CReSIS Education Programs

The United States is a leading nation in polar science, and research results have global significance. As well, the polar regions intrigue the public and provide opportunities for educational enrichment.

…. Kelly Falkner, Director of NSF Polar Programs
CReSIS Education

I. Overview of CReSIS Education Program
II. Graduate and Undergraduate Programs
III.K-12 Program and Teacher
IV.CReSIS Student Presentation
The Education Team

Linda Hayden, Director of Education
Peter Burkett, PSU EducationCoordinator
Geoffrey Fox, IU Education Coordinator
Darryl Monteau, KU Education Coordinator
Darnell Johnson, ECSU Education Coordinator
Ian Joughlin, UW Education Coordinator
Andrea Lawrence, ADMI Education Coordinator
Cheri Hamilton, K-12 Outreach Coordinator
Brandon Gillette, Graduate Research Assistant
Xiushan Jiang, Graduate Research Assistant
Kuang–Chen Hsu, Graduate Research Assistant
Kelsey Leinmiller-Renick, RET Undergraduate Student
Vision Statement for Education
To inspire, educate and train the next generation of scientists and engineers for the nation in center-related disciplines.

Mission Statement for Education
Educate and train a diverse group of students to participate and lead future research in international, multidisciplinary, polar science. Provide opportunities and paths for students at all levels to pursue careers in science and engineering.
Education Objectives

Graduate and Undergraduate Education

• Develop and teach courses that broaden technical and scientific education across partner institutions using videoconferencing facilities.
• Integrate Center research into science and engineering undergraduate and graduate courses.
• Expand these courses to other disciplines by leveraging a new KU NSF-IGERT program known as Climate Change, Humans, and Nature in the Global Environment (C-Change).
• Educate students in subjects outside their primary discipline, such as geoinformatics, glaciology, and remote sensing.
• Provide internship opportunities in industry, national laboratories and internationally.
• Organize monthly “all-hands” meetings that include presentations on some aspect of the Center’s mission.
• Engage graduate and undergraduate students in Center decisions through the CReSIS student organization.
• Increase the pool of underrepresented graduate students through exchange program, such as REU’s between research universities and minority-serving institutions.
• Motivate students to pursue careers in the STEM fields; including reinforcing the necessary foundational skills.
A total of 206 UGRA’s and 184 GRA’s have been supported since 1998. 103 are currently working in Industry and 53 in Academia.
Undergraduate/Graduate Program

- **Courses Offered**
  - Geosciences (Penn State)
  - Remote Sensing/Math (ECSU)
  - Electrical Engineering and Computer Science (KU)
  - Aerospace Engineering (KU)
  - Information Technology (IU)

- **Enrollments**
  
  Fall 2012/Spring 2013:
  - 8 Graduate courses/1 Undergraduate course
  - 127 total students enrolled in courses
Undergraduate/Graduate Program

➢ Graduate Recruitment
  • National Society of Black Engineering Conference (NSBE)
  • Relationships with KU School of Engineering, Geography
  • ADMI Institutions
  • REU program

➢ Study Abroad/Hosting Opportunities
  • KU CReSIS hosting 2 international PhD students for the spring 2013 (University of Copenhagen and Technical University of Denmark)
  • 3 KU CReSIS GRAs participated in Operation IceBridge Airborne Radar Surveys with NASA P-3
  • 2 PSU GRAs and 1 KU GRA participated in the NEEM/NEGIS mission to Greenland
Undergraduate/Graduate Program

➢ Undergraduate/Graduate Presentations and Publications

• 5 ECSU REU students and 1 PSU graduate student attended the IGARRS 2012 conference in Munich, Germany
• Brandon Gillette’s (PhD/GRA) article titled “Explorations of our Frozen Planet” was published in the December 2012 edition of *Science Scope*
• Brandon Gillette (PhD/GRA), Kelsey Leinmiller-Rennick (undergraduate) and Steve Foga (MS/GRA) collaborated on an article titled “Remote Sensing – Radar Analysis” which was published in the February 2013 edition of *The Science Teacher*
• Xiushan Jiang (PhD/GRA) and Brandon Gillette (PhD/GRA) will be at the 2013 American Educational Research (AERA) conference on their paper titled “How Effective is Problem-Based Learning in K-12 STEM Education Compared to Lecture-Based Learning? A Meta-Analysis of Quantitative Studies from 1990-2012”
• Emily Arnold (PhD/GRA), attended the Antenna Application Symposium and gave a presentation “Identification and Compensation of Aircraft Integration Effects in Wing-Mounted Phased Array for Ice Sheet Sounding”
Program objectives were:
1. To provide summer educational opportunities for undergraduate students in the areas of polar science and cyberinfrastructure; and
2. To attract a diversified pool of talented students into careers in science and engineering, including teaching and research related to polar science and cyberinfrastructure (CI).

