



# EOS SPHERES

Institute for the Study of Earth, Oceans, and Space • A University of New Hampshire Research Institute • Morse Hall, Durham, NH

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Fall 2006

Vol. 5 Issue 3

## Sittin' on Top of the World

*Undergraduates push the envelope of education through EOS-UNH research*

BEFORE FINDING himself just 700 miles shy of the North Pole in late summer twilight cradling a loaded rifle to deter hungry polar bears, UNH sophomore Chris Black's biggest travel venture had been a daytrip to Canada from Hopkinton, Mass. with his folks.

Black spent two weeks late last August in and around the island of Svalbard north of Norway deploying instruments he had helped design and build in EOS's Magnetosphere-Ionosphere Research Laboratory as a freshman. If classes hadn't begun before Labor Day, Black would have stayed to help doctoral student Hyomin Kim finish the job, but he returned early to catch the second week of classes, his breath, and to get his bearings.

"It wasn't peak season up there, where the sun just goes around in a circle," says the physics major. "It was like the sun was constantly setting, it just dips along the horizon from about 9 p.m. till 3 a.m."

As for the polar bears, Black notes, they aren't normally a problem at that time of year, but as global warming changes their habitat the big predators occasionally wander south in search of food. Black encountered reindeer and Arctic fox so docile he could touch them, but no bears looking to make a meal of him.

Svalbard is located at the region where Earth's looping magnetic field lines stream in from the South Pole. It is where scientists like research associate professor Marc Lessard – using the induction coil magnetometers that

Black helped build – can pick up wave fluctuations in the ionosphere (the Earth's magnetic shield) some 100 kilometers up in space. The research is aimed at better understanding the physics involved in the transfer of energy from the sun and the solar wind through the complex magnetospheric-ionospheric region to the Earth's upper atmosphere.

At four sites around the region located at 78 degrees north (the North Pole is at 90 degrees), Black and Kim dug a four-foot-deep

rectangular pit in the ground, carefully aligned two, cross-shaped magnetometers in a north-south, east-west direction, covered them with dirt, ran a cable to a small building containing the "acquisition system," and let nature take its course.

Sitting in his EOS office in the Space Science Center, Lessard now looks at the Svalbard data, which resembles the peaks and valleys of a seismograph, streaming in on his laptop over the Internet.

"It's pretty exciting to see an old technique be so productive," Lessard says of the induction coil magnetometer – an instrument he likens to a big doorbell coil. "It's the same

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Photo: Chris Black, UNH

*Beneath this "grave" at Ny Alesund, Svalbard, Norway lies an instrument built at EOS to measure subtle signals in the Earth's magnetic field*



Photo courtesy of NOAA

*Artist's conception of GOES-N satellite by Allan Kung.*

## What GOES Around Comes Around

WHEN THE National Polar-orbiting Operational Environmental Satellite System program (NPOESS) developed a runaway budget and ground to a halt, so, too, did work on Jim Connell's Heavy Energetic Particle Sensor (HEPS) project. HEPS, in the parlance of the space instrument business, got "descoped," at least for the time being, even though the project was on budget and on schedule.

Connell's instrument – two of which were to be built for the next-generation, polar-orbiting weather satellites –

was to be the very first operational mission for the Space Science Center. Unlike a one-time science mission, an operational mission involves multiple satellites launched through the years to provide a service (as opposed to pure science) by carrying instruments designed for continuity and reliability.

But in a bit of serendipity, and to the tune of \$10 million, what specifically made HEPS such a winning instrument design – Connell's Angle Detecting Inclined Sensor or ADIS (see *Spheres*, Fall 2005) – made it equally attractive

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EOS Spheres is published seasonally by the Institute for the Study of Earth, Oceans, and Space at the University of New Hampshire. We welcome comments and suggestions.

Spheres Newsletter  
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Printed with soy inks on 100% post-consumer recycled paper, manufactured chlorine-free.

## Sittin' on Top of the World

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concept, an electromagnet, something you might have done in the 5<sup>th</sup> grade,” says Lessard with characteristic droll humor.

Of course, instead of wrapping a nail with a bit of copper wire and running current through it to create a simple magnet, the magnetometers (which work in the opposite way by picking up magnetic fluctuations and measuring the resulting current) each have 160,000 turns of copper wire and a host of associated state-of-the-art circuitry and software to get the job done.

