January 11, 1957 - Crevasses look quite small - just a foot or two wide. They do not all run in the same direction as pictures will show. I'm sure some of the crevasses must be 200 or 300 ft wide. The weather out is beautiful. Clear skies. Temperature here at 2 miles is 20 degrees. Looking out the windows of the place you can see for miles with nothing breaking the flat mountainous area except the bump marks and scars of the crevasses. To see another color other than white would be the eighth wonder.

Bill Stroupe wasn't fazed too long by the unending swatches of snow. There were generators to run, sleds to unpack, tractors to pull, and buildings to construct. And after all, he was from Pennsylvania.

“It didn't linger with you. You take it all in and then you're busy doing work and you don't have time to write poetry about it,” he said. By the time he wrote in his diary about the crevasses from above, he had already traversed them on the ground. He had started the long journey home to his wife and his newborn daughter Elizabeth, who he hadn't yet seen after over a year on the ice.

Stroupe volunteered to go to Antarctica with the Navy in 1955 as a part of “Operation Deep Freeze.” At that time the United States pushed to establish science support camps throughout the continent for the International Geophysical Year. The area then known as Marie Byrd Land existed in a particularly prime location between the coastal Little America V camp and Thwaites Glacier. Before he knew it, Stroupe was riding a giant red army tractor over lightly-packed crevasses zigzagging somewhere along the 80-degree latitude hopping to establish the first Byrd Camp.

Stroupe's only motivation for shipping out on such a heavy mission? “I've never been there,” he told his recruitment officer.

He, along with a team of Navy personnel, one meteorologist, and a Disney Studios photographer, trailed a reconnaissance group along 400 miles of broken ice across Ross Ice Shelf from Little America V, which they had just established the prior winter. The leading team stuffed the crevasses with snow and then the “tractor train” followed by pulling five D8 tractors and attached bobsleds of construction supplies across the precarious surface with a rope.

One officer, Max Kiel, had died during a prior reconnaissance trip when his tractor fell into an unstable crevasse. After that, the team used sonar-like crevasse detectors to secure their passage. Still, Stroupe remembers the outside parts of the path cracking under the tractor's weight and vibrations like old pavement on the shoulder of a highway. “If you're not careful and that ridge collapsed, you're going down in that gulley so to speak,” he said.

At noon on December 23, 1956, the caravan arrived at its projected location. The crew immediately began unpacking the palette sleds containing all the materials needed to put together the four buildings planned for the site. By 1 in the morning, the first structure - a meteorology building - established Byrd Camp as officially open for business.

Fast-forward five decades. A large LC-130 aircraft descends over Byrd Land. From the sky small mounds appear. Fifteen or so colorful buildings puncture the snow in perfectly spaced lines. The precision in such a remote area looks impossibly organized - the modern wonder of Byrd Camp.

“It has sort of an oasis feeling,” said CReSIS student Cameron Lewis, who recently ventured to Byrd Surface Camp with the Twin Otter team this winter. “It’s just a group of tents in the middle of absolutely nowhere.”

The camp has come a long way since Stroupe and his colleagues slapped together the
MISSION ACCOMPLISHED FOR UAV TEAM IN ANTARCTICA

// BY ASHLEY THOMPSON

Eight KU aerospace engineering professors and students rang in the New Year on cloud nine, after celebrating the night in something of an unorthodox fashion, sans a standard toast or Times Square countdown. With minutes to spare before the clock struck midnight, they celebrated the success of their unpiloted aerial vehicle’s (UAV’s) first flight in Antarctica.

“We got back to the plane’s hangar around 12:15 a.m., and just noticed the time and said, ‘Oh, hey, Happy New Year!’” said Bill Donovan, chief designer of the UAV and PhD student.

Bizarre work hours were just part of the ground-breaking, 46-day mission for the UAV team during the 2009-2010 field season at McMurdo Station. The Meridian UAV/UAS has been crafted since 2005 for flying in Antarctic conditions. After numerous test flights in September and October 2009, and five tests of the smaller-scale Yak-54 UAV in Antarctica this December, the year culminated with one giant goal being reached.

The flight lasted 20 minutes, 14 of which were fully autonomous. After validating autopilot system functionality statewide at both Fort Riley, Kansas, and Dugway, Utah, the team needed to test all the surprises that present themselves in a harsh Antarctic environment, including visibility for the on-ground pilot, drag, and system compatibility once the CreSIS UAV radar was installed in the wings.

Shortly before departing for McMurdo, the Meridian’s paint job was applied, which was designed by Donovan with the idea of enhancing visibility as much as possible. The red and white design allows the pilot to easily determine the direction it’s going, and if the plane is slanting toward or away from the pilot. Lance Holly, who piloted one of the Yak missions and has been working on the Meridian since 2003, said the paint job was of surprising importance.

The five Yak missions also provided answers to key questions about the Meridian’s capabilities in Polar conditions. Each flight test would put different functions and follow vastly different flight patterns, for example. During one test, the Yak completed a large circle, the same pattern they had planned for the Meridian’s debut in the sky. Another mission sent the Yak three miles away from the ground station and back, to test its ability to follow a track. Another test brought a sense of what a radar mission would be like, as the Yak followed a grid pattern over a large area. But the proof is in the pudding, as Hale says. And once airborne, the Meridian responded as expected.

However, there were a few unexpected bumps in the road -- something that a pair of skis could have smoothed out perfectly. Two runways are situated close to McMurdo -- one skiway ideal for, not surprisingly, vehicles installed with skis, and one icy runway, ideal for wheeled vehicles, such as the Meridian. However, the Meridian’s hangar sat 1.5 miles away from the start of the icy runway. This meant trudging through divots and bumps that proved perilous with its small wheels. Next time, the crew will arrive with skis in tow, prepared for the trying trek.

