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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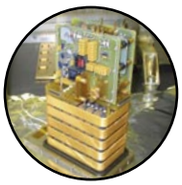

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Astrophysics meets homeland security…

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Fall 2004

Vol. 3 Issue 3

Balancing the Budget

A host of EOS researchers are taking part in the early stages of a decade-long effort to understand where the Northern Hemisphere's carbon is coming from and going to

SINK OR SOURCE, that is the question. On balance, do the North American and Eurasian continents suck up carbon or pump it out? It's an important question to answer if scientists are to calculate the total carbon budget for each landmass, for the Northern Hemisphere in its entirety, and for the Earth as a whole. It's an important question to answer if we are to fully and accurately incorporate carbon into the equations assessing the extent of future climate change.

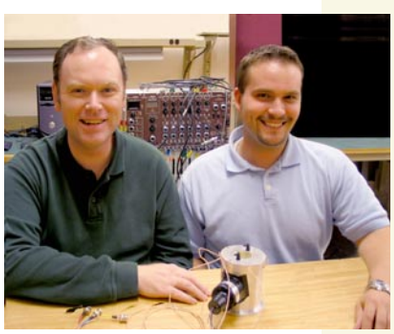
The 95-foot-tall carbon flux tower at the Bartlett Experimental Forest, a U.S. Forest Service research site in the White Mountains. The tower is led by Dave Hollinger and Andrew Richardson of USFS. Photo by Kirsty Lloyd.

In an effort to help piece together the big carbon puzzle, Complex Systems Research Center's (CSRC) Changsheng Li, Xiangming Xiao, and Scott Ollinger were recently awarded grants from NASA totaling $2 million to conduct research in a variety of ecosystems across North America (Ollinger), in the boreal forests of Russia (Li and Xiao), and grasslands in Asia (Xiao and Dennis Ojima at Colorado State University).

All of the projects were funded by NASA as part of its contribution to the multi-agency North American Carbon Program (NACP) and Carbon Cycle Science Program. NASA's partners in these endeavors include the National Science Foundation, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Agriculture and others. Both programs, as well as many others, fall under the purview of the U.S. Global Change Research Program – a steering committee that coordinates all U.S. carbon/climate work.

The NACP addresses these fundamental questions: What is the carbon balance of North America and adjacent ocean basins, and how is the balance changing over time? What are the sources and sinks, and the geographic patterns of carbon fluxes? What factors control the sources and sinks, and how do they change with time? Are there potential "surprises," where sources could increase or sinks disappear? How can we enhance and manage long-lived carbon sinks to sequester carbon? – continued on page 2

Angling for Ions



Jim Connell and Alan Enman

ALAN ENMAN BUILDS RACECARS. So, naturally, Space Science Center (SSC) astrophysicist Jim Connell chose the UNH mechanical engineering junior from a field of eleven candidates to help build a device that would degrade a beam of high-energy calcium-48 nuclei at the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University. Last August, Connell, Enman, and SSC's Bruce McKibben, spent ten days at the NSCL conducting tests on Connell's Angle Detecting Inclined Sensor instrument or ADIS, which is to fly on a future space mission.

"Jim mentioned that one reason they wanted me on the team was because of my experience building race cars. They said they'd be throwing me some odd problems to solve and maybe the race car experience would give me an advantage," says Enman. Since 1997, the Berlin, N.H. native has designed racecars, done mechanical fabrication, welded, and "even done some driving."

In addition to a nimble mind, Connell explains, "Alan knew how things fit into a system and was used to working in a team setting." This latter skill would

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EOS SPHERES

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Balancing the Budget

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As the name implies, the NACP sets its sights on the North American continent, but because the ultimate goal is to nail down the global carbon budget, NASA, in conjunction with the Russian Academy of Sciences (RAS), has extended its reach overseas for projects deemed to have merit in the big picture and, thus, funded both the work of Li and Xiao.

"NASA supports both the NACP and a new initiative for northern Eurasia, the Northern Eurasia Earth Science Partnership Initiative," says Xiao. He adds, "The global carbon models say the Northern Hemisphere is a carbon sink, but what percentage is in North America or Northern Eurasia is not clear, it is not well-defined."

In addition, NASA opted to dedicate more resources to investigating areas of Russia, Northern China, Mongolia, and Central Asia around a latitude of 40 degrees north because, says Xiao, "If you look at global temperature data, these are areas that have had the largest change in the last decades — they're hot spots."

Xiao and Li and their Russian counterparts will use modeling, remote sensing, soil analysis, and eddy flux tower data in an effort to predict how much carbon is being released or absorbed in the region. CSRC research scientist Annette Schloss will also be working on the Russian project.