2012 Program Demographics:
• 57% of participants were women
• 78% of participants were minority students (70% Black, 4% Hispanic, 4% Native American)
Research Experience for Undergraduates (REU) Program

KU

ECSU/PSU

IU

NSF
NASA
CReSIS

Center for Remote Sensing of Ice Sheets
Research Experience for Undergraduates (REU) Program

Students spent eight weeks conducting supervised research projects sponsored by CReSIS via NSF. One REU student from an ADMI institution returned for a second summer. The 2012 demographic distribution included students from 13 institutions; eight of these were minority-serving institutions (MSIs). Many of these colleges/universities have limited research opportunities in STEM. These institutions included:

MSIs

St. Augustine’s College
Elizabeth City State University
Mississippi State University
Winston Salem State University
Spelman College
Jackson State University
Norfolk State University
Haskell Indian Nations University

Non-MSIs

Gettysburg College
University of Alaska Fairbanks
Rice University
Kansas State University
UCLA
Research Experience for Undergraduates (REU) Program

Research Projects:

• Geothermal Heat Flux Beneath the Greenland Ice Sheet Calibrated and Observed Basal Meltwater Conditions
• How does precipitation and temperature contribute into the decreasing glacier mass balance?
• Traveling Radars: Designing a Sled
• Transmit Waveform Shaping for a FMCW Radar
• Utilizing Datasets from the CReSIS Data Archives to Visualize Greenland Echograms Information on Google Earth
• Using CReSIS Radar Data to Determine Ice Thickness at Pine Island Glacier by Topographic Identification of Surface
• FutureGrid Curriculum: Communicating Parallel and Distributed Computing Concepts for Disadvantaged Communities
• Multidimensional Scaling: Visualizing Gene Sequencing Data
CReSIS Student Organization (CSO)

- CSO
  - K-12 Outreach Activities
    - Ice, Ice Baby Training for Students
  - All-Hands Presentations
  - Workshops/Seminars for Students
    - Writing
    - CV/Resume
  - Social Activities
    - Bowling night
    - Monthly donuts/coffee
    - CSO Olympics
    - Graduation Recognition
    - Royals game
CSO Graduate Student Mentoring Award

"The CReSIS Graduate Student Mentoring Award was enacted to recognize the outstanding contribution that our graduate students make to the CReSIS education and outreach efforts,

The CSO award acknowledges Master’s and Ph.D. graduate students at CReSIS institutions who have greatly contributed to the research and professional development of future scientists and engineers. Awardees receive a certificate and $500 from the CReSIS Student Organization.

Recipients of this award must meet a number of qualifications established by CReSIS, including the following:

• The awardee has worked collaboratively for four or more weeks with a team of one or more undergraduate students on a CReSIS related project.
• The awardee must have the recommendation of a CReSIS faculty member to be considered for this award.
• Awardees agree to give a talk with their mentees as part of the All-Hands lecture series.
Brandon Gillette – Univ. of Kansas
How does precipitation and temperature contribute into the decreasing of glacier mass balance?

Ms. Kristin Poiner – Univ. Washington
Do strain rates determine the spatial density of crevasses on the Greenland Ice Sheet?

