

**National Science Foundation
Science and Technology Centers: Integrative Partnerships Program**

**SITE VISIT REPORT
April 24-26, 2013**

Name of the Center/Award Number:

Center for Remote Sensing of Ice Sheets (CReSIS)/# 0424589

Name of the Lead Institution/Principal Investigator:

The University of Kansas/Dr. S. Prasad Gogineni

Executive Summary

The Panel felt that significant progress has been made in achieving not only the scientific and educational goals of the Center, but also in addressing issues that have been raised in previous reviews. CReSIS advances in the detection of ice thickness demonstrate the Center's ability to apply improved signal processing algorithms to newly-collected data, and to integrate these results with modeling to achieve refined estimates of ice volume, and thus potential contribution to sea level rise. In fact, among the most important and revolutionary scientific findings, the Center's researchers have estimated that sea level rise to the end of the century from Greenland's contribution will be measured in centimeters, not in meters, as previously thought, while the possible collapse of the West Antarctica Ice Sheet (WAIS) remains a concern.

Unmanned aerial system (UAS) developments continue to be an exciting advance made possible by interdisciplinary research at CReSIS. The Center's scholarly publication output has increased substantially in quantity and in overall impact. The Panel was greatly impressed with the enthusiastic participation of students from the Center's partner universities. The Panel agreed that CReSIS programs for the mentoring and educational experiences of underrepresented minorities, and the K-12 Education and Outreach Program, are highly meritorious in their efforts to create a human resources pool for the future Science, Technology, Engineering, and Mathematics (STEM) workforce.

CReSIS has begun to address, and continues to work on, building a robust sustainability plan. The Panel encourages the Center to also include a robust succession plan for the personnel involved in CReSIS to ensure the present level of engagement and cohesive managing skills are maintained. The Panel appreciated the integration of undergraduate and graduate students in research activities, though it became clear that participation is not spread evenly over the partner institutions. University of Washington (UW), University of Kansas (KU), Penn State (PSU) and Elizabeth City State University (ECSU) are the main collaborators. This apparent asymmetry in collaborative efforts made itself evident as only the academic leadership of KU and ECSU were present for the Panel's teleconference with senior administrators, one objective of which was to discuss what efforts these institutions will make to secure support for the Center after Science and Technology Center (STC) support goes away.

Concerned about CReSIS' future, the Panel recommends the Center to make an effort to maintain visibility. The Panel sees great potential for the development of profitable technologies in various instrumentation fields, but not enough efforts placed on using this potential to develop a viable funding source. We were pleased to learn during this site visit that KU is making progress on providing support to CReSIS in their pursuit of diversification of future funding sources. We hope to see signs that other CReSIS institutions recognize the importance of funding diversification.

In summary, the Panel agreed that NSF found a winner with this program. Funding it as a Center has had a synergistic effect. The value added will be felt in the scientific community for decades to come, in terms of our understanding of ice sheet processes, sensor development, data collection, and creating the next generation of engineers and scientists who will go forward in a wide range of technical fields.

- **Leadership and Management Plan**

The Leadership of CReSIS has demonstrated an ability to maintain engagement among the partners, and a commitment to the Center's goals. The Panel was pleased to see that CReSIS has, for the most part, satisfactorily responded to comments from previous reviews. However, going forward we encourage the Center to develop a robust leadership succession plan that maintains the same level of dedication, engagement and cohesive management skills into the future.

Communication between organizations appears to be improved. The elevation to a University Center of Excellence at KU is starting to lay the foundation for the transition beyond NSF funding of the STC. However, what does it mean to CReSIS in terms of visibility and internal support? ECSU also demonstrated a level of commitment to CReSIS activities beyond official STC funding. How will the end of NSF STC funding be handled at the other member institutions? We were also encouraged by the development at KU to initiate a program to seed new ideas. What are other institutions doing in that regard?

We would encourage management to start driving and encouraging its members to be more aggressive concerning the transition by starting to put out proposals now. This is one of the most effective things management can do at this point. It often takes a year or more to get a proposal funded. In the present budget climate with government cut backs, it is none too soon to start submitting proposal applications. We would like to see more potential customers such as commercial entities, as well as exploring international sources of funding if possible (e.g., Centre National d'Etudes Spatiales (CNES) or European Space Agency (ESA); taking into account International Traffic in Arms Regulations (ITAR) of course). Dissemination of data is very important, but that will not be possible if there is no funding to maintain these wonderful tools and databases that have been laboriously gathered. We recommend the Center develop a method for supporting such an effort to help pay its own way.

