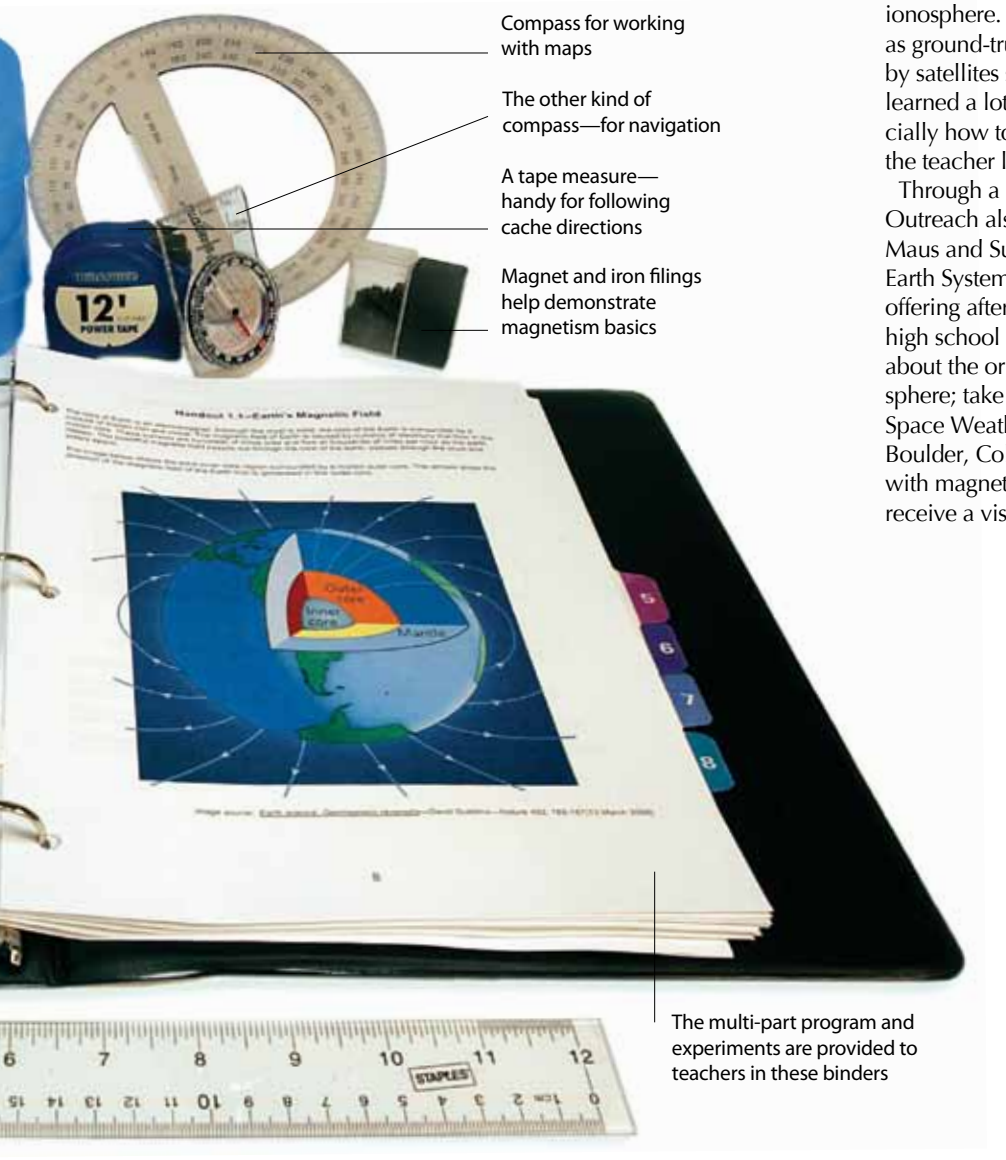
To help support the SDO mission, CIRES has already supported workshops for teachers and developed an after-school program for diverse students. CIRES also helped to sponsor a workshop for science journalists at the Laboratory for Atmospheric and Space Physics (LASP) in Boulder, Colorado.

Learn more

Contact tarthur@colorado.edu for information about ordering the after-school program kit

In the after-school program, which began focusing on Sun-Earth connections even before SDO's launch, some students built antennas for their school roofs. The antennas pick up Sudden Ionospheric Disturbances, SIDs—changes that can occur when solar events impact the Earth's ionosphere. Such data can be used as ground-truth for data collected by satellites such as SDO. "The kids learned a lot with the SIDs, especially how to handle real data," said the teacher leading the class.