A State of Flux

The eddy flux towers, structures that resemble radio towers and typically rise some 30 to 60 meters, are micrometeorological stations that measure the exchanges of carbon dioxide, water vapor, and energy between the biosphere and the atmosphere. Instruments on the towers measure the turbulence or "eddies" of air above treetops for minute amounts of CO_2 and can discern if the carbon is moving in an upward or downward motion.

The Colorado University AmeriFlux tower near Niwot Ridge, Colorado. At top is a sonic anemometer, which measures fluctuations of vertical and horizontal wind. The krypton hygrometer below measures rapid fluctuations in water vapor. Photo courtesy of Sean Burns.

Over the course of a year, the average CO_2 concentration of all the downward-moving air and all the upward moving air can be tallied; the difference between these two equals the net amount of CO_2 the ecosystem absorbed or released.

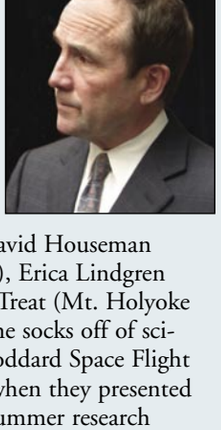
A global network of these towers, known as FLUXNET, started sprouting up around the world a decade ago. There are currently some 265 towers located in 40 countries. The network includes AmeriFlux (with the largest number, approximately 83 towers), EuroFlux, AsiaFlux, Fluxnet Canada, OzFlux, and others.

Ollinger's NACP work is a continuation of the remote sensing/leaf chemistry work he and others have been conducting in Bartlett, New Hampshire and at AmeriFlux sites elsewhere in the eastern U.S. (see the Fall 2003 issue of Spheres). The research uses hyperspectral imagery of forest canopies in conjunction with chemical analysis of leaf samples (collected by shooting leaves out of trees) from those same forest plots. Together, the data provide the scientists with a clear picture of forest productivity and related information on carbon uptake and nitrogen cycling.

The current NASA grant will allow Ollinger and company (including Xiao, Mary Martin, Michele Day, Lucie Plourde, Julian Jenkins, Rob Braswell, and M.L. Smith and Dave Hollinger of the U.S. Forest Service) to extend their work to nine sites strategically located around the North American continent. Each site contains an AmeriFlux tower. This will put the researchers that much closer to being able (through modeling and extrapolation) to map forest productivity and the related carbon/nitrogen dynamics for the entire North American continent. —DS

From the Director

Students Front and Center



THERE IS GROWING EXCITEMENT in the involvement of undergraduates in the Institute's research programs, and this issue of Spheres captures perfectly EOS's expanding commitment to our students.

Treasure the article on junior Alan Enman, a racecar-building mechanical engineering student who helped professor Jim Connell of the Space Science Center design and construct a contraption dubbed the "guillotine," which they used to degrade a beam of high-energy calcium-48 nuclei at the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University. Of the experience Alan says, "It's not something that everybody gets to do—work at a superconducting cyclotron on an instrument that may go into space." With those words he is, in effect, affirming our goal of making EOS a place for undergraduates to participate actively and seriously in high-level research.

Then there is Shannon Buckley, a junior with a dual major of Environmental Conservation and International Affairs, who is currently studying at the University of Edinburgh. Shannon has earned a special place in the heart of our air quality analysis and prediction program, AIRMAP. She has been with us in the field (and on the cover of the Boston Globe) literally from her first days as a freshman at UNH.

Our Research & Discover students, Karl Haase (New Mexico Institute of Mining and Technology), David Houseman (University of Leeds), Erica Lindgren (UNH), and Claire Treat (Mt. Holyoke College), knocked the socks off of scientists at NASA's Goddard Space Flight Center last August when they presented the results of their summer research efforts under the joint UNH-Goddard program. And we hail the success of graduate students such as Claire Hoff for winning an EPA Star Fellowship and Elizabeth MacDonald for receiving an AGU Outstanding Student Paper award.

Finally, I have spent nearly three decades trying to better understand the biogeochemistry of our planet and, in so doing, have come to realize just how important it is to link the interconnected element cycles in that study. So, when I read Wil Wollheim, one of our graduate students, explaining that while scientists have traditionally studied carbon or nitrogen "more and more people are trying to link them and understand the feedbacks," I know we must be doing something right!—Berrien Moore III

Student Profile

Wil Wollheim: Science the Old-Fashioned Way, Sort of

Wil Wollheim

Wil Wollheim grew up on Long Island, New York near the Queens border and, he says, "was exposed to nature pretty much by watching public television." The PBS programming must have tapped into something running deep inside the boy, for when Wollheim left home to study at Cornell University, his inner outdoorsman burst forth. "I entered the natural resources program there and joined the outing club, went camping, worked and spent summers at Hubbard Brook" (Experimental Forest in North Woodstock, N.H.). After graduating, he got a job looking at invertebrates in groundwater and then went on to get his Master's at the University of Wyoming studying macro invertebrates in the saline wetlands of that state's high plains region.