The Center has established an excellent involvement and training ground for the engineers and scientists of the future. This could be lost if there is not an aggressive plan put in place to obtain

funding to help support graduate candidates, undergraduate projects and outreach activities. If students see no future support, the supply pipeline may dry up.

- **Integrative Nature of CReSIS**

By design, CReSIS brings together a number of institutions with different strengths and research capabilities representing a wide cross-section of the country and the student population. Through collaborative research leading to an important set of peer-reviewed publications, CReSIS has proven that the real value of the Center's research and education work arises from the integration of efforts from its diverse component units. Academically and thematically, the Center has provided a unique combination of work in fields spanning from electrical engineering and aeronautics to remote sensing, glaciology, oceanography and climatology. This interdisciplinary aspect of CReSIS should be commended and if possible preserved as the Center moves beyond the 10-year NSF support period. Future proposals to NSF or other agencies should address interdisciplinary as well as technology transfer components in addition to basic research activities.

Although research, development and educational activities appear to be significantly integrated within CReSIS, there is perhaps less connectivity at the highest level of management representing the partnering institutions. This may simply reflect the proportional level of funded activity in some of the institutions where a PI may function more in a contractor-like fashion and less as a true Center partner with full institutional support of the overall Center's activities and overall goals. This discrepancy or asymmetric participation may have significant impact as present funding sources wane and new support is sought for sustaining a robust activity into the next decade. As an example, this committee was surprised that only the leadership from KU and ECSU was available to meet with us during this review. This could be interpreted as a red flag.

Thus, the Panel is concerned that in the future some of the 'no show' institutions may become increasingly detached from the realities of the Center and eventually cease to participate. It is important that the leadership of those institutions are contacted by the Center to ensure the connections still exist and are robust, as they should be for a healthy partnership to continue.

- **Intellectual Merit of CReSIS**

The interdisciplinary character of CReSIS is one of the hallmarks of its success. Scientists and engineers work together among partner institutions on complex tasks ranging from the design of antennas for extreme environments, to the construction of unmanned aerial systems (UASs) that remotely monitor the movements of glaciers and ice sheets. Collecting these data has enabled CReSIS to identify the central processes behind rapid ice sheet change.

CReSIS has the potential to offer significant contributions to the incorporation of ice dynamics processes in predictions of sea level rise, a need identified by the scientific community in the 2007 IPCC report. Airborne techniques have allowed CReSIS to provide much-needed remote sensing data that have improved the glaciological community's ability to model rapid ice sheet change in remote and complex environments.

Presentations during this site visit showcased CReSIS development of hardware that significantly improves the amount and the quality of data collected from ice sheets; in some cases, these improvements dramatically impacted results of basin-scale models. CReSIS is also making significant contributions to modeling, by providing higher resolution bed topography. Advances in signal processing algorithms also allow CReSIS to extract valuable internal layer and snow accumulation data from radar measurements.

The UAS and antenna developments are made possible by interdisciplinary research at CReSIS. The 2012 hard landing of a UAS appears to have created opportunities in design improvements that will improve the safety and testing capabilities of future UAS deployments. The Panel was also pleased to see the effective integration of the MRI-funded anechoic chamber into CReSIS work. Significant data processing and distribution efforts are moving forward to ensure the large quantity of data collected by these instruments can be used within CReSIS and distributed in a usable form to the greater scientific community.

As the NSF funding for CReSIS is reduced in years 9 and 10, we hope the Center will aggressively and clearly connect these significant advances in understanding to ice-sheet and climate models. These should be clearly identified contributions to the scientific community's ability to predict future sea level rise.

We appreciate the significant strides CReSIS has made in generating publications. We hope CReSIS will give more thought to how to ensure sufficient acknowledgement of the use of CReSIS data and results in publications by both CReSIS members as well as non-members. The Panel was particularly impressed with the highly motivated, highly skilled students who participated in the site visit.