Ms. Brooke Medley – Univ. Washington
Developing a method for estimating accumulation rates using CReSIS airborne Snow Radar from West Antarctica

Je’aime Powell – ECSU was awarded the Student Leadership-Graduate Level award during the HBCU Engineering Deans’ Power Breakfast.
<table>
<thead>
<tr>
<th>Date</th>
<th>Title</th>
<th>Name</th>
<th>Affiliation</th>
<th>External/Internal</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/26/12</td>
<td>Evidence of meltwater retention within the Greenland Ice Sheet</td>
<td>Dr. Åsa Rennermalm</td>
<td>Rutgers University</td>
<td>External</td>
</tr>
<tr>
<td>8/30/12</td>
<td>CReSIS Sustainability</td>
<td>Dr. Prasad Gogineni</td>
<td>Faculty/PI</td>
<td>Internal</td>
</tr>
<tr>
<td>9/5/12</td>
<td>Identification and Compensation of Aircraft Integration Effects in Wing-Mounted Phased Arrays for Ice Sheet Sounding</td>
<td>Emily Arnold</td>
<td>GRA (PhD)</td>
<td>Internal</td>
</tr>
<tr>
<td>9/25/12</td>
<td>Methodology of Science and the REU Program</td>
<td>Brandon Gillette</td>
<td>GRA (PhD)</td>
<td>Internal</td>
</tr>
<tr>
<td>10/12/13</td>
<td>Potential Paleo Perspectives on Ice Sheet Collapse – Cosmic Ray Produced Nuclides in Subglacial Bedrock</td>
<td>Dr. John Stone</td>
<td>University of Washington</td>
<td>External</td>
</tr>
<tr>
<td>10/24/12</td>
<td>Remost Sensing Studies from Space, Air, and Ground: Applications for the Cryosphere in the Western Ross Sea Region</td>
<td>Wolfgang Rack</td>
<td>University of Canterbury</td>
<td>External</td>
</tr>
<tr>
<td>11/1/12</td>
<td>Greenland Ice Cores Inform on Past Warm Climate Periods</td>
<td>Dorothe Dahl-Jensen</td>
<td>Faculty</td>
<td>External</td>
</tr>
<tr>
<td>11/19/12</td>
<td>Ice Sheet Modeling and Applications to the Past, Present and Future Glaciation of the Earth</td>
<td>Ralf Greve</td>
<td>Hokkaido University</td>
<td>External</td>
</tr>
<tr>
<td>2/19/13</td>
<td>CReSIS Collaboration-From the Science to Outreach</td>
<td>Kelsey Leinmiller-Rennick, Steve Foga, Brandon Gillette</td>
<td>Student, GRAs</td>
<td>External</td>
</tr>
<tr>
<td>3/6/13</td>
<td>Insights into Ice-Sheet Dynamics from Radar Sounding</td>
<td>Joe MacGregor</td>
<td>University of Texas</td>
<td>External</td>
</tr>
<tr>
<td>3/14/13</td>
<td>Garmin Visit to CReSIS</td>
<td>Anita Finn</td>
<td>GARMIN</td>
<td>Internal (CReSIS Students)</td>
</tr>
</tbody>
</table>
The Center has experienced significant success in minority graduate recruitment. Most notably, during Year 8, the percentage of underrepresented minority graduate students was at 30% compared to 7% in Year 2. The underrepresented minority graduate students include both Hispanic and African-American student populations.

Two 2011 REU students (Robin Evans and JerNettie Burney) began graduate studies at Indiana University in September 2012. Three other past REU students have expressed an interest in starting the masters degree program at IU in fall 2013. Jerome Mitchell continues in the PhD program at IU.

The current Education Coordinator has been actively engaged in recruiting students from Haskell Indian Nations University (MSI, TCU). Two Native American Indian students will participate in the 2013 REU program.
New lessons and revised curriculum
For K-8 students

2.9  GLACIER DYNAMICS

How do glaciers change Earth’s landscape?

Activity Time: 45 minutes

Background:

Glaciers are large bodies of ice that move on Earth’s surface. They can form in areas where the climate is cold enough for snow to accumulate and compact into ice. Glaciers play a crucial role in shaping Earth’s surface through processes like erosion, deposition, and glacial deputy. Over time, they can carve out valleys, deposit sediment, and sculpt landscapes in unique ways.

Directions:

1. Choose a location where glaciers can be observed (e.g., mountains, polar regions).
2. Observe the landscape and note the presence of glacial features such as moraines, U-shaped valleys, and hanging valleys.
3. Discuss the role of glaciers in shaping the landscape and their impact on surrounding ecosystems.

