STRATEGIC AND IMPLEMENTATION PLAN
CENTER FOR REMOTE SENSING OF ICE SHEETS

LEAD INSTITUTION
University of Kansas

PARTNER INSTITUTIONS
Association of Computer & Information Science
Engineering Departments at Minority Institutions
Indiana University
The Pennsylvania State University
Los Alamos National Laboratory
University of Washington

INTERNATIONAL COLLABORATIONS
Antarctic Climate & Ecosystems Cooperation Research Centre (ACE)
University of Copenhagen – Center for Ice & Climate
Centre for Polar Observations & Modeling (CPOM)
Indian Institute of Technology – Kanpur
University of Magallanes

GOVERNMENT & INDUSTRY PARTNERS
The Kansas City Plant (NNSA and Honeywell FM&T)

SPONSORS
National Science Foundation
Kansas Technology Enterprise Corporation
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Cover. Radar echogram from Jakobshavn superimposed over an aerial photograph by Terry Evans. Ms. Evans developed a commissioned art project with the Spencer Museum of Art and CReSIS at KU. Above. Aerial photograph of the ice sheet surface taken from a Twin Otter aircraft in late-June 2008.
EXECUTIVE SUMMARY

The Center for Remote Sensing of Ice Sheets (CReSIS), a Science and Technology Center led by the University of Kansas, will conduct and foster multidisciplinary research that results in technologies, new data sets, and models necessary to achieve a better understanding of the mass balance of the polar ice sheets (e.g., Greenland and Antarctica) and their contributions to sea level change. Long-term goals are to perform a four-dimensional characterization (space and time) of rapidly changing ice sheet regions, to develop diagnostic and predictive ice sheet models, and to contribute to future assessments of sea level change in a warming climate. CReSIS also works to educate and train a more diverse population of graduate and undergraduate students in Center-related disciplines, and to encourage K-12 students to pursue careers in science, technology, engineering and mathematics (STEM-fields).

The Intergovernmental Panel on Climate Change (IPCC) has identified ice sheet contributions as one of the largest unknowns in predictions of future sea level change, and the models used for these IPCC estimates do not account for the rapid changes to ice sheets that have been observed, further increasing this uncertainty. The problems associated with determining ice sheet mass balance and creating predictive models of ice sheet dynamics are scientifically and technologically complex, and the best way to solve these problems is through a Science and Technology Center focusing the efforts of a sizeable group of scientists and engineers for a significant period of time on this topic of global scale and high societal relevance.

The Center’s broader impacts stem from our addressing a global environmental problem with critical societal implications, providing a forum for citizens and policymakers to become informed about climate change issues, training the next generation of scientists and engineers to serve the Nation, encouraging underrepresented students to pursue careers in STEM-related fields, and transferring new technologies to industry. Students involved in the Center find an intellectually stimulating atmosphere where collaboration between disciplines is the norm, and where exposure to a wide variety of methodologies and scientific issues enriches their educational experience.

Intellectual merits of the Science and Technology Center are the multidisciplinary research it enables its faculty, staff and students to pursue, and broad education and training opportunities it provides to the students at all levels. Ice thickness and bed conditions are key variables in the study of ice dynamics and development of models. Major challenges in radio glaciology include sounding of fast-flowing glaciers with rough surfaces and imaging the ice-bed interface to determine basal conditions. CReSIS continues to address this challenge by developing high-sensitivity radars and innovative seismic sensors; our radars have sounded the deepest parts of Jakobshavn Isbræ and imaged the ice-bed interface, covered with 3-km thick ice, for the first time.

The next generation of researchers should reflect the diversity of our society. To this end, the Center will continue to work closely with two minority-serving institutions, the Association of Computer and Information Science/Engineering Departments at Minority Institutions (ADMI) and Elizabeth City State University (ECSU) in Elizabeth City, North Carolina. Other partners of the Center include: Indiana University, Los Alamos National Laboratory, The Pennsylvania State University, and the University of Washington. International and industrial partners provide additional opportunities for Center participants to collaborate on this important societal issue.
CENTER MANAGEMENT

1. General

The core management group consists of the Director, the Deputy Director, Associate Directors, and the Administrative Manager. The group meets weekly to discuss technical, scientific and financial progress and to address issues and concerns as these arise. These management meetings are mirrored by all teams (staff, education, knowledge transfer, specific technology/science working groups, etc.), to coordinate initiatives and plans on a recurring basis. Additional “all-hands” meetings that involve all faculty, staff, and students across the partners provide every participant an opportunity for input to the Center Director. In each of these cases, video and audio conference facilities, procured early in the Center’s first-year of operation and subsequently expanded, provide the capability for Center-wide exchanges.

The Center’s management structure is outlined in Figure 1. The Director is responsible for all Center operations and reports to the Dean, School of Engineering.

He provides strategic leadership and manages the Center with the help of the Deputy Director, nine Associate Directors and an Administrative Manager. Whereas the Director maintains external relationships, the Deputy Director is responsible for internal, day-to-day operations and is assisted by the Administrative Manager. An Associate Director of Operations at each partner institution leads activities at their respective universities and laboratories. Associate Directors for each program area (Science, Technology, Education and Diversity, and Knowledge Transfer) oversee activities in their respective areas and are responsible to ensure they are integrated across program boundaries.

2. Foundation/Definition Documents and Progress Reports

This Strategic and Implementation Plan (SIP) provides the vision, mission, and objectives for all Center activities. It is updated annually (September/October) and maintained at the CReSIS website (www.cresis.ku.edu).

The SIP is supplemented by project plans for Science, Models, Sensors, UAV

![Figure 1. Center Management Structure.](image-url)
Platforms, Education, and Knowledge Transfer that offer detailed explanations of these activities, expanded discussion of management structures, risk mitigation plans, and detailed schedules. These plans are also updated no less than annually and are maintained in a password protected area of the CReSIS website.

Additional Center strategy papers, plans for field programs, administrative procedures guides, and other supporting products provide a third level of detail for participants. Distribution of these documents is determined by their purpose.

In addition to our mandatory annual progress report, the Center generates and submits quarterly progress reports to the NSF via FastLane. These are intended to provide NSF Program Managers, Advisory Boards, and Center participants updates on our progress and plans. These reports are also posted on the password-protected area of the CReSIS website.

Administrative staff prepares financial updates for all Center-managed projects on a monthly basis for review by the Director and/or appropriate project PIs.

3. External Advisory Board (EAB) and Academic Advisory Council (AAC)

An External Advisory Board, with diverse expertise in areas related to the Center’s mission, meets annually prior to the annual NSF site visit and includes representatives from academic institutions, industry, and national laboratories. One-third of the board is replaced by new members every two years. A second advisory board, the Academic Advisory Council (AAC), is comprised of senior administrators from KU and partner institutions. It guides and advises the Center director on administrative matters, and any Center issues requiring administrative support are brought to their attention. This board meets twice a year using the Center’s videoconferencing facilities.

4. Succession Plan

If the Director steps down, but remains at the university, the Associate Vice Chancellor for Research and Graduate Studies will appoint the Deputy Director as Interim Director. In consultation with the NSF Program Director, the Associate Vice Chancellor for Research and Graduate Studies will establish a search committee, consisting of Center and KU faculty and administrators, to find a replacement through an internal search. Associate Directors at partner institutions and KU deans and department chairs with a stake in the Center will be consulted. If the Director leaves the university, the committee will conduct a national search to fill the position. In consultation with senior Center management, the Associate Vice Chancellor for Research and Graduate Studies and NSF Program Directors, the Director will replace Associate Directors, if required.