Black's Svalbard adventure, following a year's worth of research, was made possible by a UNH Undergraduate Research Opportunities Program (UROP) Summer Undergraduate Research Fellowship (supported in part by the New Hampshire Space Grant Consortium, which provided funding for two other SURF students this past summer) and some funding through the National Science Foundation. Without funds from these entities, Black would not have been able to make the trip, which he describes as a once-in-a-lifetime experience.

“I never even remotely imagined,” Black admits, “that I, as an undergraduate, would be traveling to the Arctic to help conduct professional research. I feel very fortunate.”

With many deadlines quickly approaching for Lessard's other projects, it was fortunate for him as well that Black could make the trip way up north.

Lessard himself got his start in this very research as an undergraduate at UNH working with Professor Emeritus Roger Arnoldy, whom Lessard succeeds in carrying on the Space Science Center's induction coil magnetometer and sounding rocket work. Two weeks after graduating, Lessard found himself at the South Pole working with magnetometers that were then six-feet long. The instruments Black helped build are a mere two feet.

■ From the Director

## Note to Young Researchers: Apply Within

“AT UNH it's easier to start earlier.” So says freshman Travis Glines (page 5) about research opportunities at UNH. He should know; Travis spent the summer of his sophomore year *in high school* working with professor Chuck Smith and others at the EOS Space Science Center. And Travis is hardly alone. In this issue of *Spheres*, we celebrate undergraduates who have discovered the excitement of working on problems whose answers can't be found in the back of a textbook. The common thread running through their stories is that delving into the unknown through undergraduate research not only enhances their present academic experience but also helps open doors to the future.

A first blush, this may seem “out of character” for EOS given our clear focus on graduate education. But graduate students do not come out of the ether. Today's graduate student is yesterday's

undergraduate and high school graduate. Doing research, taking risks, turning down one path only to realize another must be pursued, is not unlike learning to ride a bicycle – you learn to ride simply by riding. At UNH and in EOS, there is no minimum age at which to begin pedaling.

I believe our colleague, Dean Joe Klewicki, captured this spirit when he said in the winter 2006 issue of *Spheres*, “The most valuable lessons students learn through the course of their education are how to learn more, and how to be more proactive in their own education.” The students profiled here exemplify just a few of those on campus and at EOS who have been proactive indeed when presented with the opportunity to explore and discover.

— Berrien Moore III



Photo: Perry Smith, UNH Instructional Services

Chris Black

Speaking from experience Lessard says, “When you get undergraduates involved in this research, be it rockets, magnetometers, or something else, it's really exciting and stimulating regardless of whether they choose to stay in the particular field. Seeing how it's done, learning what it means to make quantitative measurements, the whole experience of getting things really working in the field is invaluable.”

Invaluable, too, is the real-world experience outside the classroom where making the grade isn't, ultimately, something just on paper. Referring to the kind of pressure Black, Kim, and other project participants (including mechanical engineering undergraduate Matt Dionne) were under over the summer, Lessard adds, “We had to ship this stuff on a certain date to get it to Norway, the trip was going to cost a fortune, there was a

lot riding on this. So it's very real-world pressure to make something work end-to-end. You get up there and it's got to be plug and play.”

With data from the top of the world now just a keystroke away, Black will be able to help analyze the ground-based Svalbard data and, in conjunction with satellite measurements and computer modeling, it is hoped this will lead to a better understanding of the dynamics of energy transfer from the solar wind to the upper atmosphere.

Of the current magnetometer research he, Black and others are doing at EOS, Lessard notes that the field of study has changed radically since he was in Antarctica nearly 20 years ago. “What's happened in the last decade or so is that a lot of satellites have gone up that are really changing how we understand things. Now you can compare ground-based and satellite data” and that has made the big picture much clearer.

In fact, Lessard adds, “One of the signals we're seeing appears to be a signature of magnetic reconnection, a basic mechanism by which energy transfer takes place in space, but a mechanism that was thought to be impossible a mere decade-and-a-half ago. We're getting more and more proof indicating that's the case. And if that's true, it tells us a lot about some of the details of the process. Which is the big prize, to understand the sun-Earth connection.”—DS



## Seeing Double

*STEREO-PLASTIC now begins its work*

JUST SHY of 9 p.m. on a starry October night at the Cape Canaveral Air Force Station in Florida, the object of over six years of work by the Space Science Center's STEREO-PLASTIC team catapulted toward the sun on a two-year, \$550-million mission. The twin spacecraft will provide scientists with the very first three-dimensional images of the sun and help decipher the origin and consequences of our star's 10-billion-ton eruptions known as coronal mass ejections. Just as our slightly offset eyes allow binocular vision and depth perception, the placement of the two spacecraft will provide 3-D imagery and particle measurement of the sun.