The Panel sees great potential for the development of profitable technologies in various instrumentation fields, but not enough efforts have been made to date to transform this potential into a viable funding source. We appreciate the apparent commitment at the University of Kansas to investigate commercializing these technologies, and we would welcome similar commitments from other partners.

- **Broader Impact: Integration of Research and Education**

The mission statement of CReSIS' education program is (a) to educate and to train a diverse group of students to participate and lead future research in international, multidisciplinary, polar science, and (b) to provide opportunities and paths for students at all levels to pursue careers in science and engineering. CReSIS clearly and impressively fulfills this mission through a wide range of activities including mentorship of graduate and undergraduate students, and extensive K-12 outreach and education.

The Panel appreciated the thorough integration of undergraduate and graduate students in research activities. Especially impressive was the incorporation of University of Kansas students into the research process through applied research experiences in classrooms and undergraduate capstone and thesis projects. What is CReSIS doing to assess the impact of this integration on

students? Dr. Hale offered anecdotal evidence of student success, but is it possible to measure this impact in a more rigorous fashion to improve future integration of research and education?

At the K-12 level, the development of an evaluation plan with a suite of tools by the Kansas State University Office of Educational Innovation and Evaluation (KSU OEIE) enables the assessment of impact for diverse activities. These instruments should continue to be employed as time permits, given staff time and responsibilities; the Panel recommends implementation of these instruments at institutions other than Kansas. As CReSIS funding from NSF enters its last two years, we suggest that time be prioritized for a strategic review of current educational assets (as suggested in Evaluation Question #6), including an analysis of content within lessons relative to teacher needs. Factors justifying this review include the impending transition of CReSIS initiatives to a more replicable and sustainable form, and the recent release of the new Next Generation Science Standards (NGSS). A review could identify opportunities to highlight CReSIS technologies given the new emphasis on engineering in the standards and identify the most effective materials for alignment with the NGSS. Questions to address may include, “What are the best materials to retain, if not all”? “What is the best method of disseminating them?” and “How can current staff time be leveraged for more national impact?”

For instance, can the excellent practice of “training the trainer” initiated by Ms. Hamilton to train teachers in the KU area be employed by both Ms. Hamilton and Dr. Hayden to train CReSIS Education Coordinators at partner institutions? This practice will leverage the scope and impact of exemplary summer middle school, Freezing Fridays and teacher professional development programs, and help build and sustain knowledgeable staff across the Center.

Revisions to the web site and to the Media Guide will facilitate dissemination of knowledge to a broad public audience. National outreach is an area which may need strengthening and collaborations within the education field such as disseminating classroom lessons through the Climate Literacy and Energy Awareness Network (CLEAN) or university portals might be investigated. The geographical distribution of CReSIS partners should help in this effort.

- **Broader Impact: Integration of Diversity into NSF Programs, Projects, and Activities**

CReSIS programs for the mentoring and educational experiences of underrepresented minorities interested in careers related to polar science, as well as the K-12 Education and Outreach Program, which aims to create a human resources pool for the future Science, Technology, Engineering, and Mathematics (STEM) workforce, are highly meritorious. Student participants were enthusiastic and skilled spokespeople. The leadership by ECSU in this area has been noteworthy and the team is to be commended for the improvements to their diversity program since the last panel review. The panel also appreciated the improved definition and tracking of data on program participants. Results of diversity program impact remains an important need, and avenues to fund quality evaluation efforts should continue to be pursued. We would also like to see institutions partnering with ECSU work toward improving and maintaining their own efforts to mentor underrepresented minorities.

The panel feels that a “Best Practice” paper should be developed to disseminate the success of ECSU’s approach to increasing underrepresented groups in STEM to both partner institutions and to research projects interested in attracting underrepresented candidates into their programs. Recent CReSIS efforts to develop new courses reflecting workforce needs and to disseminate course content to partner institutions will aid the diversity of majors, as well as broaden geographic impact.

- **Broader Impact: Partnerships and Knowledge Transfer**

Communication between organizations appears to be improved from past years. The elevation to a University Center of Excellence is starting to lay the foundation for the transition. However what does that mean for the other member institutions? What does it mean to CReSIS in terms of visibility and internal support? The member institutions appear to be taking a more active and coordinated role as compared to prior years. How will that collaboration be maintained?