5. Ethics Training

The Center takes advantage of all university-provided ethics training opportunities relevant to our mission. Examples include seminars offered through the KU School of Law and Business, as well as training provided by the KU Center for Research. Similar training opportunities are offered at other partner institutions. Additionally, the Center provides training opportunities for all participants using an online source, the Responsible Conduct of Research web-based modules. These informative and entertaining training modules are offered by the Center on Materials and Devices for Information Technology Research (MDITR). User participation is tracked by the Administrative Manager.
RESEARCH – SCIENCE AND TECHNOLOGY

1. Vision Statement for Research
To understand and predict the role of polar ice sheets in sea level change.

2. Mission Statement for Research
To improve understanding of the processes causing rapid changes to outlet glaciers and ice streams through targeted data collection campaigns combined with theoretical development and data interpretation, and to incorporate this understanding into numerical ice sheet models.

3. Situational Analysis: Opportunities and Challenges

Strengths and Opportunities:
A. Recent rapid marine-based glacier changes in both the Antarctic Peninsula and Greenland offer the opportunity to study glacier response to forcings at the terminus at various stages of collapse.
B. Advances in remote-sensing techniques during the first five years have provided better constraints on subglacial conditions (small-scale bed topography, wet vs. frozen bed conditions, etc.).
C. Strong sensor and platform development experience. This includes experience designing and fielding radars for measuring ice thickness, bed topography, and accumulation rates; advances in seismic sensor development; and unique aerospace vehicle configuration design activities. This expertise provides the Center a basis for next-generation development efforts, as driven by science requirements.
D. Diverse experience with ice sheet modeling that ranges from process-modeling studies, ocean/sea-ice modeling, and ice sheet/climate model linkages.
E. Extensive cyberinfrastructure development experience that includes prior experience in polar regions.
F. Strong collaboration with international partners that strengthens field program, modeling, and satellite observation activities.

Challenges and Weaknesses:
A. A lack of field observations has hindered quantitative testing of various theories proposed regarding rapidly changing outlet glaciers and ice streams.
B. Recurring and unpredictable outside fiscal constraints often impact proposed field activities.
C. Increased sensitivity of our radar systems continues to uncover previously unimportant signal processing challenges.
D. To significantly impact ice sheet models requires working and influencing modelers beyond Center participants.
E. Regulatory requirements, both US and international, for operation of a large-scale UAV are not well understood. These challenges will most dramatically impact expanded flight test activities in the National airspace.

4. Goals and Objectives

Goals:
- To perform a four-dimensional characterization of rapidly changing ice sheet regions using a variety of sensors.
- To develop predictive models for how these regions may change under various warming scenarios.

Objectives:
- Document existing data for target areas and identify observational and
technological requirements to improve and validate models.

B. Design and develop technologies for collecting and processing necessary data.

C. Conduct field investigations to collect required data sets.

D. Process, analyze, and distribute data to modeling groups and the scientific community.

E. Integrate data and models using state-of-the-art computing, storage, and networking cyberinfrastructure.

F. Develop diagnostic models identifying processes leading to rapid ice sheet change.

G. Incorporate improved process understanding into predictive ice sheet models.

H. Involve undergraduate and graduate students in research activities.

5. Strategies

A. Analyze existing data for target areas to determine key variables required to support and validate ice sheet models. For new data to be collected, develop scientific requirements that will drive sensor development and field campaign design (Objective A).

B. Continue improving phase-one developed technologies; expand wireless seismic sensor development; and field and validate the UAV platform. Train technical staff and students to collect field data (Objective B).

C. Use iterative system design and acquisition processes to acquire field computing hardware capable of initial data processing (Objective B).

D. Deploy sensors, platforms, cyberinfrastructure, and support personnel to collect field data (Objective C).

E. Provide high performance computing and storage to support data analysis and modeling. Assist with adapting applications to high performance platforms (Objectives D and E).

F. Process and analyze field data to produce comprehensive data sets suitable for distribution to modelers and the glaciological community (Objective D).

G. Adopt a Web 2.0-style service architecture that enables dynamic composition of model pipelines; provides secure, authorized access to data products; and provides user-friendly map interfaces (Objectives D and E).

H. Incorporate data into diagnostic ice-dynamical models to increase process understanding (Objective F).

I. Incorporate process understanding and data into predictive models to produce projections of future ice sheet changes (Objective G).

Figure 2. The Center will build on first-phase successes with radars developed to support airborne and surface-based measurements.
J. Involve undergraduate students in research projects using vehicles such as Research Experiences for Undergraduates (REU). Mentor graduate students working on Center-related research projects (all Objectives).
### 6. Implementation Plan

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activities/Initiatives</th>
<th>Lead &amp; Team</th>
<th>Timeframe</th>
</tr>
</thead>
</table>
| A. Document existing data for target areas and identify observational and technological requirements to improve and validate models. | • Assess historical and current satellite images;  
• Assess data from recent field campaigns;  
• Integrate satellite data sets with airborne and in situ data; and  
• Incorporate datasets into regional ice sheet models. | Joughin (UW)  
Stearns (KU)  
Lipscomb (LANL)  
Anandakrishnan (PSU) | ✓  
✓  
✓  
✓  |
| B. Design and develop technologies for collecting necessary data. | Develop capabilities to meet scientific requirements including:  
• radar sensors  
• seismic sensor networks  
• UAV platforms  
• cyberinfrastructure  
• in situ instruments | Hale (KU)  
Rodriguez-Morales (KU)  
Fox (IU)  
Gogineni (KU)  
Tsoflias (KU)  
Anandakrishnan (PSU) | ✓  
✓  
✓  
✓  |
| C. Conduct field investigations to collect required data sets. | • Coordinate logistics;  
• Prepare/train/qualify field teams;  
• Deploy equipment/personnel;  
• Conduct field experiments;  
• Conduct preliminary data analysis under field conditions;  
• Recover equipment/personnel;  
• Backup/archive data. | Stearns (KU)  
Hayden (ECSU)  
Link (IU)  
Braaten (KU)  
Gogineni (KU)  
Hale (KU)  
Riley (KU)  
Leuschen (KU)  
Tsoflias (KU)  
Van der Veen (KU)  
Anandakrishnan (PSU)  
Joughin (UW) | ✓  
✓  
✓  |
| D. Process, analyze, and distribute data to modeling groups and the scientific community. | • Accomplish data post-processing;  
• Conduct data analysis and synthesis;  
• Distribute data. | Paden (KU)  
Fox (IU)  
Hayden (ECSU)  
entire IU Team  
Van der Veen (KU)  
Anandakrishnan (PSU) | ✓  
✓  
✓  |
| E. Integrate data and models using state-of-the-art computing, storage, and networking cyberinfrastructure. | • Provide high performance computing and storage systems;  
• Assist with adapting applications to high performance platforms. | Fox (IU)  
Paden (KU)  
Hayden (ECSU)  
entire IU Team | ✓  
✓  
✓  |
| F. Develop diagnostic models identifying processes leading to rapid ice sheet change. | • Model development and validation using both existing and new data;  
• Conduct process studies;  
• Conduct sensitivity studies with simple models. | Van der Veen (KU)  
Fox (IU)  
Braaten (KU)  
Leuschen (KU)  
Stearns (KU)  
Taylor (KU)  
Lipscomb (LANL)  
Alley (PSU)  
Joughin (UW) | ✓  
✓  |
| G. Incorporate improved process understanding into predictive ice sheet models. | • Assess static and dynamic ice sheet conditions;  
• Estimate current and projected sea level contributions from studied regions. | Lipscomb (LANL)  
Van der Veen (KU)  
Parizek (PSU)  
POLLARD (PSU) | ✓  
✓  |
| H. Involve undergraduate and graduate students in research activities. | • Student recruiting (REU, URA, and GRA)  
• Academic monitoring, mentoring, student development toward graduation.  
• Field activities, internships, and other professional development. | All Core University Partners | ✓  
✓  |

August 2013

Strategic & Implementation Plan

Center for Remote Sensing of Ice Sheets
7. Metrics

- Develop technical report addressing observational and technical requirements for target areas; incorporate this information into Science, Sensor, and UAV Project Plans (addresses Objectives A and B).