The 13-mile journey from McMurdo Station to the hangar also introduced complications due to the team’s night shift, as they wanted to avoid daytime air traffic at the runway. Transportation options were a reservations-only shuttle or snow mobiles. However, finding a driver to pick the crew up anywhere from 10 p.m. to midnight was difficult, as was finding enough snow mobiles for all eight of them.

These small hindrances paled in comparison to delays caused by moody weather. This Antarctic summer season was said to be one of the snowiest and most severe in a decade. “We didn’t have quite as many flyable days as we expected,” Hale said. “We dealt with a lot of high winds and low-visibility situations. And the extra snow made transportation from the hangar to the runway much more difficult than usual.”

“We were too close to the ground to collect meaningful data, but for the first time the radar was turned on full-power, and everything worked great.”

- DONOVAN

Still, the crew saw enough flyable days to verify every component with the small-scale Yak UAV to ensure a confident test flight with the Meridian. And downtime back at McMurdo was filled with holiday-themed events such as Ice Stock, a music-filled New Year’s celebration, and an all-you-can eat lobster tail dinner. “I think some of us ate more lobster tail on that night than we have in our entire lives,” Donovan said. Now that’s worth toasting to.

The team departed McMurdo on Jan. 12, satisfied with the progress but knowing much work lies ahead. First will (likely) come another series of flight tests within the U.S. And Hale said he has goals to simplify the experience with the Meridian in the field, including reducing the amount of required ground crew. For the next mission in Antarctica, the group, whatever size it may be, might look a little different, as some students prepare to move on post-graduation. Thus, Hale must train the next round of students for flight test activities.

And for Donovan, the next time around promises to be a smoother, more efficient operation.

“Some days were just spent troubleshooting things that we of course won’t have to troubleshoot in the future,” Donovan said.

And a pair of skis wouldn’t hurt, either, as they aim to reach cloud nine once again.
Cameron Lewis knows what West Virginian mining towns are all about. He has family there, and has spent his fair share of holidays in rural pockets of the Mountain State. His 2009-2010 holiday season, at first glance, didn’t have much different of a feel, Lewis said. Over Thanksgiving he found himself in “a dusty town” with a couple of bars. The landscape was barren, save for harsh, icy mountain peaks on the horizon.

But then a group of Adelie penguins would come into view, and the structure of the whole analogy comes crashing down. Welcome to McMurdo Station, Antarctica. “It really is best compared to a mining town,” Lewis said of McMurdo, but it subsists in an entirely different manner. Here, it’s all science, all the time. Literally.

“It’s just one giant day down here,” said Logan Smith, who accompanied Lewis to Antarctica this field season. The sun barely sets, and the same can be said for the work schedule the CReSIS team kept up for three months on the West Antarctic Ice Sheet (WAIS).

Smith and Lewis, both Electrical Engineering PhD students, worked alongside Indiana University’s Chad Brown and CReSIS professors Fernando Rodriguez-Morales and Carl Leuschel in conducting aerial surveys of WAIS. PolarTREC middle school science teacher Gary Wesche also accompanied the crew. They arrived in McMurdo on Nov. 16, when unpacking and logistical preparations took place. Weather difficulties forced them to remain in McMurdo two weeks longer than they had planned, but the team soaked up luxuries such as running water while they could. Next stop -- Byrd Camp.

Reopened in December 2009 after closing down in January 2005, Byrd consists of 60 tent plots, a few RAC tents for meeting areas, dining halls, and twoouthouses. McMurdo had spoiled the CReSIS crew with dorm-like accommodations and proper beds. If McMurdo was a mining town, Byrd was an off-the-grid cabin. Rustic - yes.

IN ROUND-THE-CLOCK WORK

Dusty - no. CReSIS members were the very first guests in the all-new facilities, intended to alleviate some of the hectic overuse at WAIS Camp, which sees an upwards of 100 researchers per field season.

“Byrd is really enjoyable once you get used to not having some of the typical luxuries,” Rodriguez-Morales said. He has been to Antarctica but has never stayed outside of McMurdo Station.

Byrd provided close proximity to the large swath of ice (roughly the size of the Western United States) the Twin Otter DCH6 would fly over to collect data to create a holistic view of the ice bed. The CReSIS team collected diverse data by mounting three unique radar systems on the aircraft: the Multi-Channel Coherent Depth Sounder (MCoRDS), the Accumulation Radar (ALCA Snow Radar), and the KU Band Altimeter. The capabilities and specialization of each is key to measuring the ice sheet with progressively finer resolution.

The MCoRDS, the new generation depth sounder radar, penetrates almost four kilometers of ice to the bedrock. New features that had been put to the test only once previously (on the DC-8 IceBridge mission), include a more complex measurement process that digitizes data from each individual antenna. Six antennas were mounted under the Twin Otter’s wings.

“Think of it as a person having six eyes -- you could see much more of your surroundings,” Rodriguez-Morales said. “And if you close one eye, you’ve still got several other angles.”

Placing the antennas on the wings introduces more complexity to processing the data because it requires motion compensation of the plane’s own movement. “Because of the Twin Otter’s smaller size, it was necessary to use the wing space to spread the antennas out enough. We wanted to maximize the swath we were looking at,” Lewis said. “The replica system that went on the DC-8 mission didn’t have to be mounted on the wings because the aircraft’s body is so much bigger.”

The Accumulation Radar penetrates to depths of 200 to 300 meters, and provides year-by-year snow accumulation measurements. The Altimeter Radar provides a measurement of the distance between the plane and the ice, with down-to-the-centimeter accuracy. The team also installed a GPS on board during flights, which had been built and tested by a CReSIS crew during the fall. Lewis monitored both the accumulation and altimeter radars during flights while Rodriguez-Morales monitored the depth sounder. Days for both of them began at 7 a.m., ending anywhere between 5 p.m. and 10 p.m. with at least eight hours of flight time each day if the capricious climes allowed it.