Through a NASA grant, CIRES Outreach also works with Stefan Maus and Susan McLean at NOAA's Earth System Research Laboratory, offering after-school enrichment for high school students. Students learn about the origin of Earth's magnetosphere; take a field trip to NOAA's Space Weather Prediction Center in Boulder, Colorado; learn to navigate with magnetic compasses; and receive a visit from a researcher.



3...
2...
1...

The Solar Dynamics Observatory (SDO) launched on Feb. 11, 2010, from Kennedy Space Center in Cape Canaveral, Florida, will provide measurements and models of solar magnetic fields, active region dynamics, and solar extreme ultraviolet radiation that can dramatically disturb Earth's space weather environment. The Extreme ultraviolet radiation Variability Experiment (EVE) is one of three instruments on SDO. EVE will measure this radiation with unprecedented resolution, accuracy, and precision. CIRES Outreach is responsible for education and outreach related to the EVE instrument.

Scientists are comparing the data stream they expect from the SDO to a firehose of information.

PAT CORKERY/UNITED LAUNCH ALLIANCE

Bringing the ocean to inland teachers

Here in Colorado, waves crashing in the surf sound like a distant vacation fantasy. But although the Earth's oceans are out of sight, they need not be out of mind for Colorado educators. After all, much of the West used to be part of an ancient ocean millions of years ago.

CIRES Outreach brings the ocean back to Colorado by connecting oceanic, atmospheric, and climate science researchers with teachers throughout the state. The program focuses on a new ocean and climate sciences topic each year, presenting lectures by scientists who share their cutting-edge research and links to classroom/lab activities and field trips.

Videoconferences make the program accessible to distant parts of the state. "Living in Steamboat makes it difficult to take workshops," said one teacher, a participant in the 2009 Center for Ocean Sciences Education Excellence (COSEE) collaborative summer institute. "The COSEE videoconference made it easy. I felt like I was there."

CIRES is funded to partner with the COSEE-West site in southern California. Through that partnership, teachers can learn from experts in each location. In the spring of 2009, Dr. Ola Persson, Dr. Chris Fairall, and Dr. Jeff Hare from NOAA's Earth System Research Laboratory (ESRL) in Boulder, Colorado, gave presentations to teachers. During the summer institute, teachers toured ESRL's laboratories, helped launch a weather balloon, and visited the Science On a Sphere® exhibit.

This year's themes include Arctic sea ice, the Greenland and Antarctic ice sheets, sea level, global climate processes, and effects on Colorado's weather, ecosystems, and economy. Stories about the Arctic Inuit, impacts on alpine pika populations, and the effects of pine bark beetles will make these issues tangible. Teachers from Colorado will also travel to Los Angeles to participate in workshops through COSEE-West.

Learn more

Applications are being accepted for 2010. Workshop dates and details, including past presentations, are available at : cires.colorado.edu/education/k12/cosee

Meet Ola Persson

Ola Persson is a CIRES Fellow and a researcher at NOAA's Earth System Research Laboratory studying Arctic meteorology. Ola's research helped to fund the COSEE teacher workshops on Oceans and Climate through an NSF grant.

What motivates you to participate in education and outreach?

It helps me. If I can't explain something in reasonably simple terms, perhaps I don't understand the gist of it myself. That's one motivation and that's a view I've had for a long time. But the other thing is it's a requirement on proposals and grants. Sometimes one thinks it's kind of a pain, but when you actually get something done, you recognize the value of it.

Why did you come to CIRES Education and Outreach when you were writing your NSF proposal?

Well, because I don't want to have to think about how to organize an outreach project, and you do that well. So it makes it much easier.

Learn more

For a longer version of this interview, and for more information about working with CIRES Education and Outreach on your research grants, visit cires.colorado.edu/education/outreach

What do you think science education for kids should look like?