- Center products (number of technical reports, conference papers, presentations, etc.) outlining sensor, platform, and cyberinfrastructure requirements and specifications; design definitions; and analysis of test results (addresses Objective B).

- Assessment of scientific/technical objectives against field accomplishments in recurring progress reports (addresses Objective C).

- List of new data sets generated and archived, including data volume. Assessment includes an estimated number of researchers using or citing the Center-generated data sets (addresses Objectives D and E).

- Time to distribute data sets (from collection to distribution) is less than 2 years (addresses Objectives D and E).

- Summary of achievements in ice sheet modeling (models developed or integrated, conference or journal publications, presentations, etc.) as outlined in recurring progress reports (addresses Objectives F and G).

- List of graduate and undergraduate students (including student demographics) that participated in research activities (addresses Objective H).

Other Useful Metrics: Center performance across all research objectives is also measured annually during both the EAB meeting and NSF site visits. These assessments are incorporated into the annual progress report.

8. Research Management Plan

Research efforts have been subdivided into six focus areas with assigned leads: F1, Sensors and Signal Processing (Rodriguez-Morales, KU, Sensors and Paden, KU, Signal Processing); F2, UAVs (Hale, KU); F3, Field Activities (Stearns, KU); F4, Satellite Measurements (Joughin, UW); F5, Cyberinfrastructure (Fox, IU); and F6, Analysis and Modeling (Braaten, KU and Van der Veen, KU). Focus area leads coordinate research activities within and across activities, as required.

Research activities dealing with science (Focus Areas F3, F4, and F6) will be managed by the Associate Director for Science (Braaten) and those dealing with technology (Focus Areas F1, F2, and F5) by...
the Associate Director for Technology (Hale). The Associate Director for each area will coordinate the integrated Center activities, assuring effective communication, monitoring schedules and progress, and identifying problems. The Deputy Director and Administrative Manager will work with the Project Manager and the Associate Directors to adjudicate issues, priorities, and resources, as required. Individuals responsible for the details of the various activities in the research plan are identified in the implementation plan table.

Program details are further clarified in project plans for Sensors, UAV Platforms, Cyberinfrastructure, Analysis and Modeling, and Science. These documents are updated annually and posted to the password-protected area of the CReSIS website.

Field program management is further discussed in Appendix A.

EDUCATION

1. Vision Statement for Education
To inspire, educate and train the next generation of scientists and engineers for the Nation in Center-related disciplines.

2. 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.

3. Situational Analysis: Strengths, Opportunities and Challenges

Strengths and Opportunities:

A. World class instructional capabilities of the partner institutions.
B. Contemporary importance of the climate change issue and its impacts on society.
C. Participation of ECSU and ADMI in the Center provides unique opportunities to involve underrepresented populations in science and engineering.
D. Faculty experienced in nurturing and mentoring underrepresented students in science and engineering.
E. Opportunities exist to obtain additional student support beyond resources provided by the Center.
F. ECSU and ADMI can reach a large number of students from HBCUs/MSIs across the Nation.

Challenges and Weaknesses:

A. Coordinating an educational program across all partner institutions.
B. Recruiting from a limited pool of US citizens and permanent residents to science and engineering.
C. Coordinating the development and integration of new courses into the graduate curricula of the four partner research universities.
D. Implementing an effective delivery methodology for courses and symposia.
E. Establishing an effective outreach program for K-12 students and teachers.

4. Goals and Objectives

Goal: To contribute to the development of human resources in science and engineering for the Nation.

Objectives:

A. Develop and teach courses that broaden technical and scientific education across partner institutions using videoconferencing facilities.
B. Integrate Center research into science and engineering undergraduate and graduate courses.
C. 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).

D. Educate students in subjects outside their primary discipline, such as geoinformatics, glaciology, and remote sensing.

E. Provide internship opportunities in industry, national laboratories and internationally.

F. Organize monthly “all-hands” meetings that include presentations on some aspect of the Center’s mission.

G. Engage graduate and undergraduate students in Center decisions through the CReSIS student organization.

H. Increase the pool of underrepresented graduate students through an exchange program, such as REUs between research universities and minority-serving institutions.

I. Enhance and increase relevant science content that is taught in K-12 classrooms.

J. Motivate students to pursue careers in the STEM fields; including reinforcing the necessary foundational skills.

K. Improve teacher knowledge of climate science via teacher workshops and in-service days.

5. Strategies

A. Develop and deploy new or adapted courses that extend and reinforce students’ knowledge of polar science and their understanding of relevant fields (6th grade through graduate) (*Objectives A, B, C, D, and I*).

B. Support and supervise student research experiences (9th grade through graduate) (*Objectives B, C, D, H, I, and J*).

C. Develop seminars and workshops for K-12 teachers to enhance and improve their ability to teach polar science (*Objective K*).

D. Provide opportunities for fieldwork so that students can acquire and practice research skills, work beside scientists and engineers from other institutions, and apply their content knowledge in real-world contexts (graduate/undergraduate) (*Objectives D and J*).

E. Provide students with opportunities to attend workshops and seminars that enhance their content knowledge (graduate/undergraduate) (*Objectives D and J*).

F. Work with our international partners to provide opportunities for students to study/research abroad (graduate/undergraduate) (*Objectives D, E, and J*).

G. Establish and maintain a student organization with shared responsibility for Center recruitment, K-12 outreach, community service, and social networking (*Objectives D, G, and J*).

H. Provide internship opportunities with industry, at national laboratories, and internationally (*Objective E*).

I. Engage K-12 students, parents, and educators through a combination of informal education activities, classroom engagement events, and a more broad public awareness campaign (*Objectives I, J, and K*).
Figure 4. CReSIS’ Meridian UAV design/manufacture integration into the AE curriculum.
## 6. Implementation Plan