Four-and-a-half minutes into flight the Delta II launch vehicle shed stage one, stage two of the rocket ignited, and the white capsule that protects the piggybacked spacecraft during launch (called the fairing) was jettisoned exposing the twin STEREO spacecraft. At that point they were 110 miles above Earth traveling at 19,832 feet per second or 13,521 miles per hour. Spacecraft separation occurred at 9:17 p.m. and the twins began to chart their own courses. Solar panel deployment occurred shortly there-

after. At 1:38 a.m. PLASTIC principle investigator Toni Galvin reported from the Cape that everything was going "textbook perfect."

As *Spheres* goes to press, Galvin noted that the PLASTIC instruments would be turned on two days hence (October 28) for "initial engineering housekeeping" and the first apogee – the point in its orbit where an Earth satellite is farthest away – was to occur on Halloween. A full month of gradually ramping up the instruments' high voltage supplies and other sequences will follow before SSC scientists and engineers see "first light" of scientific data.

PLASTIC, for Plasma and Supra-thermal Ion Composition, will not be taking remote images of the sun. Rather, the UNH-built sensors will take *in situ* samples of the actual components of coronal mass ejections (protons, alpha particles, and heavy ions) as they flow past the spacecraft, analyze the samples onboard, and send the processed information down to Earth. As Galvin puts it, "What the combination of remote imagers and *in situ* measurements the mission provides could be likened to taking both photos of an apple orchard and tasting the apples themselves."



Photo by Calderon Balle, courtesy of NASA.

*A Boeing Delta 2 rocket carrying the STEREO spacecraft lifts off at 8:52 pm on October 25<sup>th</sup> 2006 from Cape Canaveral, Florida.*

Look to these pages for future stories on the sweet taste of PLASTIC success. -DS 🌍

## What GOES Around Comes Around – continued from page 1

for the geostationary satellite program that has been providing weather data for over 30 years, the National Oceanic and Atmospheric Administration's (NOAA) Geostationary Operational Environmental Satellite or GOES program.



Photo: K. Donahue, UNH-EOS

*Cliff Lopate*

The GOES program, which over the years has run through a series of letter designations for its geostationary satellites, will begin launching the GOES-R series this side

of the next decade. And onboard will be the ADIS instrument, in slightly modified form, as part of the Energetic Heavy Ion Sensor or EHIS currently being designed and built by Connell's SSC colleague and project lead scientist Clifford Lopate.

"The two instruments are very similar," Lopate explains. "The only real difference is that we've added an extra detector at the back of the package."

Lopate and his colleagues were recently awarded a \$10 million contract to build the sensor as part of the Space Environment In-Situ Suite onboard GOES-R. The suite, which will contain four instrument packages including the EHIS, will monitor potentially dangerous energetic atomic nuclei and electrons as they hurtle through space near Earth.

The UNH-built instrument will measure particles with the highest energy ranges – particles that can pose great risk to satellites, astronauts, and transpolar aircraft crews. Large increases in the energetic particle flux often precede the arrival of magnetic storms generated by solar activity, and these storms can damage ground-based electronics and power systems. All this activity is part of what is now commonly known as "space weather."

The UNH contract comes in the wake of an award by NASA, working in coordination with the NOAA GOES-R program, of \$101.7 million to Assurance Technologies Corporation of

Chelmsford, Mass. for development of the new satellite environmental suite.

According to Lopate, the science goal of the instrument suite is to understand what's happening to energize particles on the sun and in space and how those particles are transported to Earth. If that could be understood in great detail, accurate predictions of damaging energetic storms could be made. In other words, space weather forecasting could be dramatically improved.

"Right now space weather forecasts are nothing if not amusing," Lopate says adding, "they're not really predictive. It's kind of like having a little cup out in the rain and when the cup starts getting filled you say, 'Hey, it's raining.' It helps a little, you don't get caught in the deluge, but it would be nice to know if it will be raining an hour ahead of time."

The measurements provided by the environmental suite, including the Heavy Energetic Particle Sensor will improve the models used to make more accurate, predictive forecasts of space weather. -DS 🌍

# Research & Discover: Dress Rehearsal for Grad School

*At five years old, R&D is counting its success but not resting on its laurels*

AFTER SEEING the movie “Apollo 13,” which depicts “the most successful failure in the annals of space flight” – as NASA describes its aborted third lunar-landing mission, fifth grader Catherine Walker knew she wanted to be an astronaut.