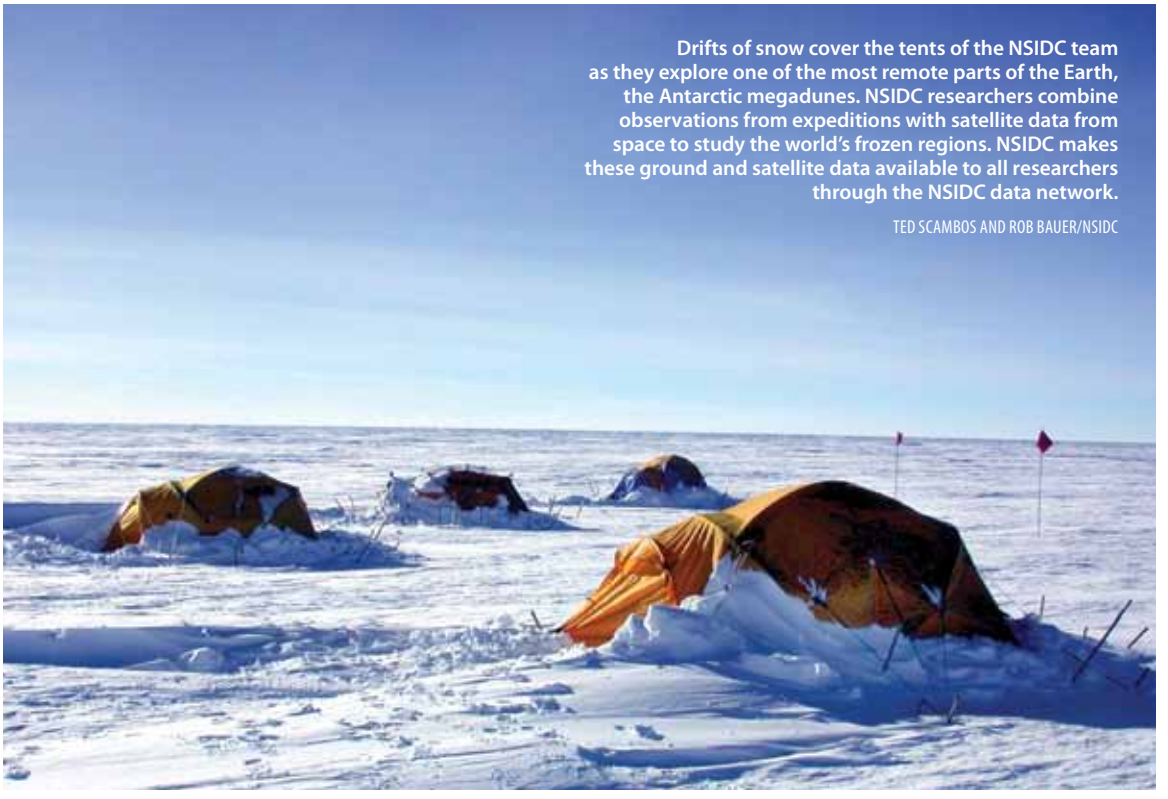
They shouldn't be memorizing a lot of facts, but obviously you have to know some facts to understand how things work. You have to know the basics of chemistry, for instance, but I think what's important is the relationships between different processes and how everything is linked. Even scientists don't always understand that. Results are only meaningful if you understand how they fit into everything else.

What did you personally get out of that workshop that you supported?

I'm an atmospheric scientist with my own narrow focus. I had to broaden the view a little bit for that presentation, and it was useful. I've used that presentation since, and have been asked to give another one as well. It's also useful for discussions between myself and oceanographers. When we discuss the different impacts on sea ice, people are hopefully able to pull back a little from their own discipline.

Do you think it's important for scientists to be engaged in outreach?

Ultimately, of course, the money paying for the research comes through public funds. You are being responsible to the people actually paying you. And on the other side, I think it's extremely important for people to be educated and to understand the issues when they come up in some political debate. People come in with some very naïve or uninformed opinions, and I think that's a big detriment to the entire society.



Drifts of snow cover the tents of the NSIDC team as they explore one of the most remote parts of the Earth, the Antarctic megadunes. NSIDC researchers combine observations from expeditions with satellite data from space to study the world's frozen regions. NSIDC makes these ground and satellite data available to all researchers through the NSIDC data network.

