Sense and sensibility

Remote sensing researchers **Drs Linda Hayden** and **Malcolm LeCompte** discuss their work towards facilitating a diversity of projects, ranging from characterising Antarctic ice sheets to discovering lost colonists

Welcome back Dr Hayden! Since our last encounter, how has your Cyberinfrastructure for remote sensing of ice sheets: Research Experience for Undergraduates site (CReSIS-REU) project progressed?

LH: The last article appeared in the August 2012 issue of *International Innovation*. That issue was devoted to the *Frontier of the Future: how North American research is creating a more sustainable tomorrow*, and it also featured an article by Kelly Kenison Falkner from the National Science Foundation (NSF) Office of Polar Programs. We have a new Arctic and Antarctic (AaA) grant for 20 undergraduate students to conduct research under the mentorship of a polar scientist. We are now working to provide a glacier exploration for additional REUs. AaA was jointly funded by the NSF Arctic Programs Division, Antarctic Programs Division and the Office of Naval Research. It also includes funding to engage an additional five pre-service teachers each year in polar-related educational research experiences. Our partnerships continue in cyberinfrastructure with Indiana University and in remote sensing, the Department of Defense and Seaspace Corporation.

The dynamics and overall mass balance of an ice sheet can be determined from accurate measurements of its area. What tools do you utilise in this assay?

ML: We use remote sensing satellite image data to determine changes or placement errors in a previously established (circa 2003) grounding line – a boundary distinguishing a floating ice shelf and the grounded ice that feeds it. We compare archived Landsat image data dating back to 1972 with more recent imagery to both validate the circa 2003 grounding line and reveal any long-term changes.

A more comprehensive understanding of the cryosphere leads to improved climate modelling. How is your cross-disciplinary approach improving this knowledge base and therefore the overall predictive capacity of models?

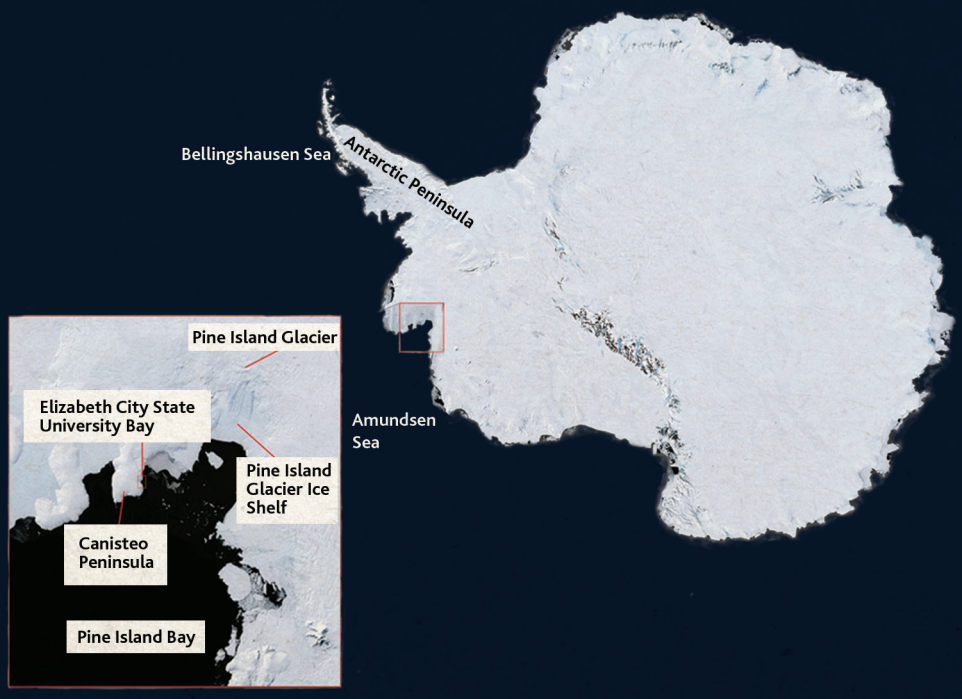
ML: Our efforts contribute to improving basic knowledge of cryospheric processes by comparing the 30 year record of Landsat imagery of Antarctic with a benchmark grounding line dataset. The grounding line is used to determine ice sheet area, a critical parameter in determining ice sheet mass