Today, as part of the Complex Systems Research Center's (CSRC) Water Systems Analysis Group (WSAG), Wollheim is the lone researcher who regularly goes out into the field and collects water samples. "I sometimes bring in field equipment that's all grungy and covered in algae and they give me strange looks," Wollheim says with a laugh. Never mind that the bulk of his time is spent churning through computer models.

A Ph.D. candidate, Wollheim says his research focus evolved from the realm of water-dwelling invertebrates because "in order to understand the differences in the biomass and the communities of these animals I had to understand the nutrients – the nutrients are the controlling factor."

Wollheim is looking at material fluxes in aquatic systems. Specifically, he's looking at nitrogen – inputs of which have doubled on continental surfaces over the decades due to fertilization. And yet, despite this loading, the amount of nitrogen that finds its way to coastal habitats is relatively small.

Says Wollheim, "So what we're trying to understand is what's happening to that nitrogen. If it's denitrified, that is, if it gets converted back to nitrogen gas, that's good, that means it's actually removed from the system. But if it's stored in places that could fill up, it might start to break out sometime in the future and that may be bad."

Understanding the fate of nitrogen will also help answer aspects of the carbon cycle, which has been the subject of much scientific scrutiny, in part because of its role in climate change. "Traditionally people studied carbon *or* nitrogen but more and more people are trying to link them and understand the feedbacks," Wollheim says. —DS

Angling for Ions

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come in particularly handy when, at the NSCL, Connell, McKibben, and Enman spent 22 straight hours testing the ADIS instrument as the cyclotron blasted it with calcium-48 nuclei.

Says Enman with a grin, "It definitely wasn't my first all-nighter. It's also not something that everybody gets to do - work at a superconducting cyclotron on an instrument that may go into space."

Connell's ADIS instrument, an archetype of design simplicity and elegance, uses four small disks about the size of a quarter and positioned at varying angles of inclination to intercept high-energy ions in space and measure their energy, direction and composition. Connell's work is being funded by a three-year, $140,000 per year grant from NASA.[1]

In the past, such measurements have required elaborate position sensing detectors that measure the position of these particles. Additionally, to interpret the data from position sensing detectors, a series of corrections and trigonometric calculations must be performed.

Says Connell, "It turns out that the mathematics required to analyze the data from ADIS is very simple compared to position sensing detectors, so we can program this into the data-processing unit on the flight instrument and let it analyze the data in flight." And this saves time, money, and precious telemetry.

But before any space-based data can be had, ADIS needed an initial test run. And this is where Enman's skills, and stamina, came in.

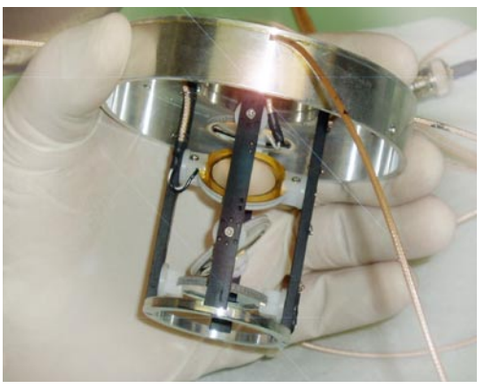
In order to "degrade" the beam being generated by the superconducting cyclotron and, thereby, replicate the large range of energies of particles in space, Enman was charged with building a simple, inexpensive contraption that would do the trick.

"My specific instructions to him were, 'It ain't gotta be pretty, it's just gotta work.' The device met both those criteria, and I was very pleased with it," Connell says.

The device, lovingly dubbed "the guillotine," was five-feet high, two-feet wide and outfitted with a cheap, 1-rpm display-case motor that powered an aluminum wedge of varying thickness. The wedge moved vertically up and down the frame once every minute to degrade the beam energy and allow Connell and company to get a range of energies that would be encountered in space.

And so, for 22 straight hours, Enman swapped out ADIS detector discs, changing sizes and angles of incidence in order to generate data that will allow Connell to refine the instrument.

Says Enman, "Playing with $2,000 quarters every half hour gets stressful after a while, especially when you're on your twenty-first



The ADIS instrument showing the inclined sensors.

hour." Remarkably, not a single, fragile disk was destroyed during the marathon. Of his experience, which also included designing test fixtures for calibrating the detectors with radioactive sources, Enman adds, "I didn't really have any intention of getting into space science, but after all this there's always that chance."

And is there a chance that he'll repay Connell for the unique research opportunity by building the scientist a racecar?