“It seemed exciting,” says the shy Mount Holyoke College junior and current Research & Discover intern. So to help launch her career Walker looked for opportunities beyond Holyoke, where she is the only astrophysics major, to a place and program that would provide a clear pathway. She found it at EOS’s Space Science Center and an R & D internship.

After all, what could be more perfect for an undergraduate/budding astronaut than to conduct graduate-level research in a NASA-UNH collaborative program that includes a summer at the Goddard Space Flight Center as part of the deal?

Says the program’s director George Hurtt, associate professor in the Complex Systems Research Center, “Goddard is the largest Earth science and space science research entity in the country, so this is a big step in the growth of young scientists that is provided by the program.”

Indeed, by design, Research & Discover, as Hurtt puts it, is a program of “opportunity” where students are provided a rich and varying menu of tools and teachers through which they can transform themselves from undergraduates into independent scientific researchers – first with a summer internship at UNH-EOS, followed by one at Goddard.

But that growth is hugely dependent upon the students’ own talent and initiative. In essence, these undergraduates are thrust into a dry run of life as a graduate student researcher.

“This is not a summer school program,” Hurtt stresses. The students who pass muster through the rigorous selection process do not come to UNH-EOS for their first summer internship to attend classes and lectures during days stuffed to the gills with predetermined activities. They are paid to work, to grow, and to do research. Still, expectations sometimes cloud the view.

*“We should all be very proud of this effort to attract the best and the brightest in this area of science.”*

*– Franco Einaudi, Director, NASA Goddard Space Flight Center, Earth Sciences Division*

“Some come here and are in shock; their days aren’t booked, they ask, ‘What’s the agenda for tomorrow?’” The answer, Hurtt explains, is that there is no agenda; it’s up to the intern and his or her advisor – who is carefully matched with a student – to chart the path.

Hammering home the program’s central premise Hurtt says, “To launch them on a solid career in science you’ve got to give them more than just a summer. You’ve got to show them a path during what is arguably one of the most uncertain periods in a scientist’s career – the transition from undergraduate to graduate.” And, he adds, with a two-summer internship following their junior and senior years and the possibility of a two-year, full-time, post-undergraduate fellowship, the program is truly “a pipeline of opportunities.”

Just listen to Wellesley College senior Mimi Szeto, a 2006-07 intern who worked this past summer with scientists Janet Campbell, director of the Ocean Process Analysis Laboratory, and Tim Moore using satellite data to study primary productivity in the ocean.

In the report summarizing her internship experience (paraphrased here) Szeto wrote, “I didn’t know much about the structure of graduate school but, now, it seems more tangible and feasible. This aspect is probably the most significant difference the program has made in my life. Before my Research & Discover internship, I would not have thoroughly considered research as a career. Now, I am looking forward to my senior year with more confidence and structure, and to what the program offers in my future, including a summer internship at NASA Goddard and a possible graduate fellowship.”

Dr. Franco Einaudi directs Goddard’s Earth Sciences Division, which provides the NASA funding for Research & Discover. Einaudi agrees that the program’s multi-year structure is unique and allows students to take maximum advantage of their summer at Goddard after developing the proper background for their research at UNH. Moreover, he asserts, Research & Discover is very attractive for students because it provides them with incentives towards a graduate degree. “We should all be very proud of this effort to attract the best and the brightest in this area of science,” Einaudi says.

At the upcoming American Geophysical Union meeting in San Francisco, Hurtt plans to summarize Research & Discover to date and, more importantly, talk about it as a model for the enhancement of graduate education in general. In other words, he plans to spread the concept with the ultimate goal of growing the program in other places and/or with other partners. Already, by leveraging support from other sources like the National Science Foundation and a separate education grant from NASA headquarters to diversify the student body, R & D is anticipating its largest cohort ever of eight students next year.

At AGU, Hurtt, who will be joined by a dozen students presenting their R & D research, will have sufficient ammunition to make his case. Some of the programs’ accomplishments thus far: twenty two student internships and six fellowships involving students – over 60 percent of whom have been female – from nine states and two countries; more than 78 scientific research presentations (including those at AGU), five undergraduate theses, two master’s theses, and four peer-reviewed publications. Moreover, 80-plus percent of the program’s alums – who come from schools like Dartmouth, Duke, UC Berkeley, Cornell, Smith, Bryn Mawr, Williams, Amherst, and UNH, to name a few – are pursuing careers in Earth and space sciences.