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<th>Timeframe</th>
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<tbody>
<tr>
<td>A. Develop and teach courses that broaden technical and scientific</td>
<td>• Support for academic year CReSIS research training; videoconferences with focus on JAVA and Matlab proficiency;</td>
<td>Hayden (ECSU) Course Instructors (all University Partners) Academic Advisors (all University Partners)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>education across partner institutions using videoconferencing</td>
<td>• Develop and provide relevant courses (graduate and undergraduate) to partner institutions via Polycom;</td>
<td></td>
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<td>facilities.</td>
<td>• Encourage graduate and undergraduate students to participate in partner-led activities via current and new technologies.</td>
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<td>B. Integrate Center</td>
<td>• Include Center research in undergraduate and graduate courses;</td>
<td>Hayden (ECSU) Course Instructors (all University Partners) Academic Advisors (all University Partners)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>research into science and engineering undergraduate and graduate</td>
<td>• Integrate classroom goals into field-science requirements.</td>
<td></td>
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<tr>
<td>courses.</td>
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<tr>
<td>C. Expand these courses to other disciplines by leveraging a new KU NSF-</td>
<td>• Encourage students to participate in IGERT programs and lecture series.</td>
<td>Braaten (KU) Lawrence (ADMI) Johnson (ECSU) Hamilton (KU)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>IGERT program known as Climate Change, Humans, and Nature in the Global</td>
<td>• Develop and conduct cyberinfrastructure training;</td>
<td></td>
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<tr>
<td>Environment (C-CHANGE).</td>
<td>• Introduction/advanced remote sensing courses for undergraduate and graduate students;</td>
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<td>• Colloquium series shared across partners;</td>
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<td></td>
<td>• Promote multidisciplinary education through faculty advisors.</td>
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<tr>
<td>D. Educate students in subjects outside their primary discipline, such as</td>
<td>• Continue promoting and participating in industry career fairs;</td>
<td>Hayden (ECSU) Lawrence (ADMI) Johnson (ECSU) Braaten (KU) Gogineni (KU) Hamilton (KU) Anandakrishnan (PSU) Burkett (PSU)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
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<tr>
<td>geoinformatics, glaciology, and remote sensing.</td>
<td>• Encourage faculty to maintain industry contacts and research relationship with industry;</td>
<td>Course Instructors (all University Partners) Academic Advisors (all University Partners) Center Staff</td>
<td></td>
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<td></td>
<td>• Work with our industry and international partners to provide relevant internship experiences.</td>
<td></td>
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<td>E. Provide internship</td>
<td>• Monthly All-Hands videoconferences by undergraduate and graduate students on their research topics;</td>
<td>Hayden (ECSU) Lawrence (ADMI) Johnson (ECSU) Braaten (KU) Gogineni (KU) Hamilton (KU) Anandakrishnan (PSU) Burkett (PSU)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>opportunities in industry, national laboratories and internationally.</td>
<td>• Continue Distinguished and Center All-Hands Lecture Series; disseminate events via Polycom or other web-based services.</td>
<td>Course Instructors (all University Partners) Academic Advisors (all University Partners) Center Staff</td>
<td></td>
</tr>
<tr>
<td>F. Organize monthly “all-</td>
<td>• Monthly All-Hands videoconferences by undergraduate and graduate students on their research topics;</td>
<td>Hayden (ECSU) Lawrence (ADMI) Johnson (ECSU) Braaten (KU) Gogineni (KU) Hamilton (KU) Anandakrishnan (PSU) Burkett (PSU)</td>
<td>✓ ✓ ✓ ✓ ✓</td>
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<td>hands” meetings that include presentations on some aspect of the</td>
<td>• Continue Distinguished and Center All-Hands Lecture Series; disseminate events via Polycom or other web-based services.</td>
<td>Course Instructors (all University Partners) Academic Advisors (all University Partners) Center Staff</td>
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<tr>
<td>Center’s mission.</td>
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### G. Engage graduate and undergraduate students in Center decisions through the CReSIS student organization.
- Encourage an active student organization;
- Hold weekly group meetings on respective campuses to allow students to voice concerns and raise issues, as well as to present successes in an informal environment.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Department</th>
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<tbody>
<tr>
<td>Hayden (ECSU)</td>
<td>Lawrence (ADMI)</td>
</tr>
<tr>
<td>Johnson (ECSU)</td>
<td>Fox (IU)</td>
</tr>
<tr>
<td>Freeman (KU)</td>
<td>Burkett (PSU)</td>
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</table>

### H. Increase the pool of underrepresented graduate students through an exchange program, such as REUs between research universities and minority-serving institutions.
- Provide first-tier internships for students from MSIs;
- Leverage REU and Student Research Opportunities (SROP) programs to bring under-represented students into our graduate programs;
- Host students from MSIs for semester-long exchange programs.

<table>
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<tr>
<td>Johnson (ECSU)</td>
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<td>Freeman (KU)</td>
<td>Burkett (PSU)</td>
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</table>

### I. Enhance and increase relevant science content that is taught in K-12 classrooms.
- Participate in and sponsor outreach activities aimed at K-12 students and teachers;
- Monthly videoconferences jointly led by CReSIS and ADMI students;
- Broader research faculty, student, and staff participation in teacher workshops, outreach activities, and family science nights.

<table>
<thead>
<tr>
<th>Faculty</th>
<th>Department</th>
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<tbody>
<tr>
<td>Hayden (ECSU)</td>
<td>Lawrence (ADMI)</td>
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<td>Johnson (ECSU)</td>
<td>Fox (IU)</td>
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<td>Freeman (KU)</td>
<td>Burkett (PSU)</td>
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</table>

### J. Motivate students to pursue careers in the STEM fields; including reinforcing the necessary foundational skills.
- Assure Center research results are presented at teacher workshops;
- Have research faculty, students, and staff participate in teacher workshops, outreach activities, and family science nights;
- Conduct teacher education activities; encourage faculty to participate;
- Maintain and support an active CReSIS teacher support network.

<table>
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<tr>
<th>Faculty</th>
<th>Department</th>
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<tbody>
<tr>
<td>Freeman (KU)</td>
<td>Lawrence (ADMI)</td>
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<td>Hayden (ECSU)</td>
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<td>Burkett (PSU)</td>
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### 7. Metrics
- Delivery and evaluation of Center subject-related courses (*addresses Objectives A, B, C, and D*).
  - Student evaluation of the perceived course relevance, overall value of course, and effectiveness of the instructor (reported as a numerical score).
  - Number (and titles) of Center subject-oriented courses developed and delivered.
  - Number and demographics of students completing each course.

- Specific instances of Center research integration into undergraduate education (*addresses Objectives A, H, and J*).
  - Number (and titles) of undergraduate courses integrating Center research.
  - Number and demographics of REU program participants.
  - Number of graduate enrollments/degrees earned by former REU program participants.
  - Workshops and other education/research opportunities.
  - Student evaluation of the perceived course relevance, overall value of course, and
effectiveness of the instructor (reported as a numerical score).

- Student presentations/honors at scientific and technical conferences (nationally and internationally) (addresses Objectives A, B, and F).

  Includes:
  - Number and demographics of student presentations at national and international conferences.
  - Number of “first author” students on Center research publications.
  - Number of Center-wide student presentations.

- Internships: Description and evaluation of activities while participating in a Center-sponsored internship (addresses Objective E).

  Includes:
  - Number of internships.
  - Supervisor review and evaluation of internship experience in Industry or with international partners.
  - Student evaluation of internship experience.
  - Resultant publications or activities.

- Description of K-12 activities including numbers and demographics of participants (addresses Objectives I and K).

  Includes:
  - Number of teacher workshops held.
  - Demographics of both workshop participants and the schools they represent.
  - Science/Technology activities for students.
  - Number of teachers engaged in CReSIS teacher discussions.
  - Summer experiences for middle school and high school students.
  - Publications and conference presentations related to K-12 activities.
  - Volume of education web activity.

- Description of activities during international exchange periods, including publications, collaborations, seminars given/attended, courses taken/given, etc. (addresses Objectives C and E).

  Includes:
  - Number of center publications which include international authors.
  - Number and demographics of students participating in outreach activity.
  - Number of international faculty/student exchanges.

