EOS SPHERES

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Taking Measure of the Entire Beast

This summer's huge NOAA-UNH air quality study will gauge the chemistry and dynamics of New England's air

Come July, hundreds of scientists from across the nation and around the world will converge on seacoast New Hampshire for six weeks of intensive fieldwork. They will come armed with the most advanced scientific instrumentation – 12 aircraft, a 274-foot research vessel, high-tech "Smart Balloons," satellites, and ground-based observatories – to take measure of the whole of New England's air. The study will track air masses as they move into the region, mix and morph, and then head towards Europe. The major objectives are to better understand the dynamics of the region's variable air quality – the source of emissions and the chemical and meteorological processing that transforms and redistributes the materials – and to determine how fine particle pollutants in the air may contribute to regional climate change by reflecting or absorbing radiation. The study will also set the stage for regular NOAA air quality forecasts, trials of which are to begin in New England this coming fall. Information derived from the field will help improve the complex numerical models needed for forecasting.

The complex and ambitious field campaign represents a benchmark in the evolution of atmospheric science and the "intellectual collect" of a diverse group of researchers, according to Fred Fehsenfeld, chief scientist at the National Oceanic and Atmospheric Administration's (NOAA) Aeronomy Lab in Boulder, Colorado. (Aeronomy is a branch of science that deals with the atmosphere of the Earth — its chemical composition, physical properties, relative motion, and responses to radiation from space.) The NOAA lab will co-ordinate the study while UNH's Atmospheric Investigation, Regional Modeling, Analysis and Prediction (AIRMAP) program will, quite literally, ground the project with its four, state-of-the-art air quality observing stations.

Image: courtesy of NOAA.

There were six men of Hindustan,
to learning much inclined,
Who went to see an elephant,
though all of them were blind,
That each by observation
might satisfy his mind.

Historically, says Fehsenfeld, "Scientists have worked on a particular problem with particular instrumentation and their focus has been in that field. As a consequence, they've been a little bit like the blind men of Hindustan – that is, they've bumped

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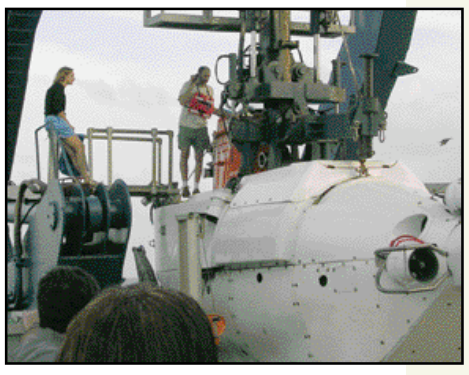

Karen Von Damm, left, waits to board Alvin, lower right, as it is readied for a dive.

To "Hole to Hell" and Back

Early in April, Karen Von Damm returned from three weeks at sea studying deep-sea hydrothermal systems known as "black smokers"— vents in the crust where Mother Earth burps up a new skin in a cloud of acidic black smoke and temperatures over 700 degrees Fahrenheit. One of these vents has been dubbed the "Hole to Hell."

Von Damm, along with UNH undergraduates Kimberly Beers, April Hyde, and Christopher Waters, graduate student Claire Hoff, and research technician Cheryl Parker of CSRC, were off the coast of Mexico above the East Pacific Rise at 9-10 degrees north latitude (referred to simply as "9 North") aboard the Woods Hole Oceanographic Institution's Research Vessel (R/V) Atlantis. Von Damm served as chief scientist on the expedition that used the ship's 23-foot long "deep submergence vehicle" the DSV Alvin to get to the ocean floor.

"We don't know how these ridges work, and the mid-ocean ridges are where the crust is made, where we're resurfacing the Earth," says Von Damm, Carpenter Professor of geochemistry and

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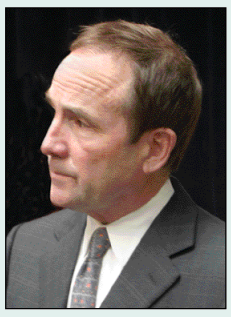
From the Director

Dodging Academic Potholes



On March 24th, the assistant professors in EOS and I started a new, joint adventure. We began what will be an ongoing, bimonthly, brainstorming activity. Over an extended lunch, we discussed EOS – its strengths and its weaknesses, and what we might do to make the Institute a better place for all. It was a no-holds-barred discussion; all topics were on the table, nothing was off limits. It was invigorating, and the entire Institute will benefit from the energy and fresh ideas that emerged.