The power of observation

Researchers at **Elizabeth City State University** have been responsible for introducing many prospective scientists to successful careers in the fields of remote sensing, cyberinfrastructure and polar science, as well as helping to deliver some fascinating results from their student research projects

UNDER THE INFLUENCE of a warming world, the ice sheets appear to be shrinking, slowly raising the level of the world's oceans. Just because this statement is true, however, does not make it representative – this process is very complex, and involves exact atmospheric, oceanic and ice dynamic conditions that are all co-dependent and difficult to predict. Most scientists agree that the rise in sea level by 2100 is likely to be around 1 metre, but some say it could be as high as two. These predictions have been made by utilising the best available models, and much rides on the accuracy of their predictions. Efforts to improve models are facilitated by acquiring improved data for model validation. The data may be acquired by *in situ* measurement or the tools of remote sensing.

99 per cent of the Earth's land ice is found in just two places: Greenland and Antarctica. These regions are monitored using satellite observation, and in recent years these data have shown that several ice shelves in West Antarctica have either disintegrated or are in the process of doing so. The loss of ice shelves is correlated with the acceleration



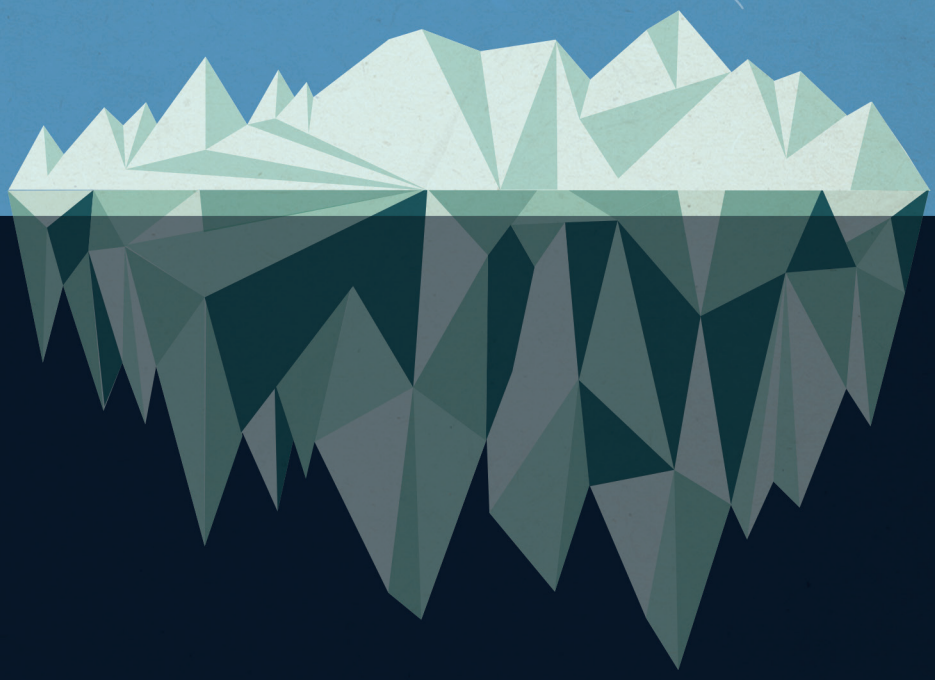
balance. Improving grounding line accuracy provides an improved basis for ground truthing predictive model results.

The Larsen B ice shelf has experienced substantial ice loss in recent years. Why is this troubling? Pine Island, located southwest of Larsen and equivalent in size to two-thirds of the UK, is a key study site for Elizabeth City State University (ECSU) scientists. What are you learning about this vulnerable region?

ML: The Larsen A and Larsen B ice shelves were believed to be retarding the flow of grounded ice into the ocean. As a result of their disintegration (notably the breakup of Larsen A in 1995 and then the Larsen B in 2002), the ice streams that once fed them are no longer retarded and subsequent measurements indicate their movement velocity has in fact increased. If the accelerated movement of grounded ice into the ocean is not compensated by an increase in accumulation at source, global sea level is likely to rise more rapidly. The Larsen ice shelves are near the northernmost extent of the Antarctic continent and so likely to be warmer than portions of the continent that lie further south. However, ECSU students and other researchers have observed and reported an ice shelf, and other marginal ice, retreating in Pine Island Bay, much closer to the South Pole than the Larson shelves (and therefore a colder clime). The small bay, whose ice shelf was determined by ECSU students to have disappeared in 2003, is now known as ECSU Bay.