"No," Connell says flatly. Turning towards Enman, Connell, tongue firmly in cheek, adds, "But what I should do is turn him loose on what I've got now. You want to put a turbocharger on my Beamer?" —DS

[1] NASA grant #NAG5-12493

Student News

Claire Hoff, a graduate student in CSRC and the Department of Earth Sciences, was awarded a full-tuition fellowship under the U.S. Environmental Protection Agency's STAR fellowship program. The Science To Achieve Results award will allow Hoff to pursue her work on finding a better way to track calcium in the environment by providing tuition, travel, research expenses, and a stipend of over $50,000 for the next three years.

Hui Feng of OPAL (see Winter 2004 Spheres) was awarded his doctorate.

At the 2003 Fall meeting of the American Geophysical Union, **Elizabeth MacDonald** of SSC was awarded an Outstanding Student Paper for her paper, "Measurement of thermal electrons at rocket altitudes in night-side active aurora." MacDonald gave a poster presentation on her thesis research data, which focuses on a new instrument designed to measure the coldest electrons in the ionosphere.

Shannon Buckley

Shannon Buckley, a junior with a dual major of Environmental Conservation and International Affairs, is currently studying at the University of Edinburgh.

Research & Discover students **Erica Lindgren** (UNH), **David Houseman** (University of Leeds), **Karl Haase** (New Mexico Institute of Mining and Technology), and **Claire Treat** (Mt. Holyoke College), completed their summer internships and made project presentations at EOS and at the NASA Goddard Space Flight Center. All four are planning to do follow-on internships next summer at GSFC.

Space Grant News

Kudos from Headquarters, and Five More Years

DAVID BARTLETT, DIRECTOR of the New Hampshire Space Grant Consortium (NHSGC), reports that the consortium was granted a five-year extension from NASA under its 15th Year Evaluation of the National Space Grant College and Fellowship Program.

"The New Hampshire Space Grant Consortium performed at the highest level for all Designated Space Grant consortia…congratulations to you and your team for this exceptional achievement. I applaud your significant improvement in the involvement of women and underrepresented minorities," said the program's acting manager, Diane D. DeTroye, in a letter to Bartlett announcing the results of the evaluation.

Says Bartlett, "If we look back to what NHSGC was in 1991, our first year funded under the program, we've made an astounding transition from a program that largely supported graduate fellowships and undergraduate scholarships at UNH and Dartmouth and did a small amount of K-12 work. Now, in addition to having Dartmouth as a member, we have the involvement of the New Hampshire Community Technical College System, Plymouth State University, the Christa McAuliffe Planetarium, FIRST Place, and Cooperative Extension. It's been a big transition and that's what I feel best about—how far we've come in terms of having a broader and more diverse impact across the state."

One of the things Bartlett is most pleased with is the collaborative efforts that have grown between the Christa McAuliffe Planetarium and NHSGC. NASA, the planetarium and EOS scientists Eberhard Möbius and Toni Galvin collaborated on producing "Living with a Star," a multimedia show about the Sun and it's relationship to Earth for which Möbius and Galvin are virtual guides.

Again with help from NHSGC, UNH, and Plymouth State University scientists, another

multimedia show, "Breathing Space," recently opened. "Breathing Space is a departure for a planetarium in that they are focusing less on things external to the Earth and more on the Earth's climate," Bartlett explains. The show compares Earth and its climate to that of other planets by, for example, looking at the runaway greenhouse effect on Venus. NHSGC provided seed money to help get production of the show underway.

Bartlett says that this and the "leveraging of contributions of other NASA programs through UNH" is a core strength of NHSGC. For example, UNH scientists, engineers and technicians are currently building two identical instruments for NASA's Solar TErrestrial RElations Observatory (STEREO) mission. The $11 million contract includes $150,000 in education and public outreach funds, some of which has already been used for planetarium programs.

"There are multiple connections that Space Grant has facilitated over the years and that's the point of the program—to build leverage into bigger interactions. This is not only good for the planetarium but for UNH as well. It's a ready-made outlet to convey our science to the public, which is what we're charged with doing from NASA through both Space Grant and the education and public outreach components of other projects," Bartlett says.

To learn more about "Breathing Space" and other planetarium programs, visit http://www.starhop.com. The NHSGC website is at http://www.nhsgc.sr.unh.edu.—DS

Around the Hall . . . EOS News Briefs . . . EOS News Briefs . . . EOS News Briefs . . . EOS News Briefs

Amy Holt Cline, COOA's Education and Outreach Coordinator, was awarded the Outstanding Teacher/Educator Award from the National Marine Educators Association last summer. Kline is currently at work on her Master's, which focuses on finding new ways to teach about the ocean through 3-D technology.