Meanwhile, Smith and Indiana University’s/Polar Grid’s Chad Brown stayed back at Byrd. Smith processed data from the previous day’s flights during the day. Approximately 80 percent of the data collected could be viewed and analyzed in the field, but much finer data processing techniques must be implemented to create the final data products; these are expected to be available within the next year.

Once the aircrew returned for the evening, Brown would begin the lengthy, all-night process of backing up terabytes of data on several different systems to ensure its safety. Work wouldn’t stop unless nature hindered flight plans. Even on down days, there was always requisite catching up to do -- be it in processing, backing up data, or building an impressive igloo, in Lewis’ case. “Working on my igloo was the only time I got sunburned.”

The team targeted particular segments of WAIS, most of which had not previously been measured by CReSIS, and flew over them in a grid pattern. Because of the extent of the area measured, grids took several days to complete. The Twin Otter’s size limited
UNIVERSITY OF MAINE PROFESSOR RETIRES

Terrance Hughes of the University of Maine has retired from teaching as of January 2010. Hughes celebrates a forty-year career in glacial studies. His work on ice streams and modeling helped emphasize key areas of change in the Antarctic and Greenland continents.

Hughes' fascination with ice began when he joined the Institute of Polar Studies at Ohio State University, now Byrd Polar Research Center. Hughes said he signed on as a glaciologist at Ohio State for one purpose: the chance to see Antarctica. This desire surely demonstrates the poles' magnetic attraction: A trip to the Mertz Glacier in 1968 snowballed into more than a dozen treks to both Greenland and Antarctica over his career.

A topographical map of Antarctica published in 1970 by the American Geophysical Society changed Hughes' motivation from adventure to concern. Hughes noticed on that map that the West Antarctic Ice Sheet (WAIS) had a concave surface profile. This shape concerned Hughes because concave profiles could indicate glacier instability. He compared basal draw, or bed resistance, to a pancake:

"If you take some pancake batter and scoop it up and put it on a griddle, it will spread out in a way that the overall profile of the pancake is convex. The reason it has that profile is because the griddle resists that spreading. When you get ice that is afloat, you don't have any resistance on the bottom side. These icebergs will have a constant thickness, a flat surface," he explained. Hughes worried then that this concave property meant the ice sheet was in transition from a sheet into a more unstable floating ice shelf.

Although Hughes modeled WAIS, he studied the Byrd Glacier in Antarctica and the Jakobshavn Ice Sheet in Greenland first-hand in the field. These glaciers contain the fastest flowing ice streams on their respective continents. In recent years, Hughes has shifted his focus to the ice shelf calving mechanisms and oceanic currents that may drive the quick flow of these glaciers. Hughes brushes off his hand in evolving the field of glaciology with modest assessment. He is quick to pinpoint scientists with whom he collaborated and the students he has mentored.

CReSIS GRADUATE STUDENT EXCELS IN AEROSPACE PROGRAM, DC-8 WORK

Arnold first began work on the DC-8 project by assisting Dr. Richard Hale as an undergraduate research assistant her freshman year. She eventually led the design for the fairing structures that housed CReSIS antenna. This position challenged her as an engineer and a colleague. She mentored other undergraduate students while designing, analyzing, and manufacturing the parts in less than three months. Arnold said the team used the "brute force method" during this time. They didn't necessarily create the most attractive-looking components, but their parts got the job done. This method also applied to Arnold's dedication to the project. Dr. Hale said that at any given time of day either he or Arnold were working on the project.

“Most of my ideas are wrong. Only a few have stood the test of time,” he explains. Instead, he finds the most pride in disseminating scientific skills to young scientists.

“Where I get my greatest satisfaction is seeing the success of students by being their advisor or teaching their courses. Seeing the success of those students is carrying on the tradition to another generation. That’s what lasts.”

Hughes will continue his CReSIS involvement in the coming months by modeling how ice flow across a gap in the Transatlantic Mountains could lead to rising sea levels. He intends to keep publishing as ideas strike him.

For now though, Hughes has swapped the remote expanses of the poles for the rural landscape of South Dakota. He grew up on a cattle ranch near Ft. Pierre and always intended to return. His current home on top of the bluffs overlooking the Missouri River offers a bucolic view containing herds of buffalo, antelope, and deer. He also enjoys being able to spend more time with his wife.

“I couldn't ask for a nicer retirement for what I have,” said Hughes. <&>
“Hopenhagen” was the word that greeted John Harrington, Jr., when he arrived at the COP15. The large green letters plastered everywhere contrasted with the warnings he had received before he left his small Kansas college town for the United Nations Climate Change Conference. Don’t anticipate rigorous scientific discourse, his colleagues cautioned told him. Expect a circus.

Harrington, professor of Geography at Kansas State University, traveled to the big tent of the Bella Center on behalf of the Association of American Geographers. He outlined his experience during C-CHANGE Colloquium Series talk co-sponsored by CReSIS at the University of Kansas on January 21st. Harrington said he attended the COP15 to build his “street cred” when communicating with Kansas organizations about climate change. He got just that – Harrington waited in line outside the conference hall for two days before obtaining one of the 15,000 spots in the Center. Harrington attended as a non-governmental observer, meaning he could not attend political talks but could observe some presentations.

“As an NGO, I was the lowest life-form there.” – Harrington

Harrington still had a leg up on many. Approximately 40,000 people showed up hoping for access to the conference. The symposium proved lively behind closed doors and in public spaces. Outside, protestors demonstrated their environmental concerns through various means, such as dressing like trees and carrying signs saying, “No Forest Fraud.” Inside, political talks truncated as each country, big and small, juggled their concerns among that of others.