The website as presented was much improved and we look forward to additional upgrades. In addition to ongoing maintenance of a current publication list, a summary of degrees bestowed at all levels should be compiled and published there as well. The Center may consider increasing the number of interactive “games” or other means of involving youth.

The knowledge gained appears to be quickly applied to practical implementation. There appears to be great emphasis on knowledge transfer which is admirable. However, in the remaining 2 years and in consideration of the tightening of budgets worldwide and here in the US, more consideration should be given on how to recoup expenses for that transfer. The Center should consider developing a topical workshop which addresses transition of research results, intellectual property, and copyrights to industry. NSF recently alerted PIs to submit a proposal on transitioning research results to industry, which the Center should investigate further. CReSIS can also identify some Small Business Innovation Research (SBIR) opportunities from some of the government agencies, as well as the NASA Innovative Advanced Concepts (NIAC).

- **Value-Added of Funding the Activity as a Center**

NSF found a winner with this program. Funding it as a Center has had a synergistic effect. The value-added will be felt for decades to come, in terms of data collected, overall understanding of ice sheets in the broader polar earth science community, sensor development, and creating the next generation of engineers and scientists who will go forward in all sorts of technical fields. This will only occur if an aggressive effort is applied to the transition to self-sufficiency. The program has progressed tremendously since its inception, and the Panel had the sense that CReSIS and the scientific community are finally beginning to reap the full rewards of this effort.

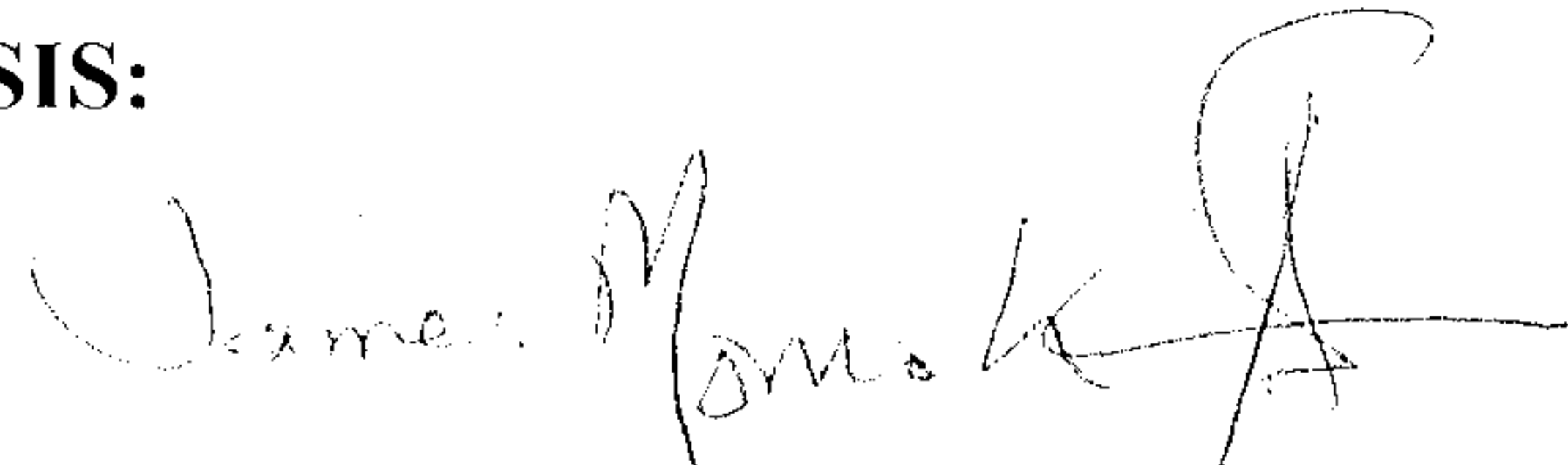
The amount of science, student involvement and graduate work shows a vigorous growth and potential for the future. In fact, a clear value of CReSIS as a multi-institution center, besides the research integration benefits, is the improved identification, mentoring, exposure and availability of underrepresented students for participation in a variety of undergraduate and graduate programs at partnering institutions. Reciprocal benefits include availability of research and