Amy Holt Cline

In early September, a research team of faculty, staff, and students traveled to Duke Forest in North Carolina to study what biogenic emissions look like under enhanced carbon dioxide emissions – conditions that likely mirror our atmosphere in the not too distant future. Led by principle investigator Huiting Mao, eleven UNH researchers were in the field making measurements for two and a half weeks. The study, funded by the U.S. Environmental Protection Agency, is investigating how biogenic emissions will respond to climate change and, in turn, affect regional air quality.

Duke Forest

Postcards from ICARTT

International Consortium for Atmospheric Research on Transport and Tranformation • ICARTT

Thanks to Richard Marchbanks of NOAA, Eric Scheuer, David Sims and Kristi Donahue for photos.

. . . EOS News Briefs . . . EOS News Briefs . . . EOS News Briefs

The U.S. Arctic Research Commission (USARC) held its 73rd session in Morse Hall October 5 - 6 to learn about a host of Arctic-related research projects scientists at the university are involved in. The presidential commission is charged with establishing the national policy, priorities, and goals for basic and applied scientific research with respect to the Arctic, and throughout the year holds business meetings and conducts public hearings in Alaska and elsewhere to receive input. Commissioners also make site visits and field trips to research facilities and projects throughout the Arctic and around the country. After their visit, Deputy Director Lawson Brigham reported from his office in Anchorage, "We've never had any better presentations anywhere. The university should be very pleased. Most of the commissioners had no idea about the range and high-level of Arctic-related research that goes on at UNH."

Faculty/Staff News

Ann Bucklin was an invited speaker for the launch of the "Barcode of Life" Initiative in Washington D.C. Led by the Smithsonian Natural History Museum and funded by the Sloan Foundation, the Consortium for the Barcode of Life (CBOL) seeks to compile DNA barcodes (i.e., short DNA sequences used to identify species) for known and newly discovered plant and animal species. Bucklin also notes that the Sloan Foundation recently funded the Census of Marine Zooplankton (CMarZ), a global survey of animal plankton biodiversity, which she leads with her German and Japanese co-investigators. In July, Bucklin will move to the University of Connecticut as head of the Marine Sciences Department and director of the Marine Science and Technology Center at Avery Point.

Eberhard Möbius and **Harald Kucharek** report that the 8th CLUSTER Mission workshop held in late September at UNH was attended by 130 space scientists from around the world." Says Kucharek, "It provided the opportunity for the international science teams to share knowledge and ideas in order to advance magnetospheric research." Möbius and Kucharek organized the five-day workshop, which was sponsored by the European Space Agency, NASA, and EOS. Also involved were Charlie Farrugia, Vania Jordanova, Lynn Kistler, and research scientists Eric Lund, Christopher Moukis, and Pamela Puhl-Quinn.

Harald Kucharek

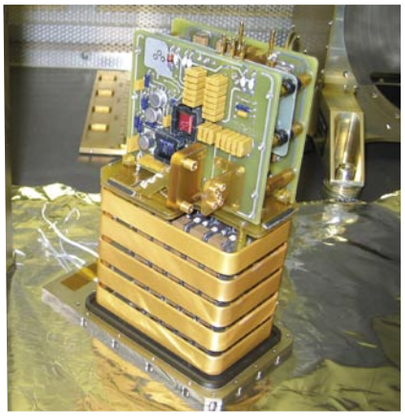
Two proposals SSC's **Jimmy Raeder** is involved in were selected by the NSF. A collaborative Information Technology Research (ITR) grant with researchers from UC Riverside and the Los Alamos National Laboratory will fund the development of new high-performance codes to study complex plasma interactions in the heliosphere and magnetosphere. The other NSF grant, under the Major Research Instrumentation (MRI) program (co-investigators Bhattacharjee, Jordanova, Kucharek), is for a 340-processor computer cluster slated to arrive in early 2005. CSRC's **Erik Hobbie** was also awarded a grant through the NSF MRI program to acquire two isotope ratio mass spectrometers and four associated instruments.

Mark McConnell of SSC accepted the position of Associate Professor of Physics.

Four EOS faculty members were selected among a field of 22 UNH faculty as "Outreach Scholars" under a new program jointly supported by Research and Outreach Scholarship and the Provost's office. The program is designed to build faculty strength in outreach scholarship and advance the academic strategic plan. At a ceremony held October 18, **George Hurtt** of CSRC, **Vania Jordanova** of SSC, **Jeffrey Runge** of OPAL, and **Barry Rock** of CSRC were inducted into the program.

Global Change Biology used a photo taken by **Changsheng Li** of rice transplanting in Yunnan Province, China on its cover. Li, **Steve Frolking**, **Rob Braswell**, and colleague Jan Fuglestvedt published a paper on climate impacts of rice paddy management in the issue.