Harrington said that rift between developing countries and developed emitters stalled discussions. Developing countries formed a “Group of 77” to act as one concerting, included voice. Primarily, they wanted a two-degree limit on global temperature increases. This goal relaxed the one and half-degree limit outlined in the resulting Copenhagen agreement in the upcoming 2010 Mexico and 2011 South Africa conferences.

Harrington described the decision as a “top-down affair” that does not anticipate rigorous scientific discourse, his colleagues cautioned told him. Expect a circus.

“Some countries were really ticked. They felt like they wasted two week there,” Harrington said. He questioned whether many representatives came to the conference on their own behalf or for the better of the planet. The words “Hopenhagen” retained some progress, however: Demark purchased carbon offsets for the entire conference by funding new infrastructure for more efficient, sustainable brick-making in Bangladesh. Alleviating tensions between economically disparate countries represents just one remedy for environmental problems. Harrington presented the climate system as an analog to a patient’s yearly physical exam. He demonstrated that these “earth symptoms,” as he called them, swing on an undefined trapeze. Recent increases in the rates of changes debunk former projections about the climate threshold, he said.

“We don’t know what those tipping points are. We used to think it was higher up. Business as usual is worst than we thought it would be.”

He blamed the complexity of the climate system and our own personal experiences for hindering action towards these upswings in environmental change. The large temperature fluxes we feel each season downplay our understanding of seemingly small but powerful global temperature rises.

“We have tremendous noise in our climate system. A slow upward trend is not something we’re keyed into,” he said, comparing humans to a frog in a slow-boiling stove pot. He added, “Global change is much more than just climate change.”

Harrington outlined what he considers the most urgent challenges to sustainability. As world population grows to a potential 9 million by 2050, food sources must require less water and meat. Any change in our energy resource will last for decades. Even if energy moves away from fossil fuels, that change will take at least 10 years to develop and implement. Education must emphasize biocomplexity instead of reductionism in terms of human and natural systems. Overall, Harrington stressed the need for climate progress beyond politics. He said the issue depends as much on economics, private business, and education as on policy.

In the end, Harrington said, politicians, engineers, businesses, and the public alike need a stronger prescription of “gaiaphilia,” or love of the planet. <<

PAPER ON GREELAND ICE SHEET PRESENTED AT COP15

Several CReSIS-affiliated researchers contributed to a report on the Greenland Ice Sheet that was presented during the final weekend of the UNFCC’s COP15 conference in Copenhagen.

Dr. Dorthe Dahl-Jensen, Centre Leader of the University of Copenhagen’s Centre for Ice and Climate, was listed as convening lead author. She presented at the Bella Center on Dec. 14, 2009, alongside former Arctic Council Chair and Danish Foreign Minister of Affairs Dr. Per Stig Møller. The presentation, entitled “Melting Show and Ice, a Call for Action,” outlined preliminary results of the SWIPA project (Snow, Water, Ice, and Permafrost in the Arctic), established by the Arctic Council in April 2008.

CReSIS professor Kees van der Veen is listed as a lead author of the report, entitled “The Greenland Ice Sheet in a Changing Climate,” and contributed to the glacial modeling section 3.2. In chapter 5 of the report, contributing author Thomas Overly, MA student in Geography at CReSIS, drew from his experiences doing ethnographic fieldwork in coastal Greenland to outline potential socio-economic and cultural implications for the Greenlandic people. <<
CRESIS PREMIERES NEW RADAR DEVELOPMENTS DURING NASA PROGRAM

// BY KATIE OBERTHALER

The whole concept sounds like the start of a trite joke: How many scientists does it take to screw in an antenna?

Quite a few, it turns out, if the antennas are clinging to the bottom of a gigantic jet in subfreezing temperatures zooming 1,500 feet above the ground.

During the months of October and November, CReSIS participated in the largest airborne survey ever conducted over a polar region. They joined over fifty scientists from various organizations in Punta Arenas, Chile as a part of NASA’s Operation IceBridge program.

The CReSIS field team consisted of Dr. Chris Allen, Lei Shei, Victor Jara-Olivares, William Blake, and Ben Panzer of KU, and Keith Lehigh from Indiana University. Dr. Richard Hale, Emily Arnold, John Hunter, Jared Anderson, Conner McMullen, Kevin Shipley, Jim Rood, and Mike Brennesson from KU’s Aerospace Engineering department designed the fairing structures to hold the antennas and helped with radar installation in California before deployment. Jill Hummels from the KU School of Engineering joined the team in Punta Arenas to document their activities.

The diverse crew in Chile transformed a 157-foot DC-8 aircraft into a flying laboratory: An airborne topographic mapper, a laser altimeter, a gravimeter, a digital mapping camera, a bevvy of GPS instruments joined, and three CReSIS radar systems all pointed their signals towards the ice as the aircraft conducted 12-hour flights over Antarctica while stationed in Chile.

These instruments acted as an understudy for a NASA satellite that will soon dismantle. ICESat-1 has collected elevation data for Antarctic ice sheets and sea ice since 2003. Its successor, ICESat-II, will not launch until at least 2014. Ice Bridge serves to fill the gap between these two events. “We would be blind without these measurements,” said Seeyle Martin, chief scientist for the Ice Bridge mission, in a teleconference on October 8, 2009.

Satellite measurements still run laps around aerial surveys in terms of land coverage, but what Ice Bridge lacks in range, it compensates for in depth.

Enter the Multi-Channel Coherent Depth Sounder, stage right. The large DC-8 set the perfect platform for CReSIS to debut its latest radar system, called MCoRDS for short. The MCoRDS signals penetrate down two kilometers to the bedrock to map its topography below the ice.

When asked the difference between this radar and the previous radar system, Lei Shei, electrical engineering graduate student, says to prepare for “a mouthful.”

