CReSIS,
GPRA Highlights FY2009

STC-II: CReSIS UAV Technology

Highlight ID: 19129, Version: AC/GPA

Researchers from the Center for Remote Sensing of Ice Sheets (CReSIS) are developing next generation radar technology to map internal layers near ice beds. The Meridian uninhibited areal vehicle (UAV) is being developed to carry a 165-lb payload with a 950-nm operating range to collect data over polar ice sheets. The UAV fuel consumption is 1/20th of a Twin-Otter aircraft with about twice the operating range. The UAV is designed such that it can be packed into a standard container for shipping to Antarctica and Greenland. It can accommodate a variety of payloads.
The UAV radar is being developed for sounding and imaging the bed of the Greenland and Antarctic ice sheets. The radar operates from 180 to 210 MHz with eight independent transmit and receive channels. The transmit waveforms are fully programmable to provide the capability to perform digital beam-steering and can be coded to generate multiple beams to simultaneously sound and image ice, and map internal layers.

Range sidelobes are a result of pulse-compression used to transmit high-energy pulses required to detect weak targets. Minimizing range sidelobes is essential for sounding fast-flowing glaciers and mapping internal layers near the bed. CReSIS researchers developed radars with the first few sidelobes lower than 75 dB below the main peak and the far-off sidelobes lower than 100 dB. This will allow mapping of internal layers near the bed.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs and the directorate of Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
Yes
Development of cutting edge technology provides new ways of studying ice sheets.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
Yes
Society will benefit from the availability of more accurate data on the melting of polar ice sheets. The collection of this data will be made possible by the use of radar technology that is being developed by CReSIS researchers.

What is the intellectual merit of this activity?
The development and utilization of uninhibited areal vehicles (UAV) and the associated equipment

enable data collection in areas that humans cannot access. These data, when combined with other information, help describe the melting of polar ice sheets and enables prediction of future events.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
Development of next generation radar technology provides data of internal layers of ice beds.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Sensor Research, Environment (including the importance of fresh water and dynamics of water processes)

STC-II: Channel geometry under Jakobshavn Isbræ, West Greenland, from airborne radar sounding

Highlight ID: 19130, Version: AC/GPA

Researchers from the Center for Remote Sensing of Ice Sheets (CReSIS) use sensitive radar sounding to study glacier discharge. Jakobshavn Isbræ, located on the west coast of Greenland, is one of the fastest flowing glaciers on Earth, and it drains about 7.5% of the total surface area of the Greenland Ice Sheet. Between 1995 and 2003, the glacier doubled its speed with a current surface velocity in excess of 12 km/yr, almost doubling its ice discharge into the ocean. Quantitative analysis and modeling of these changes has been hampered by lack of topographic control on bed geometry under the glacier. Radar sounding of the glacier has been a major challenge because of very high signal loss, caused by surface melt and warm ice at the bed, and a very rough surface. We successfully sounded the glacier with a very sensitive radar for the first time, allowing the geometry of the channel to be described in great detail after processing through two independent methods. Combining channel geometry with surface elevations and previously determined ice velocities, we find that discharge from the glacier remained more or less constant at 28 km^3/yr over the period 1985 to 1995, increased to 37 km^3/yr in 2000, followed by a slower rate of increase to 40 km^3/yr in 2005.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs (OPP) and the directorate for Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative,

potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers (AC/GPA selected)

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
Yes
The results reported represent the first time that the Jakobshavn glacier has been successfully sounded, using a very sensitive radar. The results enabled the development of a detailed description of the glacier channel.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
Yes
The impact of the results on society is the provision of more detailed data on glacier discharge, geometry, surface elevation, and ice velocities. This is pertinent to glacier melting and sea level rise.

What is the intellectual merit of this activity?
Understanding glaciers, especially Jakobshavn, is important as predictions are made on surface melting and global warming, resulting in sea rise. This has implications for human survival.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
New discoveries in radar sounding allow researchers advanced monitoring of glacier discharge.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Sensor Research, Environment (including the importance of fresh water and dynamics of water processes)

STC-II: SAR Imaging of Ice-Bed Interface Airborne Radars

Highlight ID: 19132, Version: AC/GPA

Researchers from the Center for Remote Sensing of Ice Sheets (CReSIS) have produced the first Synthetic Aperture Radar (SAR) strip-map images of the ice-bed interface. The development of high-sensitivity imaging radars has also contributed to the first ever successful sounding of one of the fastest glaciers in the world, Jakobshavn Glacier.