The Black Magic of PLASTIC



Time of Flight or TOF high-voltage power supply.

Of all the challenges faced by the STEREO-PLASTIC team - and there have been plenty says engineer and project manager Steve Turco of SSC, none was more daunting than the need for high voltage supplies.

"High voltage for space-based instruments is a very specialized technology. In some cases it's a black art, black magic," Turco says. "High voltage electric fields can take on a life of their own in some ways. They're very particular of structures around them and the proximity of those structures." The high voltage is needed for the capture and steering of the particular ions PLASTIC will be hunting for in space.

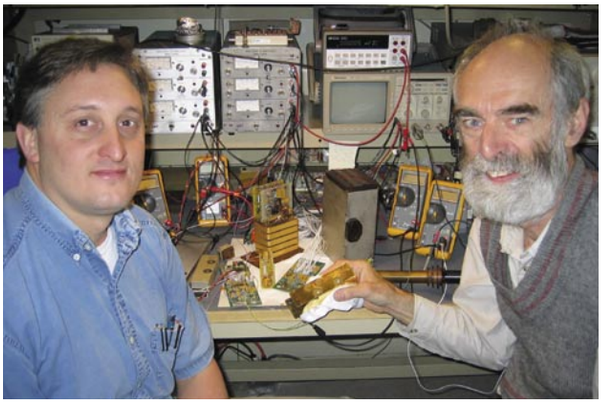
The PLASTIC (for PLasma And SupraThermal Ion Composition Investigation) instrument is an ion mass spectrometer that will sweep the plasma of space for certain charged particles. STEREO stands for the Solar TErrestrial RElations Observatory - the third in a line of solar-terrestrial probes exploring the three-dimensional structure of the Sun's corona.

And while some aspects of PLASTIC were "heritage" from the earlier Composition and Distribution Function Analyzer instrument built at SSC and flown on several missions, the high level of required high voltage was new territory.

Says Turco, "The high voltage power supplies are a large part of this instrument, it has five - one 30 kilovolt, one 5 kilovolt and three 10 kilovolt." That's a total of 65,000 volts. The electric socket in your house delivers 220 volts of juice.

"We recognized that we would like to have some expertise here in-house. With the help of a high-voltage expert consultant, Uwe Knauss of Germany, Brian King has stepped up to the challenge," Turco adds. King, who earned his Master's in electrical engineering at UNH this past September, is a research project engineer for the STEREO-PLASTIC group and now the go-to guy with respect to high voltage. Former SSC engineer Matthias Boehm was also instrumental in the power supply development.

"Controlling these high-voltage electric fields in the vacuum of space is a challenge," King says. Think of trying to contain a bolt of lightening that's actively seeking to escape from a closed box and you'll have an idea of what King was up against. Of the high-voltage supplies he adds, "To make these work you've got to have an excellent mechanical engineer (Mark Granoff) who can design structures that have contours, that are smooth and very graceful because electric fields seek rough edges where they can discharge energy, and you've got to have excellent machinists and creative electrical technicians." It is, in other words, truly a team effort to get one of these space instruments off the ground. Notes principle investigator Toni Galvin, "Testing the power supplies is also very much a team effort, and this includes David Heirtzler, Stan Ellis, John Gaidos, and Katherine Singer."



Brian King and Uwe Knauss

In addition to now having this in-house, high-voltage expertise, an added bonus out of the project is the development of two products that might merit a patent—a high voltage optical switch and a connector. Says Turco, "All the connectors we searched for were massive and heavy. So Mark and Brian designed and built something small and light, and it works great."

The first flight model of PLASTIC was completed at the end of September and is currently undergoing integration testing. Environmental testing (e.g., simulating how the instrument will perform during the rigors of liftoff and while in orbit) is soon to begin. —DS

Sea Grant News

Taking a Fresh Look at Fishing Gear

UNH's Pingguo He is helping organize the first international review of fishing gear technology in almost 20 years. A commercial fishing specialist with NH Sea Grant and a research associate professor in OPAL, He says that while gear hasn't changed much during that period, the attitudes of those who use, develop and regulate fishing gear have evolved quite a bit.

"With the collapse of the North Atlantic cod fishery in the early 1990s, people started to believe that even a mighty fish stock could be depleted," He explains. "At first this crisis led to everyone involved asking 'Who's to blame?' But over the last decade, it has led to a great deal of collaboration between fishermen, scientists and resource managers. And this has led to cooperative research involving fishermen and scientists, to gear modifications that actually work in the water, and to more acceptance by fishermen of research results."