Materials:

- Visual aids: photographs or videos of glaciers
- Diagrams of glacial processes
- Interactive software or simulation of glacier movement

Vocabulary:

- Moraine
- Erosion
- Deposition
- Glacial debris

Discussion:

- What are the major processes involved in glacial erosion?
- How do glaciers contribute to the formation of landforms like moraines and U-shaped valleys?
- What role do glacial ice play in shaping the landscape?

Assessment:

- Analyze a photograph or video of a glacier and describe the observed features.
- Create a diagram illustrating the movement of a glacier and its impact on the landscape.

Extension:

- Research the history of glaciers in different regions and discuss the implications of their retreat on local ecosystems.
- Participate in a hands-on activity where students simulate the movement of a glacier and observe its effects on the landscape.
New Animations

http://youtu.be/xyivMIghJsQ

http://people.ku.edu/~k557h516/CReSIS/SummerGame.html
Glacier Goo and YOU

New interactive book for ages 6-10

Coming soon! eBook and iPad application
New strategies – Train the Trainers!

Additional 2100 students

Additional 800 students

- Pink - Elementary
- Purple - middle school
- Yellow - high school
- Red - teachers
- Green - adults
Scientists as Trainers

TIPS AND TRICKS

TO GO PRINCIPLES
FOR SCIENCE PRESENTATIONS

- Learn from other scientists. How do you deliver the best talks? What works? What doesn’t?
- Keep your audience engaged. How do you make the talks more interesting?
- Use strong, simple language. How do you make the talks more understandable?
- Use visuals to support your points. How do you make the talks more engaging?
- Use humor to lighten the mood. How do you make the talks more enjoyable?
- Use technology to enhance your presentation. How do you make the talks more interactive?

HANDS-ON HOOKS

WHAT MAKES A GLACIER SLIP?
https://www.creesis.org/glacier_slip/what_makes_a_glacier_slip.pdf

WHEN ICS MUSICIANS THE SEA
https://www.creesis.org/ics_musician_the_sea.pdf

WHAT COULD HAVE CAUSED A WHALE WITHOUT SALT?
https://www.creesis.org/whale_without_salt.pdf

WHAT IF THE ICE SHELVES MELTED?
https://www.creesis.org/ice_shevels_melted.pdf

HOW DOES A TOPOGRAPHIC MAP SHOW SEA LEVEL CHANGE?
https://www.creesis.org/topographic_map.pdf

TIPS AND TRICKS FOR PRESENTING INCLUSIVELY TO ALL AUDIENCE MEMBERS

- Speak clearly and face your audience.
- Use adult language by using language that is appropriate for your audience.
- Use short key phrases or bullet points instead of longer sentences.
- Use visual aids to help convey your message.
- Use examples from everyday life to illustrate your points.
- Use humor to make your presentation more engaging.

TIPS AND TRICKS FOR PRESENTING TO COMMUNITIES

- Use visual aids to help explain your research.
- Use simple language to ensure that your audience understands your research.
- Use storytelling to make your presentation more engaging.
- Use humor to make your presentation more enjoyable.
- Use technology to enhance your presentation.

KEYS TO COMMUNICATING YOUR SCIENCE:
- Simple, strong, engaging.
- Use visuals to support your points.
- Use humor to lighten the mood.
- Use technology to enhance your presentation.
- Use simple language to ensure that your audience understands your research.
Teachers as Trainers

Polar Explorers Grant – Lawrence Public Schools

First interdisciplinary unit developed with CReSIS education-

Dr. Leuschen at Sunflower Elementary
Students as Trainers

REU student Malcolm McConner – Ice, Ice Baby lesson during the Celebration of Women in Mathematics at ECSU.

IU Ph.D. student Jerome Mitchell – taught robotics lesson to high school students.

CReSIS High School Robotics – mentoring elementary school students.
ECSU Mathematics Education majors conducted measurement workshops for the CReSIS middle school workshop.

CReSIS REU students conducted College and Career Lunch and Robotics Seminars for the middle school students.
Monthly classroom instruction provides:

- best practice in science instruction
- 45 minute activity with notebook journaling/assessment
- 1 class lesson for teacher
- 1 take-home student lesson

Grades K – 5 Outreach
Shake, Rattle, and Rocks!
An Ice Core as a Time Capsule

Peter Burkett (PSU), designed an activity for 75 5th graders demonstrating the history contained in ice cores.
Freezer BURN

Science Question: Does a glacier go faster with a bed of rock or a bed of water?