Interferometric Synthetic Aperture Radars (InSAR) are revolutionizing the study of polar ice sheets. Satellite data have shown that parts of the Greenland and West Antarctic ice sheets are undergoing rapid changes. However, the processes involved in the rapid changes are poorly understood. New measurements of the basal boundary conditions will improve glacier-flow models and consequently the understanding of what causes rapid changes in ice sheet mass balance.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs and the directorate of Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
Yes
Development of cutting edge technology provides new techniques in the study of glaciers and climate change.

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
Yes
The potential societal benefits are in the knowledge transfer of information on polar ice sheets, which are undergoing rapid changes that will have impact on humanity.

What is the intellectual merit of this activity?
Measurements of the basal boundary conditions will improve glacier flow models, which will enable the understanding of the causes of rapid changes in ice sheet mass balance.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
The development of the Synthetic Aperture Radar will provide strip-map images of ice bed interfaces, which will enhance the study of ice bed changes.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: Climate Change, International Polar Year (IPY), Sensor Research, Environment (including the importance of fresh water and dynamics of water processes)

STC-II: Melting Beneath West Antarctic Ice Streams

Highlight ID: 19142, Version: AC/GPA

Ice streams are enormous rivers of ice that flow downwards from the interior of the Antarctic Ice Sheet to the sea. Ice streams are on the order of several hundreds of kilometers along and 10s of kilometers wide. Velocities on the ice streams are at least an order of magnitude larger than the relatively stagnant ice on the flanks. This velocity difference leads to strong shearing across the ice stream margins. Shearing controls the flow of the ice stream and hence the volume of ice per year moving through the stream.

The fast motion of ice streams is the result of basal water which lubricates the ice sheet bed. Consequently it is of great interest to know where melt water is being produced, how much water is being produced, and how the distribution of melt water changes with time. Using recent satellite observations of glacier flow, a team from The Ohio State University and the University of Kansas recently applied a theory which describes how the sense of shearing changes from shearing drag across the nearly horizontal bed in slow moving flanking ice to shear across nearly vertical planes in the ice stream margin. The team found that that there is complex pattern of melt associated with the interplay of ice stream speed and basal drag down the length of the ice stream. In the upper reaches of the ice stream, melt is distributed across the width of the ice stream and may be the primary enabler of fast glacier motion. In the mid section of the ice stream, melt becomes concentrated in the shear margin and this may help sustain fast glacier flow. Near the terminus the situation becomes more complex where reduced heat may lead to ice stream deceleration caused by basal freezing near the center of the ice stream. But the continuation of melt in the shear margin leads to the counterintuitive result that the slowing ice stream may also be widening - perhaps leading to an ultimate bifurcation in the river of ice.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs and the directorate of Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
No

What may be the benefits of the proposed activity to society?
Yes
The project is one of several that address the melting of the polar ice sheets. The resulting information will contribute to the understanding of ice melting under Antarctic ice streams and the challenges this may pose for the society.

What is the intellectual merit of this activity?
Data collection and dissemination on ice stream velocity and basal drag are critical to our understanding of the melting of glaciers. Ultimately, the information, when added to other information about the glaciers, enables a better understanding of climate change.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
New methods in the study of ice streams will aide in the study of glacier melt.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: Climate Change, Environment (including the importance of fresh water and dynamics of water processes)

STC-II: Promoting Climate Science in the Classroom

Highlight ID: 19145, Version: AC/GPA

A series of inquiry-based**,** middle school activities and lessons related to ice and climate have been developed by the NSF-funded Center for Remote Sensing of Ice Sheets (CReSIS). These lessons, called *Ice, Ice, Baby!,* are made available online and are taught by CReSIS educators during classroom visits. The lessons are all matched to educational standards, use basic materials, and are well tested.

CReSIS sponsors annual teacher workshops using an inquiry-based instruction approach. These workshops have two primary goals: 1) to educate science teachers about the science of climate change and the cryosphere; and 2) to offer pedagogical strategies for implementing this content into the classroom. Workshops emphasize learning the hard' science and include extensive interaction with researchers. A DVD for classroom use was developed by teachers who participated in this workshop.