Says Hurtt, “Having students achieve a sense of discovery is a very important part of the overall educational process and, at some primal level, is why someone would pursue a career in science. Research & Discover can help open the door to that sense of discovery.” -DS



Mimi Szeto

Photo: K. Dvorshin, UNH-EOS



## Power to the People

DUANE HUDGINS was an average student in high school, transferred to UNH from Northern Essex Community College in Haverhill, Mass. to study mechanical engineering, did a variety of undergraduate research – including projects for the Targeted Wind Sensing program at EOS, graduated second in his class, and is now a first-year master’s student at MIT. Oh yes, and he hopes to save the world.

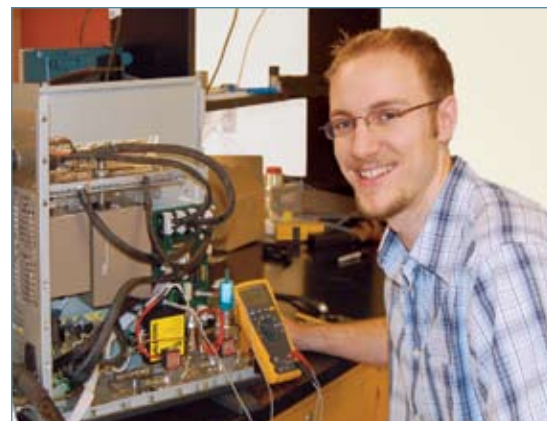
“I want to start my own engineering firm in the alternative energy field. I would really like to be a force in taking us off of fossil fuels, finding renewable sources of energy and ways to scrub excess CO<sub>2</sub> out of our atmosphere,” Hudgins says matter-of-factly.

He adds, “That’s what I want to focus on – harmonizing the energy cycle with humanity. To be able to put that power back in the hands of the people, so to speak, so that they aren’t dependent on the grid for their power needs.”

Hudgins came to UNH because of its reputation for engineering and he knew undergraduate research opportunities would be a key to his future. He began doing small research projects at the mid-point of his sophomore year in the College of Engineering and Physical Sciences.

“I started out pretty much as a grunt but by the end of my junior year I was designing power supply boxes with really complicated circuitry – then I built them myself,” he says. Hudgins adds that, just prior to beginning projects as a paid research assistant at the engineering college, he was laid off from a job. The timing could not have been better. “Once I started doing research I never looked back – it beats waiting tables any day, and the Targeted Wind Sensing program has been extremely generous.”

The Targeted Wind Sensing (TWS) program develops low-cost sensors to conduct *in situ* observations of the physical and chemical



Duane Hudgins

Photo: K. Donahue, UNH-EOS

properties of Earth’s atmosphere. For example, a miniature ozone sensor that has flown successfully on a series of NOAA “smart” balloon missions was built under the program.

The ozone instrument was developed by Climate Change Research Center lead engineer Don Troop, who enlisted Hudgins to design and conduct humidity tests to see how the sensor would function as it moved in and out of clouds at different heights and atmospheric pressures. It turned out to be a challenging and complex process.

Hudgins also designed and built parts for a one-of-a-kind instrument being developed by TWS that could someday replace the large, bulky, liquid nitrogen tanks needed to supercool air samples to a level where individual pollutants, such as volatile organic compounds, can be teased out and analyzed. This technology would be a great boon for field research in remote locations in particular.

Troop says of Hudgins, “He’s smart, but lots of people are smart. What really sets him apart is his work ethic, he’s a very hard worker.” Troop notes that Hudgins was comfortable enough to work largely on his own. “I could count on him figuring things out. Of course, I think that’s part of our job – to guide these students in figuring things out on their own, that’s part of the real-world learning process.”

Hudgins knows that having graduated second in his class and scoring high on his Graduate Record Exam played a role in his acceptance to MIT – his first choice among the other schools he applied to, including Princeton and Cornell. But, he asserts, “One of the biggest selling points is research. I mean, if you want to go to a top-tier grad school you need research or industrial experience.”

He adds, “And the sooner students start doing research the better. There’s no rule saying you can’t start in your sophomore year. You could even start freshman year. If you can get the support of a professor by demonstrating that you’re motivated and willing to learn, then you have everything you need.”-DS

## Sowing Early Seeds of Research

FOR DUANE HUDGINS (page 5), starting undergraduate research mid-way through his sophomore year at UNH wasn’t a moment too soon. Travis Glines also started his research career at UNH in his sophomore year – of high school.

