REMOTE SENSING

CENTER FOR REMOTE SENSING OF ICE SHEETS CReSIS

CENTER PUTS ICE SHEETS ON THE CLIMATE CHANGE RADAR SCREEN

Fernando Rodriguez inspects an antenna installation. *Photo: Cameron Lewis*

Top in background: Satellite view of broken sea ice. *Photo: CReSIS*

Left to right: Associate Director of Science 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.”

Headquartered at the University of Kansas (KU) in Lawrence, Kan., the Center for Remote Sensing of Ice Sheets (CReSIS) 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 has developed radar systems 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, Associate Director of Science for CReSIS.

Indeed, the 2007 report by 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 a world-class research center dedicated to the 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.

“Even one meter of sea level rise would affect about 100 million people worldwide,” says Prasad Gogineni, CReSIS Director. “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 its launch in 2005, one of the Center’s greatest achievements has been its success with synthetic aperture radar (SAR)—a system that can penetrate deep ice to provide a high-resolution record of the bed underneath. Work by CReSIS in Greenland was the first to use this technology successfully through roughly three kilometers of ice, and CReSIS work with SAR radar was recently highlighted by *IEEE Spectrum* magazine.

“Understanding what’s happening at the ice bed 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 first tested aerial “drones” in Greenland in 2008, and then also on Antarctic ice sheets in 2009. The Meridian UAV recently underwent testing with CReSIS radar in Greenland and successfully sounded ice from the runway.

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. They are further developing existing sensor systems to survey large areas remotely.

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 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 the 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; the Indiana University; the University of Washington; the Pennsylvania State University; Los Alamos National Laboratory; and the Association of Computer and Information Science Engineering Departments at Minority Institutions. 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 SIMULATOR

In October of 2010, CReSIS participated in the USA Science and Engineering Festival in Washington, D.C. One of 15 NSF organizations chosen to attend the event, CReSIS was the only representative from the state of Kansas and featured a radar simulator designed to give interested participants the chance to fly a model of the Meridian aircraft over a block of simulated ice and view the radar results on a computer screen. The exhibit allowed participants to observe the way in which fast 2-D motion results in 3-D imaging and sounding and demonstrates other aspects of radio-glaciology.

While the Expo marked the first time CReSIS offered a hands-on demonstration of radar to children, the exhibit will be redesigned to be portable, enabling more interactive outreach opportunities for the Center. CReSIS plans to develop a traveling display of both the radar simulator and the UAV controls platform that can easily be transported to schools around Kansas, as well as to the Center's partner institutions, allowing students across the country to get a glimpse of all CReSIS technologies.

CReSIS Deputy Director Carl Leuschen performs in-the-field repairs to the depth sounder at Byrd Camp, Antarctica in 2010.
Photo: Cameron Lewis

Below: Radar depth sounder antenna array mounted below the Twin-Otter wing during flight operations in Antarctica in 2010.
Photo: Cameron Lewis

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 largescale 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."

Middle school students conduct an experiment at CReSIS partner institution Elizabeth City State University in North Carolina in 2011.
Photo: Cheri Hamilton

MODELING AND 3D TOPOGRAPHY

The Center's long-term goals are to characterize ice thickness and bed topography in rapidly changing ice-sheet regions, develop diagnostic and predictive ice-sheet models, and contribute to future assessments of sea level change in a warming climate.

To achieve these goals, the Center uses the data gathered by radars and seismic instruments in conjunction with satellite data to implement models that can identify the processes responsible for abrupt changes in the ice sheets. The Center's Modeling Team consists of groups at the University of Kansas (KU), the Pennsylvania State University (PSU), the University of Washington (UW) and Los Alamos National Laboratory (LANL). These modeling efforts are supported by Indiana University, Elizabeth City State University (ECSU) and Polar Grid.

To assist modeling efforts that need detailed bed topography, CReSIS produces fine-resolution 3-D topography maps generated from data collected using synthetic aperture radars (SAR). The science community has already begun to use detailed bed topography maps generated by CReSIS to explain some of the rapid changes that have been observed.

CReSIS ice thickness and bed topography work was recently highlighted in National Geographic Magazine. CReSIS graduate student Josh Meisel and his CReSIS research provided data for National Geographic's June 2010 issue, as well as an online interactive feature on climate change at the poles entitled "Greenland's Vanishing Ice." The terrain under the ice sheets is the final frontier for mapping the earth's surface.

CReSIS GEARS UP TO TAKE TO THE AIR

Having deployed radar technologies on ground-based vehicles and aerial missions during 2008 and 2009 in Greenland and Antarctica, CReSIS will continue aerial surveys in 2011 and 2013. "For basin-scale work, you really need aerial surveys," says CReSIS Associate Director of Science David Braaten. Aerial surveys are planned for both Greenland and Antarctica, utilizing the NSF Twin Otter and the CReSIS-developed UAV.

NEWS WATCH

Glacial ice from Greenland reaches the ocean in 2005.
Photo: Leigh Stearns