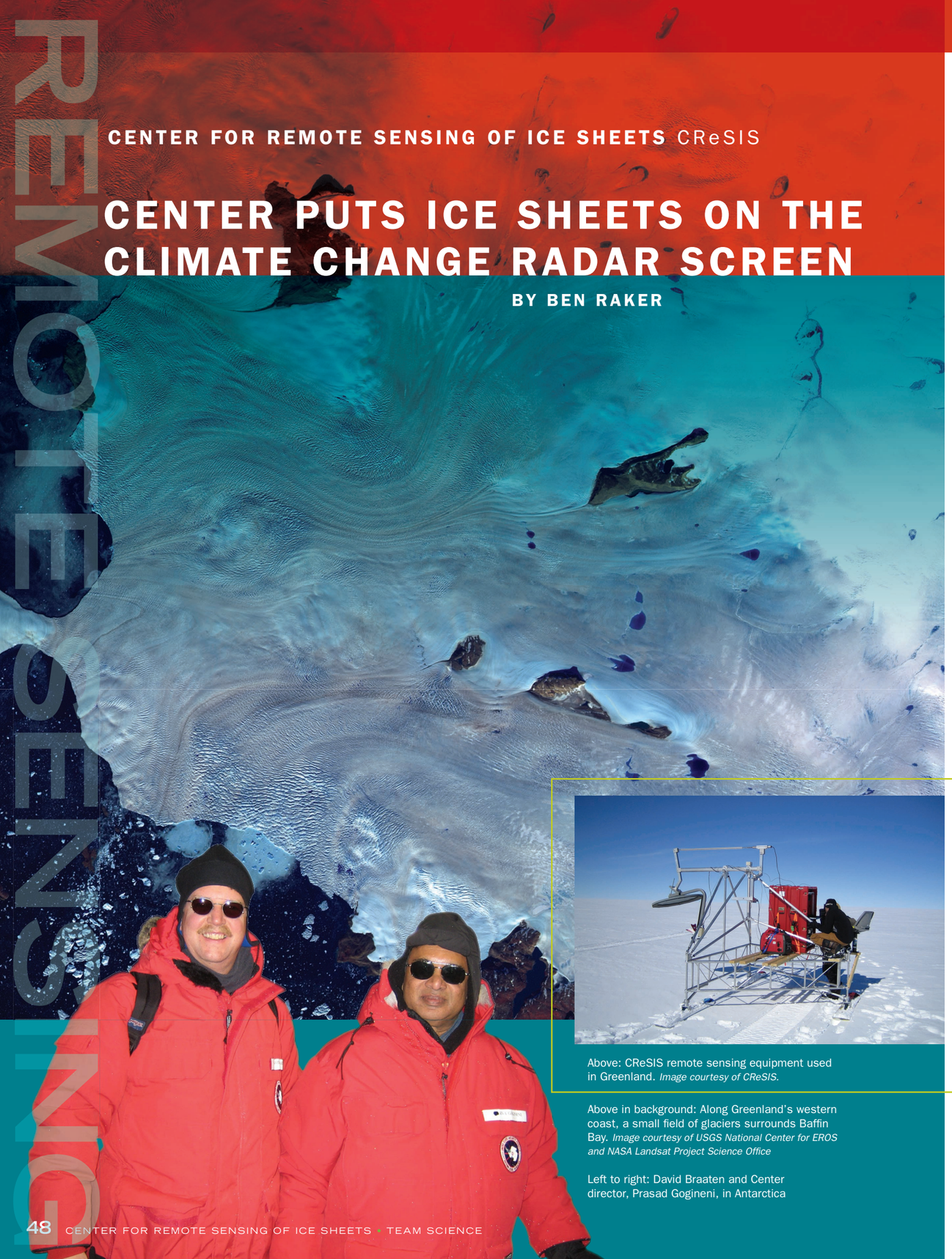
REMOTE SENSING

CENTER FOR REMOTE SENSING OF ICE SHEETS CReSIS

CENTER PUTS ICE SHEETS ON THE CLIMATE CHANGE RADAR SCREEN

BY BEN RAKER



Above: CReSIS remote sensing equipment used in Greenland. *Image courtesy of CReSIS.*

Above in background: Along Greenland's western coast, a small field of glaciers surrounds Baffin Bay. *Image courtesy of USGS National Center for EROS and NASA Landsat Project Science Office*

Left to right: David Braaten and Center director, Prasad Gogineni, in Antarctica

"Polar ice sheets are changing significantly," says Prasad Gogineni, director of the Center for Remote Sensing of Ice Sheets (CReSIS). "Some of these changes have never been observed in human history. We really don't know why they're changing, what is causing these changes—that is really what we're trying to understand."