Glines learned about Project SMART, a four-week summer residential program at UNH for talented high school 10th and 11th graders, from his science teacher at Littleton High School. He applied, was accepted, and spent the summer of his sophomore year working with the Chuck Smith, Charlie Farrugia, and Vania Jordanova (now at Los Alamos National Laboratory) of the Space Science Center (SSC).

The following summer Glines worked with SSC’s Jimmy Raeder “visualizing” or animating data Raeder generates running simulations of the process that occurs when the sun’s magnetic field merges with Earth’s.

“Dr. Raeder’s research was right up my alley,” Glines reports. In fact, it was so up his alley that Glines continued working with Raeder this past summer and will do so throughout his freshmen year as a physics major here at UNH.

Of his decision to attend UNH Glines says, “I’d already seen UNH as a Project SMART student and liked the fact that it had a lot of research going on. At some of the other schools I was looking at, you had to be close to the graduate school level in order to do much research. At UNH it’s easier to start earlier.”

Raeder notes that this summer Glines both helped with research and mentored two 2006 SMART students. “Hopefully,” Raeder says, “the cycle will repeat itself with these students coming to UNH and mentoring new SMART students a couple years down the road.”-DS



Photo: K. Donahue, UNH-EOS

Summer 2006 Project Smart students built instruments to measure changing levels of cosmic radiation as a weather balloon wafted toward “near space” at 100,000 feet.

# From What's Hot to What's Not, At Last

Visiting scientist Otto Klemm "recalibrates" himself



Photo: K. Donath/UNH-EOS

"You tend to ask too much of students if you don't know how much time it takes to do field experimentation right, so this was important," he says.

Klemm was a visiting research assistant professor at UNH from 1989-91 and when his sabbatical came up he knew exactly what he wanted to do and who to call, Bob Talbot, director of the Climate Change Research Center and the AIRMAP program. As luck would have it, aerosol formation was at the heart of AIRMAP's summer 2006 intensive campaign at Appledore – one of the Isles of Shoals off the coast of Portsmouth.

So Klemm packed up his family, including his wife Kerstin who also worked at CCRC this summer as a research scientist, his aerosol-counting Scanning Mobility Particle Sizer, headed west, and settled in at EOS for the next six months.

One goal of the Appledore campaign, which involved a host of students and EOS scientists, including Rob Griffin, Alex Pzenny, and Barkley Sive, was to study the dynamics of aerosol particles in the atmospheric boundary layer – that part of the lower atmosphere or "troposphere" that is directly influenced by the

OTTO KLEMM has always had his head in the clouds, so to speak. For the bulk of his career he has wanted to investigate the science of aerosols – the stuff suspended in a gas, such as the air we breathe – but reality had other plans.

"I wanted to focus on aerosols but in large sections of my career I couldn't get funding because in Germany and central Europe the ozone issue was so hot. All the money went into ozone research," Klemm says. Even when he landed a position at a research institute and pitched the idea of writing proposals on aerosol research, his boss said flatly, "Don't bother." Ozone in high concentrations negatively impacts human health, vegetation, and crops – thus its primacy on the research food chain.

So when Klemm – now the managing director of the Institute for Landscape Ecology at the University of Münster – returned to EOS this past summer on sabbatical to conduct aerosol research as part of AIRMAP's air quality campaign on Appledore Island, it was a welcome breath of fresh air for a researcher with the patience of Job.

Says Klemm, who at Münster spends 95 percent of his time teaching and taking care of administrative duties, "For me it's a step back into doing real scientific work from scratch, to go into the field, set up an instrument, troubleshoot, get samples, take them back to the lab and analyze." And in doing so, Klemm also had the chance to "recalibrate" himself with respect to his role directing others on their research.

Earth's surface. Of particular interest was the formation and growth of new particles.

Despite having to play second fiddle to ozone all these years, much is known about aerosols, says Klemm. "We understand their composition, size distribution, sinks, and how they affect acid rain, but we don't know the details of how they form."

Klemm adds, "Now we can investigate this because we have equipment available and a lot of modeling work has been done." Ten years ago, he points out, only the Finnish – who spent the last decade-and-a-half focusing on aerosols while the rest of the world obsessed over ozone – could do this work. Finland had no major ozone problem so it was the Fins who largely built the aerosol instruments in use today. Says Klemm, "Now America and the rest of Europe is catching up."

So why is it important to catch up? According to Klemm there are a handful of reasons.