- The following apply to all objectives:
  - Number and demographics of Center students successfully progressing through their educational program.
  - Number and demographics of Center students graduating from the Center’s academic program.
  - Student population participating in Center activities, as well as their transitions, which is defined as the progression from one academic stage to the next (e.g., course to next course, high school to college, undergraduate to graduate, etc).

8. Management Plan

The Associate Director for Education and Diversity manages all aspects of the Center’s education program and works with education staff and students at all partner institutions, as required, to coordinate activities and accomplish education objectives.
Education team meetings are accomplished for all partners bi-weekly using Polycom. Attendees include the Associate Director for Education and Diversity, Education Program Coordinators, the K-12 Outreach Coordinator, and education staff leads at all partner institutions. Program details are further clarified in the Project Plan – Education. This document is updated annually and posted at the password-protected area of the CReSIS website.

DIVERSITY

1. Vision Statement for Diversity

To become a national leader in increasing diversity among polar scientists and engineers.

2. Mission Statement for Diversity

Increase the number of students, staff, and faculty from underrepresented groups in science and engineering by fostering an interest in science throughout the K-16 minority community, and among women and individuals with disabilities. Ensure diversity in all aspects of the Center.

Encourage and facilitate involvement of students at our partner and minority serving institutions to pursue graduate education in science or engineering.

3. Situational Analysis: Strengths, Opportunities and Challenges

Strengths and Opportunities:

A. Continued partnership with ECSU and a new partnership with ADMI:

- The Center of Excellence in Remote Sensing Education and Research (CERSER) at Elizabeth City State University (ECSU) continues to be a substantial resource for outreach to a K-16 minority community.

- The Association of Computer and Information Science/Engineering Departments at Minority Institutions (ADMI) has been a collaborator with CERSER/ECSU since 2007 on their CI-Team project and now joins CReSIS as a full partner. ADMI will be able to provide significant “inreach” to MSIs and HBCUs throughout the Nation.

B. Indiana University (IU) provides additional inreach through their MSI Cyberinfrastructure (CI) Empowerment Coalition (MSI-CIEC).

C. Experience with a broader network of supporting programs (i.e., NSF programs, the Science to Achieve Results (STAR) program, the National GEM Consortium, the Louis Stokes Alliance for Minority Participation (LSAMP), partner university-sponsored efforts, etc.) that can support Center diversity efforts has been developed during the initial phase.

D. Opportunity to build on successful Research Experiences for Undergraduates (REU) programs. These evolved into a tiered approach where ECSU focuses on freshman and sophomore
candidates while the major research institutions focus on juniors and seniors.

E. Continued commitment of significant human and financial resources to attain diversity goals. Fourteen percent of the total budget is devoted to supporting research and educational activities at ADMI and ECSU.

F. The Center is focused on research that is topical and has broad societal relevance.

G. Established outreach programs targeting underrepresented K-12 students in regions around our partner institutions (Topeka and Kansas City, Kansas; northeastern North Carolina/southeastern Virginia).

Challenges and Weaknesses:
A. Limited interest in, and participation of, underrepresented groups and women in STEM fields.

B. Social, academic, and financial challenges in transitioning students from our minority serving institutions to graduate programs at partner research institutions.

C. The National competition to recruit talented candidates from underrepresented groups to faculty and staff positions within the Center.

4. Goals and Objectives
Goal: To increase the number of students from groups underrepresented in science and engineering.

Objectives:
A. Recruit and mentor graduate and undergraduate students from a diverse population. Retain 20% of the Center’s students from underrepresented groups and women.

B. Provide research opportunities for underrepresented student populations at CReSIS partner institutions.

C. Provide financial resources for students from underrepresented groups to pursue graduate education.

D. Continue the distinguished scientist and engineer lecture exchange program, allowing educators and researchers at all partner institutions to give seminars and encourage undergraduate students to pursue graduate education.

E. Conduct outreach by participating in conferences, meetings, and science fairs attended by large numbers of underrepresented students to discuss the Center’s research program and opportunities.

F. Assure diversity efforts address issues in K-12 education.

G. Maintain a diverse staff of scientists, engineers, managers, and administrators throughout the Center.

5. Strategies
A. Refine and continue implementing an effective recruitment and retention program that includes middle and high school students, as well as students at community colleges. Leverage existing recruitment programs and personnel at partner institutions (Objectives A and C).

B. Provide research opportunities to students at all partner institutions. Continue to provide summer REU opportunities as the initial gateway to attracting underrepresented undergraduate students interested in graduate school. Build on program successes from the Center’s first phase (Objectives A, B, and C).

C. Continue focusing K-12 outreach and enrichment activities on areas
with large underrepresented student populations (*Objectives A, E, and F*).

D. Leverage additional funding opportunities (NSF, STAR, LSAMP, etc.) with Center funds (*Objectives B and C*).

E. Develop a comprehensive domestic exchange program for faculty, staff, and students that provides educational, personal and professional development opportunities to underrepresented and female students (*Objective D*).

F. Continue to evaluate and participate in opportunities at national conferences and workshops focused to underrepresented and female students (SWE, SACNAS, SHPE, AISES, NSBE, etc.) (*Objectives A and E*).

G. Recruit and maintain a diverse staff. Foster professional advancement among junior staff members with training and professional opportunities (*Objective G*).

### 6. Implementation Plan

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activities/Initiatives</th>
<th>Lead &amp; Team</th>
<th>Timeframe</th>
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</table>

![Figure 6. 2010 Summer REU participants at KU.](image)
| A. Recruit and mentor graduate and undergraduate students from a diverse population. Retain 20% of the Center’s students from underrepresented groups and women. | • Maintain Center personnel database;  
• Update and implement the Center’s recruiting strategy to include new opportunities available through ADMI and IU;  
• Continue and expand the Center’s REU program;  
• Continue participation in select national conferences that focus on underrepresented minorities and women. | Hayden (ECSU)  
Johnson (ECSU)  
Lawrence (ADMI)  
Fox (IU)  
Freeman (KU)  
Lipscomb (LANL)  
Burkett (PSU)  
Joughin (UW) | ✓ | ✓ | ✓ | ✓ | ✓ |
| B. Provide research opportunities for underrepresented student populations at CReSIS partner institutions. | • Update and implement the Center’s recruiting strategy to include new opportunities available through ADMI and IU;  
• Continue and expand the Center’s REU program. | Hayden (ECSU)  
Lawrence (ADMI)  
Fox (IU)  
Freeman (KU)  
Lipscomb (LANL)  
Burkett (PSU)  
Joughin (UW)  
all Center Faculty | ✓ | ✓ | ✓ | ✓ | ✓ |
| C. Provide financial resources for students from underrepresented groups to pursue graduate education. | • Update and implement the Center’s recruiting strategy to include new opportunities available through ADMI and IU;  
• Exploit fellowship opportunities, both internally and nationally, to support fellowship opportunities;  
• Develop a plan for soliciting additional funding from appropriate programs across all potential sources. | Hayden (ECSU)  
Lawrence (ADMI)  
Fox (IU)  
Gogineni (KU)  
Lipscomb (LANL)  
Anandakrishnan (PSU)  
Joughin (UW) | ✓ | ✓ | ✓ | ✓ | ✓ |
| D. Continue the distinguished scientist and engineer lecture exchange program, allowing educators and researchers at all partner institutions to give seminars and encourage undergraduate students to pursue graduate education. | • Develop and implement a comprehensive domestic exchange program that is published as part of the Education Project Plan;  
• Implement academic year research skills training at ECSU;  
• Continue Distinguished and Center All-Hands Lecture Series;  
• Organize and execute graduate school preparation workshop at the ADMI national conference. | Hayden (ECSU)  
Lawrence (ADMI)  
Fox (IU)  
Freeman (KU)  
Riley (KU)  
Lipscomb (LANL)  
Burkett (PSU)  
Joughin (UW) | ✓ | ✓ | ✓ | ✓ | ✓ |
| E. Conduct outreach by participating in conferences, meetings, and science fairs attended by large numbers of underrepresented students to discuss the Center’s research program and opportunities. | • Identify all potential underrepresented minority and female student-focused conferences and workshops;  
• Assess recruiting value at each potential venue;  
• Develop the proposed schedule and supporting budget to support these activities;  
• Publish the calendar as part of the Education Project Plan and execute the schedule. | Hayden (ECSU)  
Lawrence (ADMI)  
Fox (IU)  
Freeman (KU)  
Lipscomb (LANL)  
Burkett (PSU)  
Joughin (UW) | ✓ | ✓ | ✓ | ✓ | ✓ |
| F. Assure diversity efforts address issues in K-12 education. | • Focus K-12 outreach opportunities to school districts with larger populations of underrepresented minority students. | Hayden (ECSU)  
Fox (IU)  
Freeman(KU)  
Hamilton (KU)  
Burkett (PSU) | ✓ | ✓ | ✓ | ✓ | ✓ |
| G. Maintain a diverse staff of scientists, engineers, managers, and administrators throughout the Center. | • Maintain the Center personnel database;  
• Update and implement the Center’s recruiting strategy. | Laverentz (KU)  
Hayden (ECSU)  
Fox (IU)  
Anandakrishnan (PSU) | ✓ | ✓ | ✓ | ✓ | ✓ |
7. Metrics