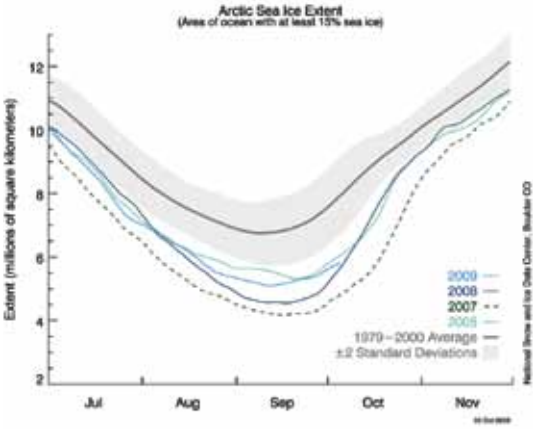
TED SCAMBOS AND ROB BAUER/NSIDC

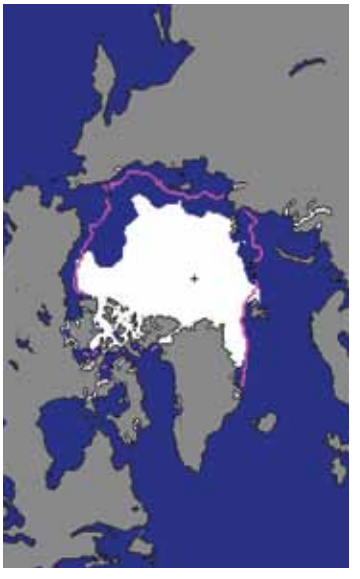
NSIDC answers Arctic ice questions in near-real time

People around the world have developed a strong interest in the layer of sea ice that expands and contracts seasonally over the Arctic Ocean. The record lows in the summers of 2005 and 2007 caught the attention of journalists and the general public, and thrust the National Snow and Ice Data Center into the spotlight.

People came to NSIDC with all kind of questions about sea ice: Would the decline continue? Why does it matter if the ice cover disappears? NSIDC developed Arctic Sea Ice News & Analysis to help the public understand what is happening to sea ice, and why it is important.

The NSIDC Arctic Sea Ice News & Analysis website offers daily updates of near-real-time data on Arctic sea ice extent. NSIDC also provides monthly analysis on Arctic sea-ice conditions and influencing factors.





Above, sea ice extent is charted showing the summer minimums over several years, and the gradual increase during the onset of winter.

Left, the white area shows the sea ice extent in Sept. 2009, and the 1979-2000 median ice edge, in pink. Both of these graphics are updated daily, year-round at Arctic Sea Ice News & Analysis on the Web.

NSIDC Education Center

The NSIDC Education Center is a portal for information about the frozen areas of the world, the cryosphere. NSIDC developed the suite of online content in response to frequent questions from the public. The Education Center includes:

- Detailed information about glaciers, sea ice, frozen ground, snow, and Arctic climate written for a general audience
- Scientist-vetted information on how climate change is affecting the frozen regions of the Earth, updated regularly
- Visual resources showing the state of the cryosphere, such as repeat photography of glaciers and satellite data viewable in Google Earth
- Features on NSIDC research in polar regions, including pictures about what it's like to work in extreme environments
- Descriptions of print and multimedia resources available from NSIDC exploring Arctic climate, climate change, and local observations of environmental changes
- Links to online educational resources and activities

Learn more

Visit these National Snow and Ice Data Center sites at nsidc.org/cryosphere and nsidc.org/arcticseaicenews

PHOTOS/CIRES

Crest View Elementary teacher Erin Shea-Bower of Boulder, Colorado, works with a student on a science project developed by graduate student Phillip Taylor. Shea-Bower says that she learns from Taylor, too. "The more knowledge I have, the more excited I am."

Project Extremes

Sending science graduate students into K-12 classrooms

When ecological and evolutionary biology graduate student Phillip Taylor applied for a fellowship with Project Extremes, he wanted to communicate science better and improve young people's science literacy. "The ability to tune a science message on the fly to each of the audiences is a skill that I could only have learned by being involved in the National Science Foundation program," said Taylor.

Project Extremes (EXploration, Teaching and Research for Excellence in Middle and Elementary Science), funded by the NSF through GK-12 (grades K-12) Program, is a partnership between the CIRES, several departments of the University of Colorado at Boulder, and

Graduate student Phillip Taylor talks with 5th graders in Erin Shea-Bower's class. "Phil set up some amazing indoor/outdoor laboratory-like explorations," Shea-Bower said.

the Boulder Valley School District (BVSD). The focus is to place Science, Technology, Engineering, and Math (STEM) graduate students into BVSD's more socioeconomically diverse schools, enriching science education for students and the professional development of young scientists, called "Fellows."

Teachers and students gain valuable insight into the subject and process of science. "The kids are always thrilled to have 'Phil, our science guy' in class," said fifth-grade teacher, Erin Shea-Bower. "As a general rule, elementary students do not have access to labs, but Phil set up some amazing indoor/outdoor laboratory-like explorations, complete with dissecting microscopes and pond samples."