Hypothesis: We think the water will help the goo move faster.

:: 2012 CReSIS Middle School Program
http://cerser.ecsu.edu/cresis/cmsp2012/
Results:

The goo/glacier moved faster when on top of a water bed.

Goo hitting the rock
Description: this is what happened in one of our tests

Finished product
Description: what it looked like when it was finished.
Grades 9 – 12 Outreach

- Classroom presentations
- Graphing calculator training
- Science Olympiad Event Sponsor
High School Robotics – Ten students at I.C. Norcom High School in Portsmouth, Virginia
• Explored the use of autonomous robotics in industry and research
• Used the engineering design cycle and the fundamentals of robot design, analysis and robot prototyping
• Tested their robot design
Community Outreach

• Topeka Discovery Center
• Science Buzz Kiosk at KU Natural History Museum
• Family Science Nights at K-12 Schools
• Johnson County Science Cafe
Teacher Professional Development

- Haskell Indian University Teacher Pre-service Courses
- Teacher Resource Day at UMKC (University of Missouri – Kansas City)
- Kansas City, KS Science Teachers In-service Presentations
- Webinars with Fort Hayes State and Polar Educators International
- KATS Kamp (Kansas Association of Teachers of Science)
- *Science Scope* and *The Science Teacher* articles

Dec. 2012; "Explorations of our Frozen Planet"

Feb. 2013; "Reading the Ice: Using Remote Sensing to Analyze Radar Data"
Recommendations:

- Refine survey items to strengthen clarity and relevancy
- Revise survey scales to ensure accuracy
- Improve the reliability and validity of surveys by applying the Instrument Inventory Matrix especially designed for CReSIS surveys

Resulting in revisions in:

- Ice, Ice Baby pre-and post-survey (2012-2013)
- Ice, Ice Baby teacher evaluation survey (2012-2013)
- Glacier animation survey (2012-2013)
- Freezing Friday evaluation survey (2012-2013)
2011 – 2012 Ice, Ice Baby

Teacher Evaluation

1) "Ice, Ice Baby" is of significant educational value to my students.
2) My students enjoy Ms. Hamilton's presentations.
3) My students' interest in polar science is piqued by the presentation.
4) I integrate the supplementary materials provided by CReSIS into my...?
5) I have my students complete the science journal entries that Ms. H...?
6) I have my students use the student science journals for science le...?
7) I would be interested in participating in the pilot-testing of new...?
8) I would be interested in attending a professional development workshop...?
Future Outreach

- Glacier modeling activity for high school
- Survival lesson for grades 4-8
- New animation featuring echograms
- New Ice, Ice Baby videos and pictures
- NSTA STEM Conference Presentations in May 2013
CReSIS RET Student

- Introduction
- CReSIS RET Program
- Science Connections
- *The Science Teacher*
- ‘Reading the Ice’
- Collaboration and Writing Process
REU/RET Program

• Expanded in 2011 to include pre-service teachers

• 2 RET participants in 2011; 3 RET participants in 2012
Research Experience for Pre-service Teachers RET Pilot Program

RET interns were assigned to specifically-designed research teams led by members of the CReSIS Education staff. Their projects included curriculum development efforts to integrate CReSIS science and data into the K-12 classroom, and *Utilizing ARCGIS in Education to Map a Glacier and its Changes Over Time*. Students on the RET teams were undergraduate students with a major Mathematics Education.

Erica Petersen Fr - MATHED - MVSU

Marvin Elder Jr - MATHED - MVSU

Malcolm McConner Sr - MATHED - ECSU
RET Experience

Goals for Program:

• Increase knowledge base about research and technologies that advance understanding of ice-sheet and glacier dynamics.

• Understand the role of CReSIS in the development of reliable models to predict future sea level rise in a changing climate.

• Use new knowledge and teaching experience to create lesson plans for middle and high school students that incorporate CReSIS research and polar science.

Experiences at CReSIS

• Attended presentations by CReSIS scientists and engineers about current research and state-of-the-art technologies.

• Created a lesson mapping sea level rise for the K-8 Ice, Ice, Baby! curriculum.