Progress against these metrics will be reported in the Center's annual progress report to the NSF. Additionally, presentations at both the EAB meeting and NSF site visit will highlight accomplishments in this area.

- Number and type of recruiting activities and contacts made. This information should highlight those events that are specifically organized for recruitment of students from underrepresented minorities and women. Contacts information will include an assessment of follow-up interest after each recruiting event (addresses Objectives A and E).

- Demographics of K-12 school districts supported by Center outreach/education activities (addresses Objectives A and F).

- Demographics of Center participants as compared to national and university averages (addresses Objectives A, B, and G).

- Center financial support directly to (addresses Objective C):
  - faculty, staff, and students from underrepresented groups;
  - female faculty, staff, and students;
  - recruiting events focused to underrepresented minorities and women;
  - exchange activities focused to underrepresented minorities and women.

- List and amount of additional funding obtained by the Center to support activities supporting diversity objectives (addresses Objective C).

- Listing and evaluation of Center domestic exchange opportunities, particularly those at ECSU, with ADMI participants, or that focus to underrepresented minority students and women (addresses Objective D).

8. Management Plan

Implementation of the Center’s diversity strategy will be managed by the Associate Director for Education and Diversity, Dr. Linda Hayden (ECSU). Each partner PI will serve as their organization’s diversity coordinator. The Center Administrative Director shall provide oversight to diversity activities involving the staff.

KNOWLEDGE TRANSFER

1. Vision Statement for Knowledge Transfer

To serve as an internationally recognized resource for ice sheet research and education.

2. Mission Statement for Knowledge Transfer

CReSIS will engage in two-way knowledge transfer that benefits the Center, scientific and academic communities, industry, and the public.

3. Situational Analysis: Opportunities and Challenges

Strengths and Opportunities:

A. Strong portfolio of phase-one knowledge transfer accomplishments that have expanded the Center's visibility.

B. Support from university technology transfer offices. In particular, support from the KU Center for Technology Commercialization and financial and supervisory support from KTEC.

C. High potential for commercial spin-offs of Center-developed, novel technologies.

D. University support through government relations offices to
engage policymakers from local to national levels; this includes access to the Dole Institute of Politics at KU and the Center on Congress at IU that might partner with the Center on activities focused to policymakers.

Challenges and Weaknesses:
A. Rapidly processing, distributing, and archiving tera-byte scale data sets while maintaining the data’s value to internal Center educational and research interests.

B. Selecting and maturing the “right” technology transfer opportunities while balancing those activities with intellectual property considerations and stringent development/field timelines.

C. Communicating a scientifically sound and understandable message to policymakers and the public without advocating specific policy direction.

D. Engaging policy makers and their staff in climate change discussions without stepping over the “lobbying” line; balancing resources to pursue this activity.

E. Working with extremely busy policymaker and staff schedules to develop more substantive engagement activities.

4. Goals and Objectives

Goals:
- To transform an enormous volume of remotely sensed data on ice sheets into new knowledge that can be readily shared.
- To inform the public and policymakers of significant ice sheet changes and outline the implications of these changes on sea level.
- To assist in the professional growth of Center participants.
- To stimulate regional and national economic growth resulting from Center-developed, marketable technologies and capabilities.

Objectives:
A. Disseminate scientific and technical knowledge to peers.

B. Commercialize Center-developed technologies and encourage entrepreneurial activities.

C. Interact with, and provide information to, the general public on ice sheets – their importance and vulnerabilities.

D. Provide information and expertise on climate change issues and their impacts to policymakers and the policy-development process at the state and federal levels.

E. Provide Center participants with unique learning opportunities.

5. Strategies

A. Continue aggressive efforts to produce scientific/technical papers and presentations at relevant international conferences and workshops (Objective A).

B. Continue working with the PolarGRID MRI effort to develop cyberinfrastructure for field and university-based applications that are sufficiently capable to handle near real-time data processing in the field and to accommodate post-field campaign data transfer, processing, backup, and distribution (Objective A).

C. Complete development of a standardized “family” of first-order data processing tools that allow more rapid data processing and product generation for distribution (Objective A).
D. Continue working with appropriate national data centers to archive raw scientific data; synthesized data, and technical information (Objective A).

E. Work with KU’s CTC and LRTC to explore strategies for candidate technology transfer opportunities. Leverage participation by Professor Sanjay Mishra (KU School of Business) to advise the Center in these matters. Similar expertise and advisory services are available at other partner research institutions (Objective B).

F. To the extent possible, make use of all Center participants to engage public audiences on issues related to CReSIS research (in specific) and climate change (in general) (Objective C).

G. Leverage our K-12 outreach efforts to reach a larger audience (parents, educators, and students) and arm them with a baseline understanding of climate change issues (Objective C).

H. Maintain and continue to improve a family of knowledge transfer “tools” that includes the Center website (www.cresis.ku.edu), quarterly newsletter (The Icebreaker), media kits, brochures, and a Climate Change FAQs booklet. Leverage student expertise in journalism, education, and fine arts in developing these products (Objective C).

I. Work with KU and partner university government relations staff to contact appropriate congressional and state delegations (Objective D).

**6. Implementation Plan**

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activities/Initiatives</th>
<th>Lead &amp; Team</th>
<th>Timeframe</th>
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<tbody>
<tr>
<td>A. Disseminate scientific and technical knowledge to</td>
<td>• Continue producing scientific/technical reports and publishing</td>
<td>All Center Faculty and Technical and</td>
<td>6 7 8 9 10</td>
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</table>
peers.

- Continue participation in appropriate scientific/technical conferences and workshops;
- Develop and employ software and hardware necessary to rapidly process, synthesize, and transfer CReSIS-generated data sets;
- Continue work with appropriate archival locations for indefinite CReSIS data storage.