He has been a key player in fostering cooperative research in New England, as well as instrumental in forging new ties among EOS, NH Sea Grant and UNH Cooperative Extension. The fishing gear symposium he is helping to organize is scheduled for November 2006 in Boston. It will be convened by the International Council for the Exploration of the Seas (ICES), a 19-nation collaboration that coordinates and promotes research in the North Atlantic.

Pingguo He, right, back to camera, works with fishermen from Poland, Maine, on a fishing net designed to catch flat fish, but let cod escape.

"The US tendency is to think of our fisheries problems as being unique, but the problems are global," according to Ann Bucklin, director of NH Sea Grant and one of the country's two delegates to ICES. "We can learn a lot about fisheries management and about the interconnectedness of species and their habitats through international collaboration. We can also use it to give UNH faculty and students opportunities to participate on the world stage." — Steve Adams, NH Sea Grant

Searching for Neutrons, Landing a Twofer

THE TECHNOLOGICAL DEVELOPMENTS of the early U.S. space program brought us such staples of everyday life as hand-held vacuum cleaners, smoke detectors, and ergonomic furniture. Now, technology being developed within the Space Science Center to "photograph" neutrons some 45 million miles from Earth is being adapted in the name of homeland security.

Jim Ryan, Mark McConnell, John Macri, and several undergraduate students are working under a three-year, $750,000 grant from the U.S. Department of Energy to re-engineer a space-based instrument currently under development. Their DOE version will eventually be used in shipping ports, train stations, and truck stops to detect contraband radioactive material.

Although originally conceived to accurately detect low-energy neutrons streaming off the Sun, the "neutron camera" or Fast Neutron Imaging Telescope being built by the team under a two-year, $200,000 NASA grant can do the exact same work a little closer to home.

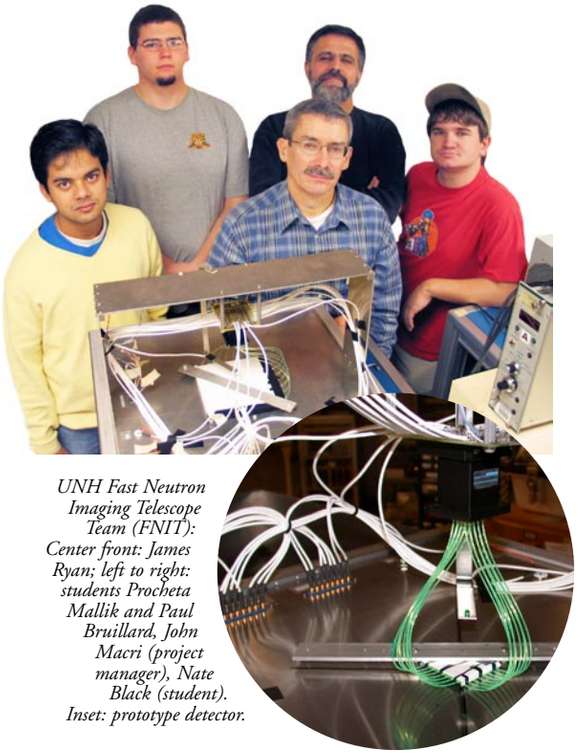
"It turns out," says Ryan, "that the neutrons coming from radioactive, fissionable material - plutonium, uranium - fall right smack in the same energy range as those we're looking to detect closer to the Sun." And, he adds, to locate radioactive contraband "what you need is a sensitive, small, lightweight, low-power detector, which is just what we've been working on this past year."

The Earth-bound detector would be roughly the size of a "two-suiter suitcase, maybe even smaller," Ryan says, adding that it could be even more sensitive than the space-based version because a source of power would be no issue. "You could plug the thing in." Ryan also envisions a smaller, hand-held version that, for example, could be easily taken on board a ship. Typically, however, the detector would be stationed in a port or at a truck stop where it would unobtrusively scan vessels and containers in bulk.

Unlike a Geiger counter, which simply clicks at a higher rate the closer it is to a source of radiation and cannot filter out the ever-present background radiation, the neutron camera discreetly records every neutron that interacts with the instrument and puts each one in a specific "bucket" based on what direction that neutron came from. The buckets are then emptied and, using software developed at SSC, the instrument "focuses" the neutrons into a coherent picture, emerging just like an image in a Polaroid snapshot.

The NASA project was initiated because the low-energy neutrons from the Sun that are the instrument's quarry only live 15 to 20 minutes and, even traveling at the speed of light, tend to peter out before making it to Earth.

And so, space scientists must go capture these elusive subatomic particles at a distance more than halfway to the Sun, or the farthest point in Mercury's solar orbit.



UNH Fast Neutron Imaging Telescope Team (FNIT): Center front: James Ryan; left to right: students Procheta Mallik and Paul Bruillard, John Macri (project manager), Nate Black (student). Inset: prototype detector.