• Developed lesson plans based on the remote sensing technology used in CReSIS research.
Science Connections

- K-12 Outreach
  - Freezing Fridays
- Educator Education
  - KATS KAMP
  - Teacher Resource Day, Science Pioneers
- Curriculum Development
  - Online Data Portal
  - Journal Publications

Facilitating teachers through CReSIS education material at KATS KAMP, April 2012
Photo by Carol Williamson
Understanding the behavior of ice sheets, thick, continental ice masses and glaciers, is increasingly important as our climate changes, particularly in the Polar Regions. This article describes two lessons, based on the SRE image, expose, explain, elaborate, and evaluate model, that help students practice scientific data collection and introduce them to remote sensing. Using radar data and images from the Center for Remote Sensing of Ice Sheets (CReSIS), a National Science Foundation (NSF)-funded science and technology center that works to improve the next generation of ice sheet models, students accurately represent the physical processes that occur on Earth.

The two lessons presented here center on CReSIS radar data collected via radar attached to the wings of an aircraft from the Polar Regions. After analyzing these data over various surfaces, the students measure physical characteristics of electromagnetic waves that are reflected by different boundaries within an ice sheet or glacier, then compare different layers of snow accumulation below the surface, bedrock, and ice.

The signals are processed to produce a two-dimensional image, or echogram. Students identify a glacier’s grounding line—the boundary between the floating ice shelf and the grounded ice that rests on bedrock—from radar collections from 2005 and 2007, and then compare the grounding line locations in the different years. The ice thickness lesson allows students to identify the distance a radar signal travels from the surface to the glacier bed and calculate the thickness using the data. Teachers can combine these lessons into a two-day lesson, or each can stand alone.

Lesson 1: Grounding Lines

Engage

In the first lesson, students not only learn how to interpret an echogram, but they also study glacier processes and use data to understand why grounded glaciers behave in a certain way. They first use Google Earth to plot the location of the grounding line from two different years and analyze how the grounding line position has changed. Students then work in groups, using the internet to answer the following questions about topics such as glacier formation and movement:

1. Sketch a glacier and label several parts.
2. What is a grounding line? Why is it important?
3. What part of a glacier do you think freezes the fastest? What makes a glacier speed up?
4. Give an example of a method of technology that researchers use to collect data about glaciers.

Explain

Teachers can check students’ understanding of the echogram (Figure 1) by asking students to use Google Earth to plot each grounding line’s location. These points can indicate the aircraft’s flight path and help students determine how often changes in the grounding line’s location occur. For example, if the distance increases from 2004 by 2007, students can determine that the grounding line is retreating.

While interpreting the echogram, students discuss the following questions as a class:

1. What characteristics of a glacier do we see in this echogram?
2. How can the students identify each characteristic?
3. Estimate the latitude and longitude of the grounding line.
4. In what direction is the ice flowing?
The Lessons

• Real-world applications are used to learn science concepts. Students are engaged in hands-on inquiry that investigates questions involving real-world problems.

• Uses the 5E Model lesson plan format (engage, explore, explain, elaborate, and evaluate).

• Lessons correlate to National Science Education Standards.
Grounding Line Location

Objectives: The students will be able to...

- Identify glacier grounding lines using several years of data
- Understand reasons for the change in grounding line location over time
- Plot data that is collected from echograms
- Interpret flight lines using latitude and longitude

Figure 1: Echogram courtesy of CReSIS data from 2002. PDF 20020528 slide 28. [https://www.cresis.ku.edu/data/greenland](https://www.cresis.ku.edu/data/greenland).
What made this lesson fun (and a more compelling lesson for teachers) was…

Working with Steve!
Calculating Ice Depth

With the help of John Paden!

Objectives: The students will be able to...

• Interpret echograms
• Calculate the depth of the ice sheet
• Create a depth scale for an echogram

\[ T = \frac{(t_{\text{bed}} - t_{\text{surface}})}{2} \times \frac{c}{\eta_{\text{ice}}} \]
Collaboration

• General ideas for lessons from education team
• Data and realistic connection to CReSIS came from the collaboration with CReSIS researchers
• Through these connections, the science is brought to life
Writing Process

• Rewriting RET lessons into an article that reads and flows together well
• Going through the peer review and editing process