CReSIS sponsors an after-school program, called *Climate Pathfinders*, that is challenging students to examine their role in the community regarding climate change and empowering them to take action.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs and the directorate of Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
Yes
A large part of the student population consists of underrepresented minorities.

What may be the benefits of the proposed activity to society?
Yes
People of all ages are interested in knowing about climate change and its challenges. This project addresses an important way of transferring climate science information to young people via their teachers.

What is the intellectual merit of this activity?
The population that understands climate science will be increased in size.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
Advances discovery and understanding of ice and climate science while promoting teaching, training, and learning to teachers and students.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: American Competitiveness Initiative (ACI), Climate Change, Environment (including the importance of fresh water and dynamics of water processes)

STC-II: Integrating Research into Undergraduate Curriculum

Highlight ID: 19146, Version: AC/GPA

The NSF-funded Center for Remote Sensing of Ice Sheets (CReSIS) is integrating technology research and development into the undergraduate classroom. Students are involved in the design and implementation of concepts that contribute to engineering and scientific advances. Aerospace Engineering (AE) at the University of Kansas has integrated Uninhabited Aerial Vehicle (UAV) development for CReSIS throughout the AE undergraduate curriculum. Thirteen different courses include some component of UAV development - from instrumentation to materials to avionics to propulsion systems. AE students also have the opportunity to collaborate with electrical engineering students to integrate sensor systems into the UAV, providing them with a similar environment they will experience in industry.

Flight planning activities for CReSIS airborne surveys in Greenland and Antarctica are being conducted by undergraduate students and faculty at Haskell Indian Nations University using Geographic Information System (GIS) technology. In conjunction with their GIS coursework, students plan and optimize airborne radar survey flights over the ice sheets. They develop individual flight plans based on maximum range of the aircraft, mission flight hour limitations, and refueling locations, and design the surveys to obtain data needed by scientists to understand and model why ice sheets are changing rapidly in certain areas.

The Center for Remote Sensing of Ice Sheets (CReSIS) was funded by the National Science Foundation (NSF) in 2005. The University of Kansas serves as the lead institution for CReSIS. NSF management of this Center is provided by the Office of Integrative Activities (OIA), the Office of Polar Programs and the directorate of Education and Human Resources (EHR). The Science and Technology Centers (STC): Integrative Partnerships program supports innovative, potentially transformative, complex research and education projects that require large-scale, long-term awards.

Primary Strategic Outcome Goal:

- Science & Technology Centers

Secondary Strategic Outcome Goals:

Does this highlight represent potentially transformative research? *If so, please explain why. For more information, see Report to Congress: Transformative Research at the National Science Foundation, April 16, 2008 and Important Notice 130: Transformative Research*
No

How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc?)
Yes
The undergraduate students are a good mix of persons from underrepresented groups.

What may be the benefits of the proposed activity to society?
Yes
New knowledge transfer is very important, particularly when pertinent to the continued existence of mankind. The results of this project, when added to the overall research of CReSIS, will enable a better understanding of the challenges of melting of ice sheets and, hence, climate change.

What is the intellectual merit of this activity?
The dissemination of information on the design and implementation of concepts that are focused on CReSIS research is facilitated by the classroom topics of undergraduates. Therefore the students who take the courses learn about uninhabited aerial vehicle development, flight planning, collaborate with electrical engineering students, and enrich their backgrounds on the topics offered.

What are the broader impacts of this activity?
Merit Review Broader Impacts Criterion: Representative Activities, July 2007
Integrated curriculum will provide students with hands on learning of CReSIS research.

O/D/OIA 2009

Program Officer: Margaret E. M. Tolbert/Julie Palais

NSF Award Numbers:
0424589

Award Title:	Center for Remote Sensing of Ice Sheets (CReSIS)
Start Date:	06/01/2005
Expires:	05/31/2010
Awarded Amount to Date:	$19,032,230
PI:	S. Prasad Gogineni, pgogineni@ku.edu
Institution Name:	University of Kansas Center for Research Inc
State Code:	KS
PE Codes:	7555, 5280, 5116, 5111, 1297

NSF Contract Numbers:

NSF Investments: Climate Change, Sensor Research, Environment (including the importance of fresh water and dynamics of water processes)