Dr LeCompte, you have been instrumental to the ECSU Bay project. What is its mission and how are you ensuring its success?

ML: The ECSU Bay project is essentially complete. My role as Research Mentor was to make sure the students understood what we were attempting and the analysis methods used, as well as to ensure our work was reported in the scientific literature. We now have a graduate student conducting similar work examining the archived Landsat image data record of the Antarctic Peninsula. His results may also be publishable based upon what he has found so far. Other polar researchers have recently approached us with offers of collaboration in their particular research projects. So, in brief, the strategy is to now expand the scope of our previous work and promote involvement with other polar research projects, forming collaborations with other polar scientists.



of the ice streams or glaciers that act to diminish the vast inland ice sheets. What is even more troubling is that the rapid changes being observed cannot be explained using most existing ice sheet models.

FACING A CReSIS

Since 2005, the Center for Remote Sensing of Ice Sheets (CReSIS), a consortium of universities, led by the University of Kansas, and including Elizabeth City State University (ECSU) in North Carolina, Indiana University (IU), Pennsylvania State University and the University of Washington, has been working to remedy this problem. IU and ECSU have also been responsible for delivering new cyberinfrastructure to researchers in these remote areas through the PolarGrid project, as well as demonstrating that synthetic aperture radar can image the beds of ice sheets, enabling a new generation of high-resolution ice sheet models with realistic boundary conditions.

But perhaps the most refreshing aspect of CReSIS is that a portion of the research conducted in its name is contributed by undergraduates, as part of the research experience for undergraduates (REU) programme. The academic year research training involves ECSU students while the summer programme has served more than 11 minority serving institutions (MSIs) and 20 non-MSIs. What is more, this is only one of the REU opportunities offered by ECSU, as part of the Center of Excellence in Remote Sensing Education and Research's (CERSER) remit. Thanks to this empowering facility, ECSU and non-ECSU undergraduates can participate in hands-on polar research. Over the past four years, a number of accomplishments have developed from REU projects, many of them helping to shape the scientific understanding of ice dynamics – and most of them overseen by aficionado's ECSU computer science professor Dr Linda Hayden and CERSER research fellow Dr Malcolm LeCompte.

ICE TO SEE YOU

The majority of the work CERSER shares with its students revolves around better understanding changes to the ice sheets in Greenland and Antarctica. As well as having a bay named after the university when the ice shelf and that they had been observing there disappeared, REU students have gone on to conduct independent research in this field.

Left to right: David Braaten, Jerome Mitchell and SivaPrasad Gogineni.

INTELLIGENCE

CENTER OF EXCELLENCE IN REMOTE SENSING EDUCATION AND RESEARCH

OBJECTIVES

To provide academic year and summer research training and research opportunities in the areas of cyberinfrastructure, remote sensing and polar science with an emphasis on underrepresented minorities.

KEY COLLABORATORS

Dr Geoffrey C Fox, Distinguished Professor of Computer Science and Informatics, Indiana University, USA • **Dr Sivaprasad Gogineni**, Distinguished Professor, University of Kansas and CReSIS Director, USA • **Dr Andrea Lawrence**, Associate Professor and Chairman, Department of Computer and Information Sciences, Spelman College, USA • **Dr Robert Bindschadler**, Emeritus Scientist, NASA Goddard Space Flight Center, USA • **Professor Eric Klingelhofer**, Mercer University and First Colony Foundation VP for Research, USA • **Charles Luther**, (retired) former Scientific Program Officer, Office of Naval Research and past President IEEE Geoscience and Remote Sensing Society, USA • **Edward 'Clay' Swindell**, Museum of the Albemarle (MoA) Collections Specialist and Archaeologist, USA

PARTNERS

Center for the Remote Sensing of Ice Sheets (CReSIS) • **Office of Naval Research** • **National Geographic Society** • **First Colony Foundation** • **SeaSpace Corporation** • **MoA** • **IEEE Geoscience and Remote Sensing Society Chapter** numbers 03191 and 66221