**8. Education Staffs**

<table>
<thead>
<tr>
<th>B. Commercialize Center-developed technologies and encourage entrepreneurial activities.</th>
<th>Mishra (KU)</th>
<th>Fox (IU)</th>
<th>Chakrabarti (KU)</th>
<th>Gogineni (KU)</th>
<th>Riley (KU)</th>
<th>Leuschen (KU)</th>
<th>Tsoflias (KU)</th>
<th>Anandakrishnan (PSU)</th>
<th>Burkett (PSU)</th>
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<tbody>
<tr>
<td>• Conduct market studies of select Center technologies;</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>• Engage the LRTC and CTC to explore technology transfer processes;</td>
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<td>• Begin transitioning select Sensor and Platform Project Plan components to business plans;</td>
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<tr>
<td>• Use KTEC and CTC to explore venture capital options;</td>
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<td>• Host recurring Technology Expos;</td>
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<tr>
<td>• Monitor appropriate Intellectual Property processes and proceed with advice from LRTC/CTC.</td>
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<tr>
<th>C. Interact with, and provide information to, the general public on ice sheets – their importance and vulnerabilities.</th>
<th>Chakrabarti (KU)</th>
<th>All Center Participants</th>
<th>Hayden (ECSU)</th>
<th>new Web Coordinator (ECSU)</th>
<th>Freeman (KU)</th>
<th>Hamilton (KU)</th>
<th>Journalism Students (KU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Organize recurring public climate change lectures, activities, and workshops.</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>• Upgrade, manage, monitor, and assess the Center’s web presence.</td>
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<td>• Develop and produce a quarterly Center newsletter.</td>
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<tr>
<td>• Leverage K-12 outreach events, where appropriate, to reach parents, educators, and students on broader climate change issues.</td>
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<td>• Develop and implement a more rigorous Center communications strategy.</td>
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<table>
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<tr>
<th>D. Provide information and expertise on climate change issues and their impacts to policymakers and the policy-development process at the state and federal levels.</th>
<th>Chakrabarti (KU)</th>
<th>Braaten (KU)</th>
<th>Lawrence (ADMI)</th>
<th>Hayden (ECSU)</th>
<th>Fox (IU)</th>
<th>Gogineni (KU)</th>
<th>Lipscomb (LANL)</th>
<th>Alley (PSU)</th>
<th>Joughin (UW)</th>
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<tr>
<td>• Continue mailings to Congressional delegations for partner institutions to keep CReSIS research visible;</td>
<td>✓</td>
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<td>• Utilize government relations offices, as necessary, to interface with Congressional delegations;</td>
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<td>• Respond to Congressional inquiries, as required.</td>
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<thead>
<tr>
<th>E. Provide Center participants with unique learning opportunities.</th>
<th>Chakrabarti (KU)</th>
<th>Hayden (ECSU)</th>
<th>Fox (IU)</th>
<th>Laverentz (KU)</th>
<th>Lipscomb (LANL)</th>
<th>Anandakrishnan (PSU)</th>
<th>Joughin (UW)</th>
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<tbody>
<tr>
<td>• Resource Center participant professional development opportunities;</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>• Continue coordinating and executing a Distinguished Lecturer/All-Hands Seminar Series;</td>
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<tr>
<td>• Solicit and support industry internships/exchanges;</td>
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<tr>
<td>• Support international exchanges.</td>
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7. Metrics

- Number of peer-reviewed and non-peer reviewed publications, books, conference presentations, and other scientific/technical outputs (*addresses Objective A*).
- Number of invited presentations at meetings, conferences, and
workshops by Center faculty, staff, and students (addresses Objectives A and C).

- Number of posted and/or archived data sets (addresses Objective A).
- Number of patent disclosures or awarded (addresses Objective B).
- Number of start-up companies and associated venture capital funding (addresses Objective B).
- Number of public awareness outreach events (include audience size and demographics, if available) (addresses Objective C).
- Newsletter distribution, new requests, and feedback (addresses Objective C).
- Number of web, Congressional, media (by type – i.e., radio, television, web, etc.), technology transfer/business development, or general public inquiries (addresses Objectives B, C, and D).
- Center visits and/or workshop participation by local, state, national, or international policymakers (addresses Objective D).
- Distinguished Lecturer/All-Hands Series presentations (participation and speaker demographics) (addresses Objective E).
- Participation in professional development short courses and workshops by Center participants (specify whether the course was internally or externally-developed; if internally-developed, provide participation and demographics) (addresses Objective E).
- Internship participation (description of opportunity and participant demographics) (addresses Objective E).
- International exchange/travel opportunities (includes field campaigns; provide description of activity and participant demographics) (addresses Objective E).

8. Management Plan

Knowledge Transfer activities are managed by Professor Swapan Chakrabarti, Associate Director for Knowledge Transfer. Technology Transfer activities are specifically managed by Professor Sanjay Mishra, KU School of Business.

A Knowledge Transfer team meeting is conducted bi-weekly that includes the Associate Director for Knowledge Transfer, the Center Web Coordinator, a K-12 outreach activity coordinator, and representatives from each partner institution. Center efforts are further coordinated with university and organizational communications staffs, to include the NSF’s Office of Legislative and Public Affairs.

Program details are further clarified in the Project Plan – Knowledge Transfer. This document is updated annually and posted at the password-protected area of the CReSIS website.
Appendix A: Field Programs

The Center will conduct field activities in Greenland and Antarctica in order to: (1) collect data sets in areas currently undergoing or expected to undergo rapid changes; and (2) test and optimize sensors and platforms at established field stations. In planning and executing these field activities, participants from all focus areas will interact extensively to collect appropriate gridded data sets with adequate sampling of the key parameters. Airborne surveys will measure surface elevation and ice thickness, image the ice-bed interface, and map deep and near-surface internal layers. Coordinated satellite measurements will provide ice surface velocity. Our in-situ measurements, obtained with a surface-based ultra-wideband accumulation radar and an active seismic system, will provide fine-resolution spatial and temporal variations in accumulation rate and information on subglacial sediment structure and water content. Detailed field work coordination will be accomplished in consultation with the NSF technical management team and the NSF-OPP field support managers. Bi-weekly field logistics coordination meetings will be conducted. These will involve the NSF, Raytheon Polar Services Company (RPSC), CH2M Hill Polar Services, and other appropriate support personnel/organizations. Ms. Judith Riley and Dr. Leigh Stearns at KU will assume responsibility for organizing and hosting these meetings.

Greenland

Our field plans include two airborne deployments in Greenland. The first, an airborne field campaign, is planned during mid-March 2011 prior to significant surface melt occurring in southern Greenland and after sufficient daylight hours become available. The field campaign will involve approximately 100 hours of survey time on the Ken Borek Air Twin Otter aircraft. CReSIS will install a suite of instrumentation, including the Multi-Channel Radar Depth Sounder, the accumulation radar, an ultra-wideband microwave radar, a Ku-band altimeter, and a Novatel DGPS/INS system. In addition to the KBA crew, a team of four to five scientists/engineers will participate in the deployment.

We are also proposing additional testing and validation of the Meridian UAS and radar sensor package in Greenland during late spring and early summer 2011. NEEM Camp is identified as a suitable location for demonstrating UAS field capability. Deployment will last about four weeks and will require a field team of 10 people and UAS transportation; and chain of custody will be managed during weekly logistics planning meetings and an existing structure will serve as the hangar. We expect the deployment to last a maximum of four weeks, beginning mid-July 2011.