The MCoRDS radar contains eight separate signals, or “channels,” which engineers call the heart of the radar. Each channel communicates with a corresponding antenna. On the DC-8, five antennas rested on the belly of the aircraft and three monitored electromagnetic interference (EMI) on the inside of the aircraft. Previous radar systems struggled to reign in the energy sent out by these antennas. With the MCoRDS system, Shi’s “mouthful” reveals seemingly magical feats: scientists can perform clutter rejection, beam-steering, and wave-form shaping. This dizzying litany essentially means that the system narrowly squints eight very knowing eyes to see one point. MCoRDS is less heart and more retina.

“It’s like having eight radars in one enclosure,” said Victor Jara-Olivares, electrical engineering graduate student who helped operate the radars in flight.

MCoRDS gives scientists more control over their signal to finely locate points below the ice, such as a groove carved into the bedrock by a flowing glacier. This precision remained critical for the Ice Bridge program. The DC-8 covered the whole neighborhood of glacial real estate. It flew over the interior Antarctic ice sheet, outlet flows, sea ice, floating ice shelves, and ice tongues.

“We can focus the beam on what we’re interested in, instead of a mountain off to the side,” explained Shi.

Ice Bridge didn’t want to just cover mountains and valleys, though. The team also wanted to make sense of the patterned coastal sea ice. That’s how Ben Panzer ended up looking out over crystalline, perfectly-formed icebergs and nunatak mountain peaks jutting up from miles upon miles of ice for the first time.

Scientists and crew pose outside of the DC-8 aircraft.
Panzer, a graduate student at KU, recently developed the KU Ultra-Wide Band Snow Radar. The radar worked in tandem with the airborne topographic mapper to measure the surface thickness of sea ice. It’s a fortuitous name, but “KU” refers to the radar’s frequency, not the University of Kansas acronym. Panzer also operated the third radar system, called the KU Band Altimeter. Graduate student Aqsa Patel developed the altimeter, which calculates the distance from the airplane to the ground.

Radar can’t measure below the water’s surface, but scientists know that about ninety percent of sea ice remains underneath the water. The Snow Radar surface measurement allows scientists to predict the thickness of the remaining sea ice.

The Snow Radar, along with the gravimeter operated by Lamont-Daughtery Earth Observatory, will help break up some of the unknown properties about sea ice and ocean movements in the cryosphere system. The DC-8 flew over the Weddell and Amundsen Seas, as well as Pine Island Bay. Although scientists generally regard Antarctic sea ice as less dramatic and more stable than its rapidly-changing Greenlandic counterpart, these areas contain complex feedback systems that are not yet well-understood.

Bringing the survey down a few stratospheres provided finer details of all of the ice features surveyed by the DC-8. Thorsten Markus, principal investigator for Ice Bridge, said in an interview posted on the Ice Bridge blog, “ICESat does not have radar, so in this regard we are getting a value-added product in Ice Bridge. In an ideal world, people would put a radar altimeter together with a laser altimeter - something you can do on a plane, but not as easily on a satellite.”

The trip marked Shi and Panzers’ first time in the field. They both spent their summers in 2009 helping CReSIS members almost nonstop in designing and building the radar systems. Shi said troubleshooting during MCoRDS construction and testing incited his nerves.

“People hype up field problems. I was just anxious to know what they were,” said Shi.

Shi’s anxiety quelled once he got into the regular rhythm of long flights and short naps. The MCoRDS system worked well overall. Unlike other teams, CReSIS members didn’t have to scramble to calibrate their systems or keep their equipment warm overnight. The bedrock appear as a vibrant rainbow of recorded signals on their radar screens. The extra time let them take in the surreal white view blanketing these colorful targets.

Panzer said the Antarctica mountains especially surprised him. “I didn’t expect to see so much rock. It’s a desolate place, but I was glad I was 1,500 feet above it rather than on the surface,” he said.

Many of the scientists’ colleagues were on that surface this summer. Ice Bridge’s base in Punta Arenas offered an atypical field experience for first-timers. Some veteran field researchers expressed a combination of wistful longing for the remote field camps and gratitude for more civic surroundings. No one complained at the respite of fresh Chilean meals, a steady stream of coffee during those long flights, and a warm hotel bed to crash on every night.

CReSIS members enjoyed the unusual field logistics because they received an in-depth glimpse into research and methods of other science teams. Even the most sleep-deprived, bleary-eyed data processors found some awe in others’ work.

“People get excited about the various things going on, and it helps motivate you,” said Dr. Allen.

Allen also said the interaction provided a good bellwether for how prepared and organized CReSIS members had come. Plenty of hands and minds also meant smoother troubleshooting when systems went awry, or workers’ strike stopped the flow of fuel and hardware. Sometimes, you just can’t anticipate all the field hazards.

Panzer said, “You’re out there living and breathing this stuff...it’s always good to talk things over with someone.”

Other scientists literally talked over the MCoRDS radar on the airplane. The MCoRDS was a sort of glitterati on a private jet. “The computer screen mounted on the University of Kansas’ radar rack is a popular in-flight gathering spot since it provides a real-time view of the radar data that allows us to ‘see’ the bottom of the glacier while we fly over it,” Michael Studinger, co-principal investigator from Lamont-Doherty Earth Observatory wrote on the Ice Bridge blog from the field.

Story Source: www.nasa.gov - Operation Ice Bridge website and blog.
Credit: Kathryn Hansen, Science Writer, NASA Goddard Space Flight Center; Micheal Studinger, Lamont-Doherty Earth Observatory; Jill Hummels, Public Information Officer, KU School of Engineering; Seeyle Martin, Chief Scientist, University of Washington.
The PSU team poses among the hilly terrain of their remote field camp. From left to right: Luke Zoet, Don Voigt, Leo Peters, Sridhar Anandakrishnan, Knut Christianson, Mike Javred, Rebecca Boon, and Jim Koehler.

made them easier to move and use. They also showed effective noise reduction in the data. The team expressed pleasant surprise over the clear signals recorded by the geophones. With these improvements, the team covered up to 7 kilometers of land per day. In past years, they could only record data over about 3 kilometers per day.