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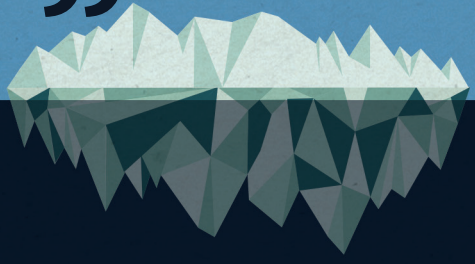
ECSU
ELIZABETH CITY STATE UNIVERSITY

> **"I have had the honour of working with Dr Linda Hayden and ECSU for seven years with a focus on supporting the cyberinfrastructure of CReSIS under the inspiring leadership of Dr Sivaprasad Gogineni. A highlight has been the involvement of undergraduates trained by Linda in my research. Currently we have four Master's and one PhD student (Jerome Mitchell) from ECSU enrolled in IU's School of Informatics and Computing. We continue to host several undergraduates every year in our summer Undergraduate Research programme and expect five to attend this summer"**
>
> Distinguished Professor
> Geoffrey Fox, Indiana University



Dr Malcolm LeCompte and graduate student Michael Jefferson with GPR device.

REU alumni Jerome Mitchell and Theresa Stumpf, for example, are both pursuing PhDs at CReSIS institutions – and they were also both honoured with the NASA Earth and Space Science Fellowship in 2012, which was awarded to fewer than 17 per cent of all applicants.

Stumpf was responsible for installing and testing the CReSIS radar systems on NASA's P-3 aircraft at Wallops Flight Facility. She then assisted in collecting radar data while surveying the Beardmore, Lennox King and Nimrod glaciers. Stumpf enthuses: "The CReSIS REU Program allowed me to begin working with an expert in radioglaciology (Dr Gogineni) and watch him use his gifts to make substantial contributions to science – that made me want to be a better engineer." Mitchell had a similar experience on the West Antarctic Ice Sheet. "My experiences provided a solid foundation for thinking independently and writing technical literature, which has been a necessity for me thrive in my PhD programme," explains Mitchell.

THE LOST COLONY

In a second and starkly contrasting group of projects, the CERSER researchers are using ground penetrating radar (GPR) to settle some contentious points in the study of American history. Their first target, in collaboration with the Museum of the Albemarle, was to investigate an important site related to the Culpeper Rebellion. This colonial revolt took place in 1677, a century before the American Revolution, and was the first to oppose English sovereignty. The lab's assistance proved instrumental in elucidating the events of this historical confrontation between crown and colonists, and when the museum undertook a new project in collaboration with the First Colony Foundation and the National Geographic Society, they naturally invited CERSER to assist them once again.

This project aimed to answer a longstanding mystery within America's colonial past: the fate of the Roanoke colonists. In the late 16th Century, a group of British colonists settled in a coastal region of what is now North Carolina. Arriving on Roanoke Island in 1587, the 100+ group of settlers, hoped to make a home in the alluring 'New World'. Mysteriously, only three years later, they all disappeared without a trace; their deserted camp was discovered by a subsequent group bearing supplies from England, and the only clues as to what had happened were the words 'cro' etched into a nearby tree, and 'croatoan' carved on the settlement's gatepost.

ECSU remote sensing students and scientists may have provided essential assistance in uncovering the answer of their disappearance. With the same GPR system that used radio waves to explore the Culpeper site (quite similar to those used for investigating polar ice sheets), the team of researchers, under the supervision of LeCompte, has been able to detect subsurface features that may represent buried evidence of the lost colony. The CERSER group also provided aerial and satellite multispectral image data analysis of the targeted location and its surrounding area, as well as a GPR survey, and the evidence for previously unknown early colonial habitation at the site is strong. As LeCompte points out, however: "Only excavation will reveal the true nature of what was observed by the GPR".

A CHANCE TO SHINE

As well as solving mysteries of the past and answering questions of the future, these REU projects play a vital role in ensuring that STEM research opportunities are available to all. With women accounting for 42 to 63 per cent of REU students over four years, and minorities 58 to 89 per cent, it is clear that CERSER is serving prospective scientists of every background – as well as the scientific community and society at large.