Studying the behavior of these neutrons is important if scientists are to understand how the Sun produces cosmic rays or, more specifically, why a tremendous amount of energy appears to get pumped into the electrons and protons of solar flares.

Says Ryan, "If that's true, that's significant. Most things in nature don't work that way. It would be a tremendous surprise, for example, if you lit a candle and instead of just a dumb, hot flame, all of a sudden you produced nuclear radiation. Going from a low-quality energy source to a high-quality energetic product runs counter to so many other physical properties, but that appears to be what's happening on the Sun." —DS

Faculty Profile

Ru Morrison

KENNETH GRAHAME, AUTHOR OF THE CLASSIC 1908 children's book *The Wind in the Willows,* and Ru Morrison, current research assistant professor in the Ocean Process Analysis Laboratory (OPAL), have a least two things in common. Both of their families had houses in Scotland when the lads were growing up, and Morrison, like the book's unflappable main character, "Ratty," has a thing about boats. "'Believe me there is nothing—absolute nothing—half so much worth doing as simply messing about in boats,'" Ratty proclaims in the book.

When it came time for Morrison to choose a life's work, he ditched medical school in London after two years and decided to set to sea to become a different kind of doctor.

Says Morrison, "I come from a long line of medical doctors, and I'd done two years of med school, but I just didn't have the drive. So, after an accident that gave me time to do some navel gazing, I realized that I was a scientist and I'd always liked messing around in boats."

So Morrison enrolled in the School of Ocean Sciences at the University of Wales, Bangor and ended up in the field of bio-optics. "I wanted to do something with biology and physics as well, and this covers both of the bases."

Ru Morrison

Today, Morrison is one of only a handful of scientists around the world doing the measurements required to understand exactly how phytoplankton in coastal waters absorb and re-emit or "fluoresce" sunlight. It is a realm of investigation that is in its infancy and one that could provide more information about global levels of carbon.

Morrison's work using "hyperspectral" instruments both under the water and aboard an orbiting satellite is the type of ocean observing that is at the forefront of efforts to understand the whole, interconnected ocean ecosystem. And this is a scientific approach that was emphasized recently by the U.S. Commission on Ocean Policy's "An Ocean Blueprint for the 21st Century." Among other things, the presidential commission urged a new "ecosystem-based" approach to management, in which, says Morrison, OPAL's Center of Excellence for Coastal Ocean Observing and Analysis or COOA is actively engaged. —DS

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Alvin, the Sequel

AT 40 YEARS OLD, ALVIN IS READY TO RETIRE.

After having helped confirm the theory of plate tectonics, located a hydrogen bomb that had been accidentally dropped into the Mediterranean Sea, explored deep-sea hydrothermal vents, discovered new life forms, and surveyed the Titanic, the famous three-person submersible has earned a rest. And EOS's Karen Von Damm is chairing the National Science Foundation committee charged with overseeing the possible construction of a replacement Alvin. The new vessel will be capable of reaching more than 99 percent of the seafloor to depths of 6,500 meters — where the pressure is 650 times what we feel at sea level.

Says Von Damm, "There hasn't been an HOV built in 20 years that will go to these depths." HOV stands for Human Occupied Vehicle. By being able to get to 99 percent of the ocean floor, Von Damm says, the replacement Alvin would allow scientists to study the crustal subduction zones where the Earth's tectonic plates are being subsumed and recycled. —DS

Alvin: Illustration courtesy of Woods Hole Oceanographic Institution.

Setting Priorities for Earth System Science

Decadal Survey

Last August, with Berrien Moore III in attendance as co-chair, along with Richard Anthes, president of the University Corporation for Atmospheric Research (UCAR), the National Research Council held a workshop in Woods Hole, Massachusetts to organize an important new "decadal study" entitled, "Earth Science and Applications from Space: A Community Assessment and Strategy for the Future." The two-year study is intended to articulate priorities for Earth system science and the space-based observational approaches to address those priorities. The study seeks to establish individual plans and priorities within the sub-disciplines of the Earth sciences and create an integrated vision and plan for the Earth sciences as a whole. It will also consider Earth observations requirements for research and for a range of applications with direct links to societal objectives.

The survey is intended to be a community assessment; broad participation by the Earth science community is essential to the work of the survey committees and to the ultimate success of the study. To that end, the survey's web site http://qp.nas.edu/decadalsurvey contains a link where members of the community can post comments about any aspect of the survey. In addition, a number of outreach activities are planned, including community forums in conjunction with the Fall 2004 AGU meeting and the AMS meeting in January 2005.

The study will be organized using a model similar to that employed by the NRC for its astronomy and astrophysics surveys and for recently completed decadal surveys in solar and space physics, and planetary exploration. —DS