These explosions will help the team demystify the bedrock topography, what Christianson refers to as “the smoking gun of ice sheets.” Although outlet glaciers such as Thwaites react to atmosphere and oceanic factors, the rock platform drastically alters the glaciers’ movements.

“How they respond is very much a function of what’s underneath – what they’re sliding over, what they’re moving over,” said Sridhar Anandakrishnan, professor of geosciences at PSU.

From what the scientists can tell so far, Thwaites presents a topographically diverse profile. The bedrock varies greatly over a distance of even 20 kilometers. Christianson said he was especially surprised at the rolling hills the team encountered this year just on the surface. These field observations will translate into more complex theoretical views back in the lab.

“When people build a model of a glacier, they tend to have a very uniform picture of the bed. What we’re finding is that it isn’t that way,” said Anandakrishnan.

In addition to seismic data, a CReSIS team flew a Twin Otter over 300 kilometers of the Thwaites site to obtain high resolution radar data of the area. The PSU team will compare the two types of data to form a defined picture of the glacier from many angles.

The team won’t be returning to Antarctica, but PSU researchers will conduct seismology research on Jakobshavn Glacier in Greenland this summer. They’ll study supraglacial lake drainage might contribute to the ice sheet’s increasing velocity.

PSU scientists use a tracked vehicle to coordinate georod cables on Thwaites Glacier.

The team’s research success comes not just from data acquisition. Fighting an unforgiving environment with adaptable personalities makes all this science possible in the first place. Anandakrishnan said managing a group of people as diverse as Thwaites’ bed topography poses the biggest challenge during these projects.

**PSU Completes 3-Year Survey of Thwaites Glacier**

// BY KATIE OBERTHALER

Knut Christianson commutes nearly an hour to work some days. He gets out of bed, eats breakfast, and then turns on his vehicle. Even in poor weather conditions he tries to keep up with the rest of traffic - all 8 other snowmobiles driving across Thwaites Glacier.

Christianson, a graduate student at Pennsylvania State University, swapped interstates for isolation over his winter break. He spent two months with other PSU scientists conducting active seismology near a remote part of Thwaites hundreds of miles from any other encampment. The drive simply came with the territory of a country lifestyle.

“You have a little bit of a drive to your worksite in Antarctica. Which is substantially longer than it takes to get from my apartment to campus.”

The dry, cold environment eliminates not just traffic, but sweat and smell. Rebecca Boon, fellow PSU graduate student, knows something about these sacrifices made for science. This season marked Boon’s first trip to Antarctica. By the end of the season, she wouldn’t have minded swearing off showers.

“After 41 days of not showering, 51 days without doing laundry and 67 days without shaving, if I were to say we had anything short of a fantastic season I would kick myself for going in the first place,” said Boon.

Boon had reason to celebrate, too. The team successfully collected seismic data over 65 kilometers of remote ice surrounding their remote field camp. This survey completed a three-year project to track Thwaites’ fickle movements. The team has assessed three key locations of the glacier. The first year, they were stationed near the glacier’s grounding line - a kind of glacial graveyard where the ice sheet transforms into a floating ice shelf. They spent the second field season visiting the nucleation site of the glacier. This year, they studied the moving ice mass in between. The seismology work will help map the bedrock of outlet glaciers over this vast region.

Boon said she might as well have signed up for space travel because the continent was unlike anywhere she had ever seen. While the team wasn’t planting flags on any unclaimed planets, they did stake their claim to Thwaites glacier over and over again.

The PSU team first secured a series of large rods called georods in a long line in the snow and connected them with cables. Then they would detonate a buried explosion. Small receptors called geophones inside of the georods recorded the explosion based on the resulting energy waves. Wireless sensors called geopebbles also recorded these waves, along with GPS data. They then repeated this process through a synchronized choreography of packing explosives, digging georod holes, and burying and unburying cables. Each person rotated jobs. The universally-coveted job, despite its labor-intensive actions, was digging. The motion helped circulate heat. They surely kept themselves warm digging an average of 50 to 60 holes per day.

Significant technology updates allowed the team to accomplish this assembly line much faster. The team debuted the geopebbles this year in the field. Their wireless setup...
CReSIS IN THE CLASSROOM

// BY ASHLEY THOMPSON

Teri Fulton and her fourth-grade students at Whittier Elementary School in Kansas City, KS partner with CReSIS Education Outreach Coordinator Cheri Hamilton for the 2009-10 school year. Here, she discusses the complexities of teaching climate change science in the classroom, the annual teachers’ workshop, and her favorite “light bulb” moments.

1. WHAT DID YOU GAIN FROM PARTICIPATING IN THE CLIMATE CHANGE WORKSHOP?

The Climate Change workshop was one of the most informative workshops that I have ever attended. We took a pretest, prior to the start of the workshop, and I felt that I should drop out before it even began because I had absolutely no prior knowledge about the subject and I guessed at most of the answers to the quiz. When I suggested that this might be over my head and perhaps I should take an easier course, I was encouraged to stick with it. After all, the reason I signed up was that I was woefully lacking in content knowledge in this area of Science. One of the most important things that I took from the workshop was that the information presented was not meant to alarm the students. It challenged us as educators to literally go forth and teach so that the solutions our world so desperately needs for the future can begin with today’s students. It’s exciting to hypothesize that there is a student sitting in today’s fourth grade who might possibly dedicate his or her life’s work to finding solutions to our world’s climate change crisis. Information is a powerful thing and it’s important to make it available to all students.