Taylor has also been an excellent resource for Shea-Bower. "I am learning in far greater depth about some of the topics that I have been teaching for a while. The more knowledge I have, the more excited I am to teach a particular topic," she said. "It's been terrific."

Learn more

about teacher education and K-12 classroom resources through CIRES Education Outreach at cires.colorado.edu/education/outreach/projects/resources.html

Fellow Michelle Ochomogo feels that being a Latina in the classroom allows her to connect with Latino students and answer questions about why she went to college, and what college is like. She and her colleagues have designed a series of campus visits to hear about the Fellows' research and see their labs. "The students get to interact with college students and professors to see that it's not a scary place and the campus has all types of people," said Ochomogo.

Hopefully, these tours pave the way for these students, some of whom will be the first in their family to graduate from high school. "These Fellows are able to offer these kids some of the finest science materials, experts, knowledge, and experience around," said Shea-Bower. "It's not every day that a group of fifth graders gets to work with a pre-Ph.D. candidate who was just published in *Nature*. Not every day at all."

COURTESY NSF

"Doing science in Antarctica is fascinating to me," Schwartz says. "You don't have available what you might need all the time."

Q&A with adventurer, middle school teacher Ian Schwartz

CIRES travels to the ends of the Earth with middle school science teacher Ian Schwartz. Schwartz, who teaches Earth science at Casey Middle School in Boulder, Colorado, joined three graduate student Fellows from the University of Colorado at Boulder in November 2009 to conduct research at the Dry Valleys field site in Antarctica. Education and Outreach sits down with Schwartz to talk about his experience and find out how extreme science in Antarctica energizes classroom science back home.

What was the highlight of conducting research in Antarctica?

Not only doing a piece of research that is related to the long-term study, but also having the opportunity to participate in other research going on there and seeing how it fits into the larger project to answer one big common goal. As a middle-level teacher, I spend a lot of time teaching big ideas, and it was great to process it in a way where you are looking at how all the little pieces fit together.

Did you have any big "Aha!" moments about how science is done?

Beyond the science we were there to do, there's a real logistical component of doing science in Antarctica that's fascinating to me. You don't have available what you might need all the time. Science is a way of thinking, and you need to think through and problem-solve just to do the research you went there to conduct.

What will you bring back to the classroom after this experience?

As teachers, we have more competition than ever for kids' attention in school. Unless things are relevant, kids aren't listening. I can draw upon my experiences in Antarctica to make learning more relevant. For example, yesterday we talked about the seasons and how it's light all the time in Antarctica now. I can show my students pictures of us doing research at midnight when it's still bright outside to illustrate the point I made yesterday. This brings science alive.

MySphere

How people work, research, and relax at CIRES

Ian Schwartz, Casey Middle School Teacher-in-residence at McMurdo Dry Valleys, Antarctica, as part of a CIRES outreach program.

1. Mountain tent. We have worked inside the hut and lived in the tents for months!
2. Solar panel: The rotating base allows us to move the panel to face the Sun as it makes the trip around the sky during the 24 hours of Antarctic daylight.

3 Scientists' gear: No critters and dry conditions mean that gear can be left outside. The downside: 24 hours of daylight will really fade your pack.

4 Simple outhouse consists of a bucket and a Styrofoam seat. To keep this pristine environment clean, waste will be capped and shipped to Antarctica's McMurdo station.

5 Full toilet/gray water drums and propane tanks. They can only be 90 percent filled to account for expansion as the liquid freezes. Note the barrier to protect against spills.

6 Spare wastewater drums, strapped together because of the wind.

7 Boxes contain solid garbage from our day-to-day lives.

8 Not seen behind the hut: Large crate containing the survival cache with sleeping bags (2), rubber insulation mats (2), stove, dehydrated food, fuel, radio, shovel, and snow saw.

CIRES

The Cooperative Institute for Research in Environmental Sciences is a research institute dedicated to better understanding the Earth system.

Our research is essential for understanding the processes and feedbacks in many Earth science disciplines, and to foster cross-disciplinary understanding of the cryosphere, biosphere, atmosphere, geosphere, and hydrosphere. CIRES scientists are identifying and quantifying changes in a warming climate, providing baseline data against which to measure change, and informing the public and the policy makers about these changes.

CIRES is a cooperative institute of the University of Colorado at Boulder and the National Oceanic and Atmospheric Administration.

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