CReSIS, which is headquartered at the University of Kansas (KU) in Lawrence, Kan., takes as its focus one of these largest gaps of knowledge in the field of climate change research: how collapsing polar ice sheets contribute to sea level rise.

Toward this mission, the center is developing radar systems, remote-control vehicles, and other new technologies to map the polar ice sheets to a depth and scale never accomplished before. The researchers have already begun collecting data to drive models for better prediction of this poorly understood consequence of global climate change.

"How fast and how much sea level is going to rise—that's in a nutshell what we want to know," says David Braaten, deputy director of CReSIS.

Indeed, the 2007 report of the assembly of scientists and officials known as the Intergovernmental Panel on Climate Change (IPCC) finds ice sheet changes to be an area of concern for further research. The report acknowledges that current models would not have predicted the extent of increase in ice sheet melting that has been observed within the last decade.

As the world's only center dedicated exclusively to large-scale study of the polar ice sheets, CReSIS is playing a central role in filling this information gap. And assessing the potential effects of melting-induced sea level rise on human populations makes the center's research particularly important. "Even one meter of sea level rise would affect about 100 million people worldwide," says Gogineni. "There's no way to make a good estimate about sea level rise because we don't know enough yet about the behavior of the ice sheets," adds Braaten.

Mapping Uncharted Territories

In order to understand how an ice sheet moves, scientists essentially need to map its top, bottom, edges, and interior. They need to understand what is going on at the surface of the ice where new ice is accumulating, what the layers inside the ice reveal about its past movement, what is happening at the sides that might constrain the ice, and what the ice is flowing over—if it is ground, what the surface is like; if it is fluid, how much this helps the flow of the ice.

Since launching in 2005, one of the center's greatest achievements has been demonstrating success with synthetic aperture radar (SAR)—a system that can penetrate deep ice to provide a high-resolution record of the bed underneath. Recent work by CReSIS in Greenland was the first to use this technology successfully through roughly three kilometers of ice.

"Understanding what's happening under the bed of ice is extremely important," says Gogineni. "Right now there are not many tools available to do that over large areas."

As the radar passes over the ice—either on the surface or in the air—the radar casts its signal at an angle downward and records the reflected returns in a top-view swath of what is just to either side of the radar's path. By sweeping lawnmower-fashion back and forth, the researchers can put the swaths together and map a large area.

Much of the CReSIS fieldwork to this point has involved proof-of-concept exercises with this technology and initial ground-based surveys. But the goal is to soon put the radar on uncrewed aerial vehicles (UAVs), which can cover more area more quickly. Researchers aim to test newly developed aerial "drones" in Greenland in 2008, and then also on Antarctic ice sheets in 2008–2010.

Additionally, researchers affiliated with the center are already creating data sets using depth sounder radar and seismic surveys to map the ice and ice beds in cross-sections downward. They are working with satellite data to analyze the velocity of ice movement. A paper in the journal *Science* resulted from this work in 2006. And they are further developing existing sensor systems and ground-based robotic vehicles to survey large areas remotely.

David Braaten, left, and Prasad Gogineni, right, in Antarctica.

Team Science for Timely, Coordinated Research

Much of the work on developing new technologies takes place back at the universities within the CReSIS partner system. Work on such projects as the design of aerial drones, robots, and miniaturized systems to be carried on aircraft require the coordination of engineers and scientists from various fields. This coordination also provides opportunities for a wide range of students at undergraduate and graduate levels.

CReSIS researchers and students come together from the fields of aerospace, electrical engineering, computer science and engineering, geology, geography, and even education. Universities partnering in CReSIS include KU; Elizabeth City State University, a historically African-American university in North Carolina; Haskell Indian Nations University in Kansas; the Ohio State University; the Pennsylvania State University; and the University of Maine. CReSIS also collaborates with various industry and international partners.

"The greatest advantage of the center is that it brings together the engineers, the people who go into the field, and people like myself who take the data and analyze it," says Kees van der Veen, a professor in the department of geography at KU.

Braaten notes that the center brings people together more often than would happen if they only met at periodic conferences and meetings. This efficiency also serves a greater purpose because of the time-sensitive nature of research on sea level rise. "It's not something we can wait twenty years to solve," he says. □

HANDS-ON RADAR DESIGN

Under the sponsorship of CReSIS, students at the University of Kansas are designing a prototype radar system with the goal of eventually miniaturizing and deploying their equipment in the polar regions.

Undergraduates in KU's electrical engineering program are working on a year-long senior design project called Multi-waveform Radar for Classroom Demonstration and Ice Sheet Altimetry (MRAD). This type of radar will be used in the field to take high-resolution measurements of ice-surface features and thicknesses.

The students planned their design using computer software and then built it up component by component into a demonstration model. "It's cool to be able to learn about something in the classroom and then design it," says Heather Owen, an electrical engineering undergraduate working on the project. She says that the prototype is already being used in classrooms for demonstration.