2. WHAT DO YOUR STUDENTS ENJOY THE MOST ABOUT THEIR TIME IN THE CLASSROOM WITH CHERI?

The moment “Ice, Ice, Baby,” as the students fondly refer to Cheri Hamilton, arrives in the classroom, there is a palpable feeling of excitement. For the hour that she comes monthly, she has the complete attention of every student in the room. What’s not to like about miniature lab coats, science notebooks keyed with animal stickers, kettles full of boiling water, bags full of ice, hands-on activities and specific learning outcomes clearly presented in a scientific format? There has not been a lesson presented that my students haven’t responded to. My most uninvolved students come to life when CReSIS lessons are presented.

3. IS THERE A FAVORITE ACTIVITY?

After a quick class vote - very heated I may add - the group decided that their favorite experiment so far was “Cold Water Motion” which showed how hot and cold water moves. They use cups with holes, ice cubes, food coloring and a great visual with bubbles.

4. WHAT DIFFICULTIES ARISE WHEN TEACHING CLIMATE CHANGE SCIENCE AS OPPOSED TO OTHER BRANCHES OF SCIENCE TO YOUR STUDENTS?

Climate change science has to be taught in the context of opportunities to find solutions. It’s an ever-evolving, changing, current event and the more our students can be factually informed, the better they will be to approach solutions through scientific inquiry. Rather than a recitation of memorized facts, CReSIS is designed to encourage thoughtful responses based on hands-on inquiry with real-world implications.

5. WHAT HAS BEEN YOUR FAVORITE “LIGHTBULB” MOMENT IN THE CLASSROOM DURING CRESIS-BASED LESSONS?

My favorite “lightbulb” or “ah-ha” moment came when I saw students mentally grappling with the information that they were creating with their hands-on experiment with evaporation and how it is affected by heat and cold. Their hands and eyes were busy as they observed, drew, poured and felt, but the mental activity I saw and heard as they struggled to make meaning of the results of their experimentation was awesome. There is nothing better than to hear, “How I get it!” It’s that kind of learning that stays with students and becomes a part of the schema upon which they continue to build.

CReSIS GRADUATE STUDENT EXCELS IN AEROSPACE PROGRAM, DC-8 WORK CONTINUED

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In the end, seeing the thing she created hanging on the aircraft provided enough motivation.

“I really enjoyed the work, to be put in that position early on in my career as a lead designer on a multi-million dollar project,” said Arnold.

She has continued making strides as a young female engineer. She is now completing her first year in KU’s Aerospace Engineering PhD program. In November of 2008, Arnold’s design of a light sport aircraft won the top individual score at the 2009 American Institute of Aeronautics and Astronautics design competition. She is also continuing her work with NASA. She is helping fit CReSIS antennas on the wing and fuselage of the NASA P-3 airplane for its spring deployment to Greenland. She is involved with “every nut and bolt of the thing” by acting as a liaison between the design team and the electrical team.

Dr. Hale expressed total confidence in Arnold’s continuing success in graduate studies. “She was ready for independent research. She has already had the capable training,” he said.

Arnold will use these skills cultivated at CReSIS when she graduates. She hopes to conduct lab research in the future. The theoretical design and hands-on work in a lab attracts her. She hopes to eventually enter academics. She might have to contend with a few more spars in her career, but Arnold will fit them into her success without question.

TWIN OTTER TEAM BATTLES THE ELEMENTS

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flight lengths to a little over four hours. Most days, if weather allowed, they would complete two four-hour flights, stopping at a fuel cache between runs.

“We’d have five or so days back to back where we could fly, and that was great,” Rodriguez-Morales said, “and then you’d have a series of three or four where we couldn’t fly. That was how it seemed to work out.”

These delays extended their stay at Byrd to 35 days in total, which wasn’t entirely bad news for some. The solitude of Byrd meant few distractions, a nice respite from the hectic daily life as a polar scientist. But civilization beckoned, as did showers, and the researchers departed Byrd, one by one, in mid-January.

“It’s been a bit of a culture shock, to acclimate back into society,” Lewis said of the three months spent away from daily showers, plumbing, and indoor sleeping quarters.

“The extra time at Byrd was nice, but truly, it was enough,” Smith said. “It’s nice to be back.”

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first four little units marking out the first Byrd Camp. Since the original traverse, it has served as an underground compound, above-ground site, and even a sled-mounted mobile site during the 1970s and 1980s. In the 1990s and early 2000s, Byrd served as a hub for the International Trans-Antarctic Scientific Expedition (ITASE), a worldwide effort that involved conducting ice core analysis at 100 km intervals, traveling 1000-kilometer routes on Caterpillar Challengers and bulldozers. Because of its location, Byrd acted as a staging area for prepping for truly deep-field conditions, as well as something of a back-up plan locale should weather impede fieldwork.

“You always want a secondary place to go, just in case weather is horrible and you’re trapped,” said Gifford Wong, PhD student in glaciology at Dartmouth, who has traveled to Antarctica seven out of the last 10 austral summers.

The site last closed shop in 2005. However, capacity limits at larger establishments, such as McMurdo Station and WAIS Divide, drove Raytheon Polar Services to revitalize the glacial ghost town this year.

“We've learned from past camps that anything over 50-60 is known as mayhem,” said Chad Naughton, science support planner for Byrd Surface Camp. Naughton coordinated the logistics of building the remote field camp. He said the site's long history, preexisting infrastructure, and location relative to Pine Island Glacier made it a logical place to establish the site once more.

Today, compact Twin Otter airplanes have replaced the bulky tractors. Byrd Camp’s main purpose in this century is fuel. The increase in aerial surveys of the region makes Byrd Camp an ideal pit stop between flights when WAIS Divide feels burdened by occupants.