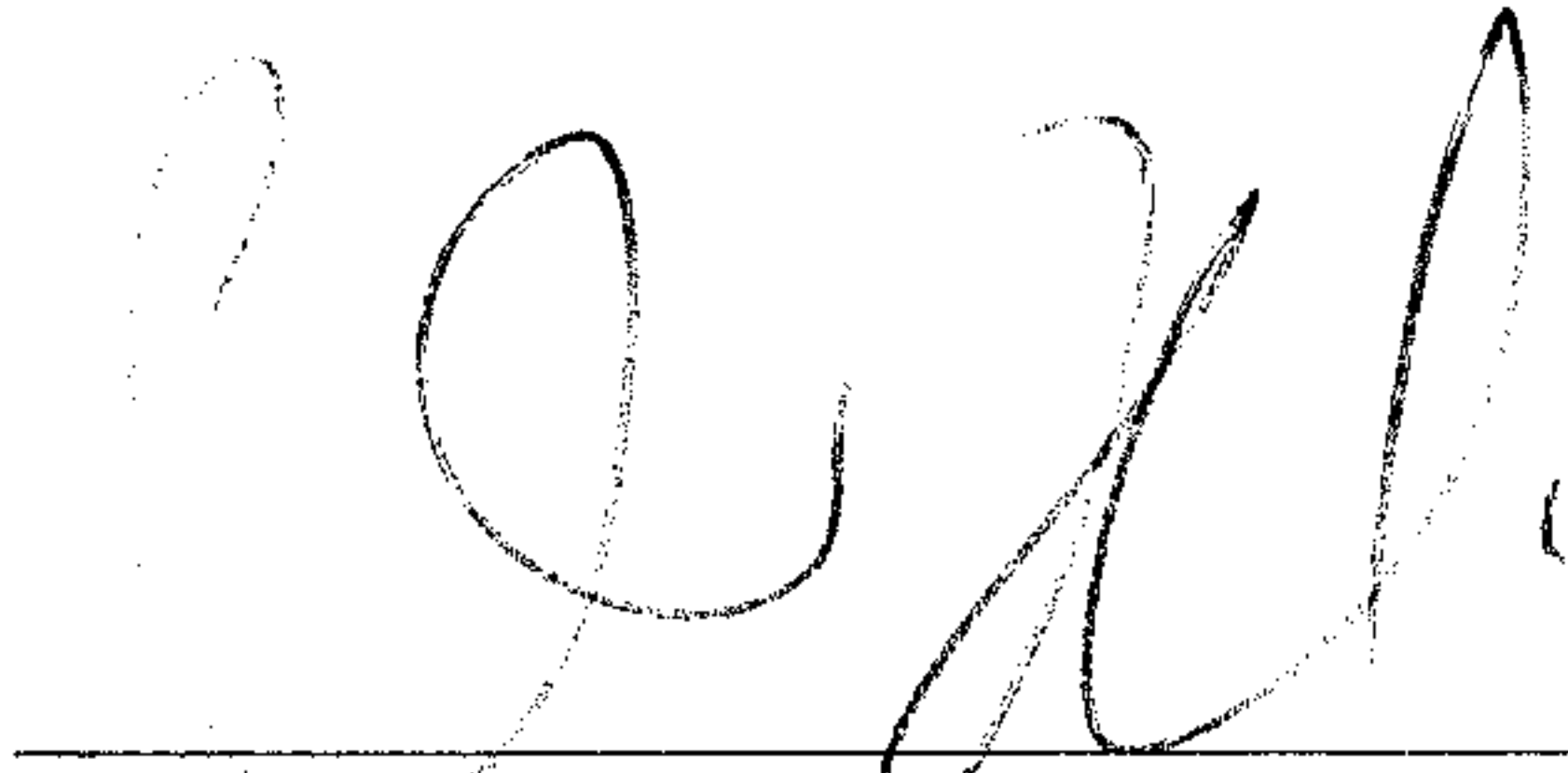
educational programs and facilities that provide prospective students with a wide selection of scientific fields, geographical choices and career paths to choose from. For example, it is clear that ECSU recognizes the positive influence the partnership with larger campuses has had on its programs and students.