Aerosols play a very complex role in the climate system. For example, in radiation transfer, which has to do directly with global warming, they play a dual role by both increasing or decreasing the greenhouse effect

depending on their size and location. They also affect the lifetime and formation of clouds – the physical properties of clouds, which has a strong influence on global changes, too. "So these are very complex, overlapping effects," he says.

And aerosols are mechanisms of transport, moving organic compounds from one place to another thus playing an important role in the biogeochemical cycle and the transport of pollutants around the globe.

Back in Germany, Klemm will analyze the data from his brief return to the field. This information is a crucial addition to the overall AIRMAP summer campaign dataset and will be the basis for numerous joint publications.

Says Talbot, "It was amazing how the Klemms seamlessly fit into the AIRMAP group. Otto provided the leadership in the planning and execution of the Appledore campaign while Kerstin helped test and bring numerous new instruments on-line for us." On a lighter note Talbot adds, "In the midst of all this activity, their two sons, Thomas and Christian, became fluent in English and enjoyed ski jumping at Lake Placid." -DS



# Putting the Uncertainty of Science Back in the Classroom

*CSRC researchers join an effort to reinvigorate K-12 Earth science education*

IMAGINE A ROOMFUL of 8<sup>th</sup> graders being asked by their science teacher to answer questions like these: Is your town a source or sink of carbon? What is the carbon balance of the landscape around your school and how do you expect it to change in the next century?



of Charles University in Prague, and senior personnel Rita Frueder and Sarah Silverberg. Together they will develop a series of educational activities and resources for students based on work they are already doing under the North American Carbon Program (see Fall 2004 *Spheres*).

Explains Ollinger, “Our approach is to take elements of current carbon cycling research and develop appropriate questions and exercises that students can use to investigate the same questions scientists are currently wrestling with.”

Ollinger believes one key reason their proposal received funding was that NSF liked the idea, as he puts it, “that we don’t have a pre-conceived notion of what the student answers should be. That’s part of the design.” The GLOBE approach, in other words, is to have students actually mimic the scientific process for a relevant topic rather than have them studying components of science that have already been figured out.

Based on his own experience, Ollinger notes, “The transition from studying science to actually doing science can be very stark because often, when studying science, you’re not really exposed to the process of uncertainty, you’re never really confronting things that no one knows the answer to.” He adds, “And in my brief experience teaching so far, I think students respond a lot better and become more motivated when they know that no one knows the answer to the question you’re asking. They realize that, in fact, they could be the first person to figure this out.”

For more on the GLOBE program and the Carbon Cycle project, visit [http://www.globe.gov/globe\\_flash.html](http://www.globe.gov/globe_flash.html). -DS

If the National Science Foundation has its way, instead of puzzled expressions and shrugged shoulders, kids in the near future across the country and around the world will plunge into solving such problems fully armed with state-of-the-art scientific tools and techniques. And a team from the Complex Systems Research Center headed up by Scott Ollinger is helping NSF pave the way.

Ollinger is the UNH principal investigator on a four-year, \$1-million project recently funded under the Global Learning and Observations to Benefit the Environment program, GLOBE for short. The long-standing NASA-NSF program promotes and supports students, teachers, and scientists to collaborate on inquiry-based investigations of the environment and the Earth system. (GLOBE began as the brainchild of former Vice President Al Gore and CSRC’s Barry Rock served as the program’s first senior scientist.)

Last summer, NSF announced four new Earth System Science Project (ESSP) partners for GLOBE, one of which is the Carbon Cycle project the CSRC team is now ramping up. According to NSF, the new project was created to help “reform geoscience education by connecting scientists with the practice of teaching and learning science in the classroom.”

In addition to Ollinger, Carbon Cycle project members include co-investigators Mary Martin, Rob Braswell, Annette Schloss, Jana Albrechtova

# Greenland’s Glaciers: Slip Slidin’ Away

EOS SCIENTIST Mark Fahnestock has teamed up with researchers from the Geophysical Institute at the University of Alaska Fairbanks (UAF) to investigate the recent, rapid acceleration of a large Greenland outlet glacier by deploying Global Positioning System receivers directly on the glacier. Jakobshavn Isbrae (background) flowed at a stately 20 meters per day for the last half century, but recently accelerated to 40 meters per day in response to the loss of a floating ice tongue that blocked rapid progress down the fiord.



*Jakobshavn Isbrae glacier*

In this photo, Jason Amundsen of UAF measures the motion of markers out on the ice using optical surveys. To the left, the white pole (put in place for an optical survey back in the mid 1980s when the glacier was moving slowly) holds an antenna for communicating with GPS installations on the ice.