“If you think of a gas station in a remote area, that's your lifeline to getting the science done,” said Naughton. One of the first steps in creating the camp was grooming the 10,000-foot skiway for these airplanes to land. Naughton said the capabilities to store and obtain fuel remained the camp’s primary goal.

The camp's logistics have also changed Byrd from a little outpost to a full-fledged science base. On the first traverse, the army constructed just four buildings - the meteorology building, a power plant, a galley, and an outhouse. Interlocking 4 x 8 feet panels allowed the army to construct each building in snow berms so that severe snow drift doesn't cause damage. Most recently, Raytheon dug up a Jamesway and a Caterpillar Tractor preserved from past years. Raytheon also uses RAC-Tents for the science tents. The RAC-Tents' modular design calls for 4-foot paneled increments that go up and break down fairly quickly.

The results would astound Stroupe. During the past 2009-2010 field season, 60 methodically placed 4-foot paneled increments that go up and break down fairly quickly.

Aerial view of Byrd circa 2009

individual plots comprised Tent City – campers’ quarters. There was also a Jamesway galley for meeting and eating, a communications tent, washing and medical facilities, two berthing units, fuel huts and berms, along with a large freezer cave and a weather station. When the CReSIS crew arrived, some structures had not yet been assembled/weather delayed the crew by almost two weeks. Still, the basics were in place.

“Zip zip and away you go!” said Stroupe.

Raytheon continues to use large palettes to hold all the supplies needed to quickly build the field camp. Instead of lugging them across dangerous broken ice for months on sleds, however, Raytheon now flies them in.

“You basically build the camp one LC flight at a time,” said Naughton.

The first airplane will not leave until the initial crew has established safe lodging, running hot water, and communication with McMurdo Station. They then spend approximately three weeks stitching together the palleted materials with existing infrastructure.

Wong traveled to Byrd as a carpenter's assistant in 2001 with a crew of nine men as part of that season's “put-in” team, which is a group of carpenters, electricians, and planners that precede the scientists and set up shop. Sometimes this involves lugging Jamesways and other regularly used structures out of storage in McMurdo and flying them back down to Byrd.

More typically, however, structures are kept in place for the austral winter, protected and boarded up with plywood or taken down, boxed up, and buried in snow berms so that severe snow drift doesn't cause damage. Most recently, Raytheon dug up a Jamesway and a Caterpillar Tractor preserved from past years. Raytheon also uses RAC-Tents for the science tents. The RAC-Tents' modular design calls for 4-foot paneled increments that go up and break down fairly quickly.

The results would astound Stroupe. During the past 2009-2010 field season, 60 methodically placed
I’ve been extraordinarily fortunate to have incredibly talented and more importantly cheerful and willing students and colleagues. It makes a huge difference for people to have an emotionally balanced and cheerful outlook,” he said.

Newcomer Boon echoed this sentiment. She said she didn’t mind the tough digging or living hundreds of miles away from any permanent settlement. Effectively interacting with numerous personalities in the field challenged her most. She said the transition from populated Christchurch, New Zealand, to McMurdo Station, to WAIS Divide camp, to the tiny PSU camp helped maintain her sanity among first-time uncertainty. She said that experience surely certified her to be a politician if a career in geophysics did not pan out.

Boon said the other PSU team members who had already paid their dues in Antarctica in past seasons helped her acclimate to field life. “I did build up a long list of misadventures and mistakes by the end of the season, which we ultimately had a big laugh over. This included falling off a moving snowmobile, the proven ability to drive in a straight line but in the wrong direction, contaminating half my gear and leaving it buried in a sealed bag beneath a snow mound for most of the season.”

The team eventually found a rhythm working together among mis-haps, a bout of the H1N1 virus, and those long drives to work. The fruit cake wasn’t a bad incentive either. PSU has made the cake a requisite item among the radar and snowsuits in their luggage each year. It provides a taste of home during the holidays. The team proved that traditions can arise everywhere, especially among strangers at the bottom of the world.

SCIENTISTS FLOCK TO BYRD CAMP CONTINUED

“When we were sitting in a Lazyboy on the edge – we were very comfortable but you’re right there, at the edge of potential disaster,”
- WONG

Typically the food we eat is freeze-dried, military-style,” Zook said. “It comes out of a bag with instructions like, ‘Poke here, boil for five minutes, eat.’” The crew that season relished in Zook’s finding nightly.

Zook’s discovery unearthed only a fraction of the items buried under and around Byrd Camp. Whole structures from the original Byrd Station and intermediate sites remain veiled by snow that has swept fiercely atop the structures throughout the winter seasons.

“We can see it, the old towers and such, and other structures, but it’s considered a kind of dangerous place,” said Zook. Ghost stories and theories about the hidden mounds are plentiful, but they might just be one feature even radar can’t detect.

“No one knows what’s there and where it’s at. It’s a mystery,” said Naughton.

In 2000, Bob Zook, a communications specialist at Byrd Surface Camp, was shoveling snow in Antarctica to insert a pole wired for communications, when his shovel hit something hard. He and a few others began brushing off the dustings of snow until the object came into full view. It was a sort of hatch; a wooden door that led down underneath the ice. They pried it open, and there was a staircase. Zook bravely descended into cold, miserable darkness, unable to quell his curiosity. What they had found was a food freezer from expeditions’ past, stocked with such delicacies as king crab legs, marinated pork ribs, and one 75-pound bag of chocolate chips, with an estimated count of 1 million pieces. A 35-pound bag of cornbread mix was later discovered in the treasure trove, and the many months on the ice were warmed with a plethora of chocolate cakes and cookies throughout the season.

CReSIS professor Kees Van der Veen spent a month at Byrd Camp in 1988

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