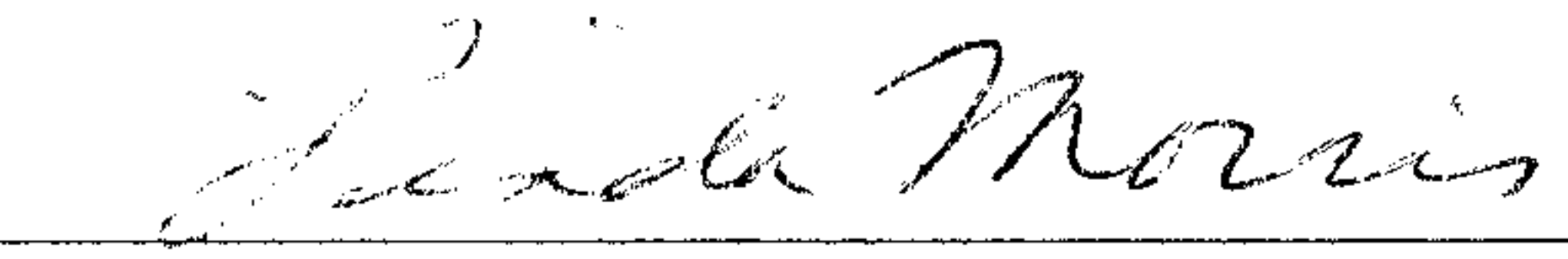
It is imperative that the program not lose its momentum. Center management has to provide the primary leadership in determining strategies for maintaining and growing the Center's capabilities. It needs to maintain a strong, respected and creative management and support staff, both at the University of Kansas and at partnering institutions. The Panel would like to see a well-developed personnel section in future sustainability plans. The Center has the tools and head start to maintain its pre-eminence. During the next two years, NSF should continue to closely monitor the progress on the Center's transition to the post-STC era.

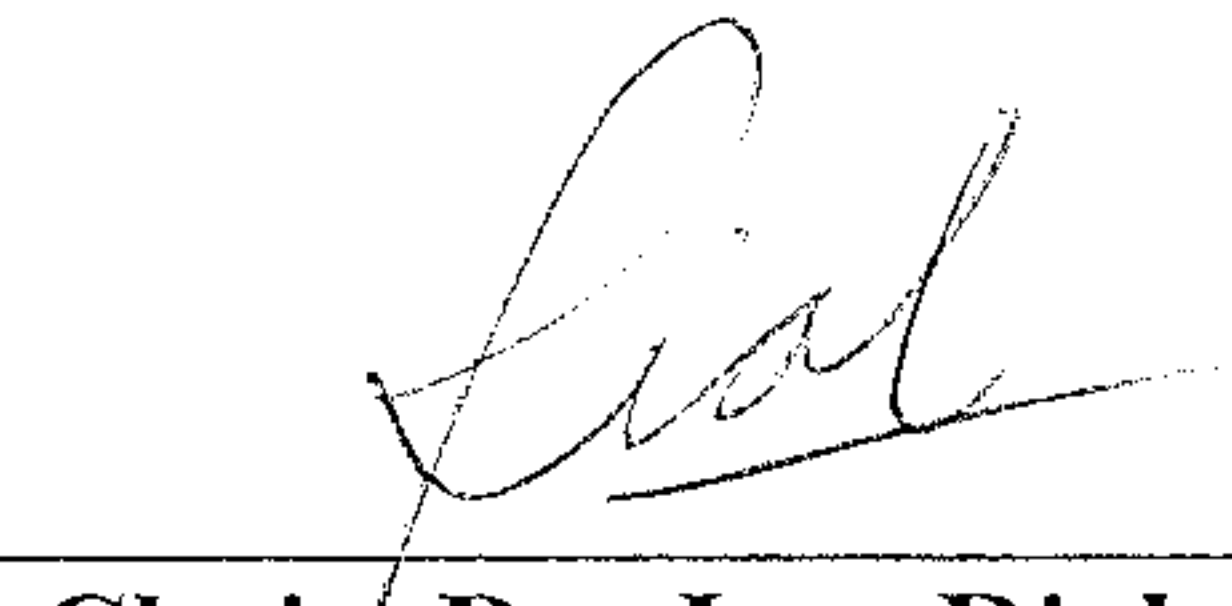
Signatures of the STC Site Visitors for CReSIS:


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