Look for a feature on Fahnestock and his work in Greenland in an upcoming issue of the *UNH Magazine*. -DS

## Research News

CSRC’s **Xiangming Xiao** reports that the National Institutes of Health (NIH) have approved a four-year, \$1.55-million project to begin a new phase of his work using remote sensing techniques to study the ecology of Highly Pathogenic Avian Influenza. The interdisciplinary, international project, for which Xiao is principle investigator, combines epidemiology, ornithology, agriculture, and environmental remote sensing in an effort to model avian influenza transmission in Asia, and opens a new direction for research work at EOS and UNH.

**Andy Rosenberg** began serving as chairman of the Census of Marine Life U.S. National Committee November 1.

**Erik Hobbie** (lead scientist), **Scott Ollinger**, **Serita Frey**, and **Ruth Varner** were funded by NSF to do work on mycorrhizal fungi at the Bartlett Experimental Forest in the White Mountains.

**Roy Torbert** was awarded a part of the Electric and Magnetic Field Instrument Suite and Integrated Science investigation on NASA’s Radiation Belt Storm Probes mission. (Principle Investigator on the project is Torbert’s former colleague and SSC assistant research professor Craig Kletzing of the University of Iowa.)

**Karen Von Damm** and **Ruth Varner** were recently funded as part of the NSF Geoscience Teacher Training program. Lead investigators are Karen Graham of the Leitzel Center and Julie Bryce of the Department of Earth Sciences. The team is developing a series of workshops for teachers to improve the quality of geoscience instruction at middle- and high-school levels.

**Pingguo He** reports that OPAL is hosting visiting professor Dr. Chun Woo Lee from Pukyong National University in Korea for the coming year. Lee specializes in mathematical and computer modeling of fish production systems.

**Joe Salisbury** received a NASA New Investigator Award to study carbon dioxide in coastal waters. The award represents a novel approach to estimating coastal ocean productivity – estimates that are notoriously difficult to make – using UNH models and satellite data.

**Steve Frolking** will be UNH’s principle investigator on a recently received collaborative award supported by NSF’s Carbon and Water in the Earth System program. Co-PIs on the project include Glen MacDonald of UCLA and Zicheng Yu of Lehigh Univ. The four-year project has a total award of roughly \$1.9 million.



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## State of the Seas: A Global Synthesis

ESTABLISHED IN 1902, the International Council for the Exploration of the Sea (ICES) is the oldest intergovernmental organization in the world concerned with marine and fisheries science. The intervening century has seen a rapid decline in the health of the world's oceans and its fisheries, and it's been 20 years since ICES pulled together a large gathering of scientists to grapple with issues related to integrating commercial fishing with ecosystem conservation.

Chris Glass, director of the Northeast Consortium, spent three years helping organize ICES's 2006 international symposium in Boston (October 30 – November 3) in an effort to bring disparate stakeholders together to chart a viable path for the future.



ICES Image: Sarah Cull by Eric Hopkins

As the meeting was poised to begin Glass said, "What we're trying to do here is explore ecosystem-sensitive approaches to fishing using all the technology we have to be both more efficient at catching fish and protecting the habitat." He added, "There have been meetings that have dealt with the habitat issue alone, or the fishing part alone – this is an attempt to bring those two disciplines together in a meaningful way." -DS

## A Milestone for EOS



IT WAS SIX YEARS in the making, but in October EOS was officially designated as the very first University Institute at UNH. With the title, EOS will increase its role and visibility on campus by, among other things, having representation on the dean's council, which will allow the institute more input in decision-making processes.

"It's a recognition that EOS is considered part of the fabric of UNH. We have a base to grow, expand, and change in an atmosphere of security, which is always a nice thing to have," said EOS associate director David Bartlett in wake of the official word. According to Bartlett, the designation is the next logical step in the evolution of scientific research on campus.

Establishing University Institutes has been a long-standing goal within UNH's Academic Plan and "speaks to the need to grow strategically as a significant and excellent research university," according to the USNH Online Policy Manual. University Institutes, the manual states, "would bring together well-established, successful and complimentary centers and other working groups in order to significantly advance the teaching, research, and public service mission of the University."

According to John Aber, UNH vice president for research and public service, EOS has blazed the trail for other University Institutes to follow. Aber added, "This really helps to make EOS more a part of the university conversation. An important part of that is to bring research and teaching closer together, and we feel they've done that very well." -DS