Our second Greenland airborne field campaign will survey outlet glaciers in northern Greenland and is scheduled to begin around mid-May 2013. Two options are currently being considered. The first is the 79N glacier in NE Greenland and the second is the Petermann Glacier region in NW Greenland. The final decision on the survey regions will be made in 2012 after consulting with the scientific community, our advisory board, logistics considerations, and the leveraging potential with other funded international field campaigns. We expect logistics requirements to be similar to the 2011 deployment in terms of flight time, deployment duration and the number of personnel required.

Integrated surface-based measurements have been planned for 2013 and will last three to four weeks. These measurements will be conducted from a local field camp with skidoos as well as some helicopter and fixed-wing aircraft support for logistics. The surface-based field program will incorporate a combination of seismic, GPS, and ground-based radar in Northern Greenland and will be based on science outcomes from airborne work. This work will be in
concert/follow-on with the airborne and UAS work.

Antarctica

CReSIS plans two airborne field campaigns in Antarctica in 2011/12 and 2013/14. The 2011/12 campaign is scheduled to begin mid-November 2011 and is expected to last approximately two months. Our target area is Byrd Glacier, which drains a large part of East Antarctica through the Transantarctic Mountains into the Ross Ice Shelf and is believed to be relatively stable. Although some progress has been made in sounding this glacier recently, detailed fine-resolution bed topography that can be generated with CReSIS sounding/imaging radar will benefit a number of investigations. Recent observations suggest that this glacier may be changing more than previously assumed. We will conduct radar surveys with both the Twin Otter and the UAS aircraft from Williams or Pegasus Fields (based out of McMurdo). Due to limitations on Twin Otter flight durations, a refueling cache with a groomed runway will be required at a location near Byrd glacier, preferably at the field camp established to support in-situ measurements. Flight lines will be based on the outcomes of ongoing work by other PIs (in particular the NASA/KU-funded radar experiments). We anticipate a requirement of around 100 flight hours to conduct the Twin Otter surveys. The UAS will have additional requirements similar to those of the 2009 deployment, including a hangar and other infrastructure to support the UAS flights. Our field plans also include integrated surface-based measurements over a three- to four-week duration. Remote efforts will be conducted from a local field camp with skidoos as well as some helicopter and fixed wing aircraft support for logistics. The proposed field plan will incorporate a combination of seismic, GPS, and ground-based radar in the trunk and a lower catchment of Byrd Glacier. This work will be in concert with the airborne and UAS work accomplished during the 2011-2012 field season.

Our second Antarctic deployment in 2013/14 will consider several target outlet glaciers along the Transantarctic Mountains, including Byrd Glacier. The final selection of sites will be made by our science team in consultation with the broader science community. We anticipate that the CReSIS UAS will be ready for routine data collection by the end of summer 2013, and the 2013/14 season will primarily rely on this airborne platform to conduct airborne surveys. However, a request for Twin Otter flight hours will be made based on the progress and status of the UAS in early 2013. The 2013/14 effort will also focus on operating a ground-based phase-sensitive radar at several locations downstream of the grounding line to measure basal melt rates with simultaneous GPS measurements.

Figure 8. The CReSIS Meridian UAS.
Appendix B: Intellectual Property Agreements
This section outlines the policy for handling intellectual property generated by the Center for Remote Sensing of Ice Sheets (CReSIS). CReSIS fosters a close partnership between the center institutions, as well as other academic, government, and industry researchers. Intellectual property is a likely product from many of the research areas within CReSIS, and the intensive interactions between Center partners enabled by CReSIS are likely to result in the generation of intellectual property solely and jointly owned by Center partners. Funding for CReSIS activities comes from several sources, including the NSF, internal sources from within the universities, and contributions from other academic, industrial, and national laboratory sources. In addition, the various institutes may bring significant expertise and facilities that existed prior to the formation of CReSIS.

Our underlying tenet is that intellectual property policy, procedures, and rights will reside with the CReSIS partner(s) responsible for developing them and not with CReSIS itself. Center partners are universities and government laboratories that participate in CReSIS. It is not the policy or responsibility of CReSIS to resolve disputes between institutions participating in CReSIS. Center Institutes may develop technologies that have commercial value.

Situations may arise in which an industrial partner must protect its commercial interests through a nondisclosure agreement with one or more Center Institute(s). When intellectual property is developed that is potentially jointly owned by Center partners, the stakeholders should negotiate typical inter-institutional agreements. Such agreements will be negotiated independently of CReSIS in the usual manner, and then honored by CReSIS. The role of CReSIS shall be to facilitate communications between Center partners and industry, as well as to share technical developments as fully as possible within the usual constraints that govern interaction between industry and academia.
KU will lead the Center with core partners at ADMI, ECSU, IU, PSU, and UW. Key individuals (Associate Directors for Operations) at partner institutions are: Dr. Andrea Lawrence at ADMI, Dr. Linda Hayden at ECSU, Dr. Geoffrey Fox at IU, Dr. Sridhar Anandakrishnan at PSU, Dr. Ian Joughin at UW, and Dr. William Lipscomb at LANL.

As lead institution, The University of Kansas (KU) continues to provide overall direction and management, as well as expertise in radar and remote sensing, Uninhabited Aerial Vehicles (UAVs), and expands efforts towards modeling and data interpretation.

ADMI. The Association of Computer and Information Science/Engineering Departments at Minority Institutions (ADMI) has worked with Center partner, ECSU, since 2006 on their CI-Team grant and joins CReSIS as a full partner in order to expand the program’s reach nationally to more underrepresented groups.

ECSU. Elizabeth City State University (ECSU) and the Center of Excellence in Remote Sensing, Education, and Research (CERSER) contributes its expertise to analyzing satellite data and generating high-level data products. ECSU brings extensive experience in mentoring and educating traditionally underrepresented students.

IU. Indiana University (IU) provides world-class expertise in CI and high-performance computing to address challenges in data management, processing, distribution and archival, and high-performance modeling requirements.

PSU. The Pennsylvania State University (PSU) continues participation in technology development for seismic measurements, field activities, and modeling. Policymaker outreach and some limited K-12 activities are also accomplished.

UW. The University of Washington (UW) provides expertise in satellite observations of ice sheets and process-oriented interpretation and model development.

LANL. Los Alamos National Laboratory (LANL) rounds out the “core” partnership and will contribute in the area of ice sheet modeling.

All partner institutions will be actively involved in the analysis and interpretation of observational and numerical data sets.

An expanded family of international and industrial partners has been identified that provide focused contributions and opportunities for Center programs.
Appendix D: Guidelines for Data Control and Release

The Center will distribute processed data sets to the wider scientific community via Internet-accessible data servers as soon as possible, but usually within one year of the completion of the field campaign. In no cases will the Center purposefully withhold data beyond two years. Raw data sets (Level 0) will be available to the scientific community upon request. It is expected that the National Snow and Ice Data Center (NSIDC) will eventually serve as the long-term archival of all CReSIS data sets and discussions in this regard have already been initiated. A strategy to best establish a long-term (post-CReSIS) data archive is still under development. In addition, PolarGrid, a MRI project separately funded by the NSF, will be part of TeraGrid. PolarGrid is led by Indiana University and Elizabeth City State University in collaboration with CReSIS. Both universities are full partners with the Center. PolarGrid is providing CReSIS with high performance computing for data processing, field data processing capability, and some archiving and community access to CReSIS data sets.