The prototype will need to be miniaturized for use in aerial surveys, which is the work of Cameron Lewis, a KU graduate student. Lewis says that the box measuring 2 ft by 1.5 ft by 3 ft now holding the prototype will eventually need to hold it and all of the other sensors onboard an aerial drone. Eventually, the multi-waveform radar must be shrunk down to a board about 4 in by 4 in. Still, Lewis welcomes the challenge CReSIS is presenting him: "Not very many people build radars for civilian purposes—but CReSIS has a practical reason to do this," he says. "I'm using my education, and that's a great feeling."

Background: Left to right: Cameron Lewis, Heather Owen, John Hecker, James Sulzen, Deebu Abi

Below: Left to right: Deebu Abi, Heather Owen, Cameron Lewis, James Sulzen, John Hecker

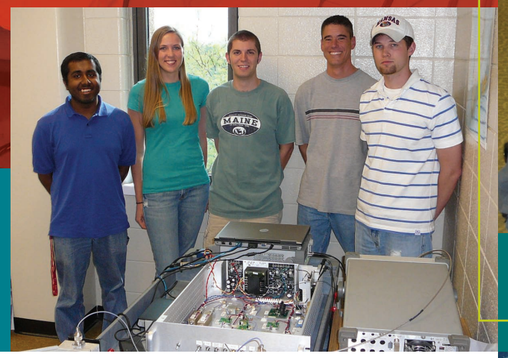


Photo: Thomas Overly © 2006

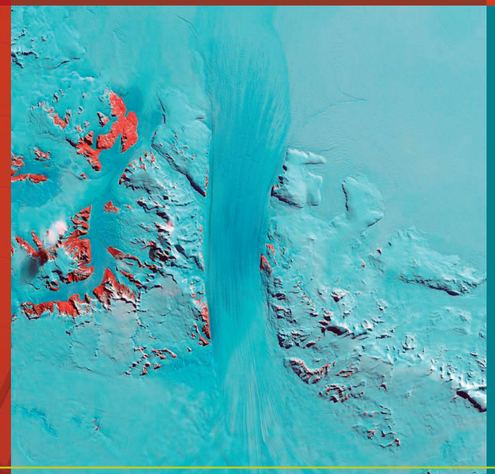
MEET THE DIRECTOR

Prasad Gogineni

Prasad Gogineni began work on remote sensing of ice sheets in 1992. This work gradually led to the predecessor program for CReSIS, called the Polar Radar for Ice Sheet Measurements (PRISM) project.

Gogineni credits time at NASA with insights into writing large-scale proposals and managing large projects. In his current program, he continues to enjoy working with students, and sees great promise for CReSIS in the years ahead.

"I am very excited about what the center can do—I really feel that we are on the cusp of a breakthrough to make major advances in glaciology and modeling of the ice sheets."



Students at Haskell Geographic Information Systems Laboratory

MAPPING SEA LEVEL CHANGE AT HASKELL INDIAN NATIONS UNIVERSITY

One of the CReSIS projects to attract broad press attention in early 2007 was a project completed by students at Haskell Indian Nations University (Haskell), a four-year university in the U.S. exclusively for Native Americans, and a CReSIS partner. Since 2001, Haskell has been working with its Lawrence, Kan., neighbor KU, and over this time has developed a lab and expertise in geographical information systems (GIS)—computer mapping systems that can essentially overlay different types of data on the same maps.

For its recent CReSIS project, Haskell students used GIS to make a digital elevation map of the world, and then input population data and projected scenarios for different possible levels of sea level change. This GIS dataset, which is now downloadable as a Google Earth overlay, shows the impact of sea level change on populations in eight different regions worldwide. It uses such high resolution that people in coastal Florida might zoom in on their street and see what sea level change would be required to inundate their neighborhood.

The maps may be viewed through the CReSIS Web site at: http://cresis.ku.edu/research/data/sea_level_rise/

In addition to having Haskell as a partner, CReSIS also draws on the strengths of Elizabeth City State University (ECSU) in Elizabeth City, N.C. It is an historically African-American institution with a record of research and education in remote sensing for undergraduates. Through the associations with these two institutions, CReSIS seeks to provide opportunities to populations traditionally underrepresented in science and engineering.

CReSIS GEARS UP TO TAKE TO THE AIR

Having tested radar technologies on ground-based vehicles in Greenland, and aerial drones at KU and partner institutions, CReSIS looks to gradually shift into aerial surveys in 2008–2010. "For basin-scale work, you really need aerial surveys," says CReSIS deputy director David Braaten. Before these aerial surveys can happen, technology must be miniaturized to work on a low-altitude, uncrewed airplane. Aerial surveys are planned for both Greenland and Antarctica, some in coordination with International Polar Year activities.

NEWS WATCH

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