During our talk I pointed out that, several years ago, the Institute faculty made the decision that there was one very large academic "pothole" we must avoid – the pothole of the inverted triangle with many more full professors than associate professors and many more associate professors than assistant professors (often an all-too-lonely single assistant professor at the bottom tip of the triangle). Because of our earlier decision, we had recruited heavily at the assistant professor level and, currently, the demographic profile of Institute faculty is a fairly healthy geometric shape with 24 full professors, 17 associate professors, 16 assistant professors, and another 10-plus, young, post-doctoral colleagues.

This is, however, a dynamic pattern, and given the highly talented young faculty in EOS, there is every reason to expect that they will be promoted. This positive event, when coupled with the expected "lifetime" of associate professors and full professors and a limitation on the growth in numbers of EOS faculty, makes the inverted triangle the "attractor" for this dynamical system. What should we then do to avoid the inverted triangle pothole?

I am not sure, but I plan to ask our assistant professors at our next luncheon. They may suggest, in the spirit of keeping everyone on their toes, that all full professors, including yours truly, return to being assistant professors after a decade or so "in grade"—or some equally imaginative (and less facetious) out-of-the-box idea. As I said, *nothing* is off limits at these exciting new sessions.

– Berrien Moore III

Sea Grant News

Sea Grant Plans for Release of Major Ocean Policy Report

As anticipated, the recently released preliminary report of the U.S. Commission on Ocean Policy recommends sweeping changes in the way marine resources are studied and managed, citing habitat loss, commercial fishing, polluted runoff, and invasive species as pressing issues threatening the coastal areas where half the nation's population now lives.

The report is the first major government assessment of the state of the oceans in 35 years, and it calls for the establishment of regional ocean councils, coordinated by a national council run from the White House. These councils would govern entire marine ecosystems, rather than focusing on single species or confining efforts within state borders.

"Ocean ecosystems are complex but our management systems view each type of human activity that impacts the oceans as separate and disconnected," said Andrew Rosenberg, UNH professor of natural resources and an EOS faculty member who is one of 16 commissioners nationwide who authored the report. "We need a coherent management system regionally and nationally that truly fits the pieces together."

This focus on regionalization is one the National Oceanic and Atmospheric Administration (NOAA) has already begun to adopt. Efforts such as the New England Air Quality Study (phase two of which gets underway this summer – see cover story) show NOAA's commitment to addressing complex regional issues such as air quality and weather forecasting. The ocean panel's recommendations will likely mean that NOAA will step up its commitment to tackling regional marine resource issues as well. And as a component of NOAA, the National Sea Grant College Program will likely need to follow suit.

NH Sea Grant recently hosted a panel discussion to explore opportunities for the Northeast Sea Grant programs (Connecticut, Maine, New Hampshire, Woods Hole Oceanographic Institute, MIT, New York and Rhode Island) to coordinate some of their research activities on a regional scale. Com
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action of continental and coastal
We found, and this is going to be very
ortant to better characterize this summer,
the land and sea interact, and this implies
emissions from Boston and Washington
the Eastern Seaboard can be carried over
r and don't just keep going east but are
etimes brought back in to the Gulf of
ne – in a changed form," says Albritton,
in March joined Senator Judd Gregg,
AA administrator Vice Admiral Conrad
enbacher, Jr., and other dignitaries at
to announce the field campaign. Gregg,
rman of the Senate Appropriations
committee, has secured millions in funding
AIRMAP and the overall field experiment.

MAP director Bob Talbot notes, "Our goal
summer is to gain a better understanding
is impact (local and regional sources) using
surements from AIRMAP ground stations
mobile platforms, such as aircraft and the
AA Research Vessel Ronald Brown."

ough ozone's role as both a greenhouse gas
ate change) and as an air pollutant
ative impact on plants and animals) will
key part of this summer's investigation,
surement and analysis of fine particles or
ols will be front and center during the experiment. Says Albritton, "The measurement of particles and their role in climate has been transformed over the last ten years." For example, he says, techniques are now available that allow the arrival of a single particle to be sensed by an instrument and for that particle to be broken by a laser into individual chemical components each of which, in turn, is analyzed.

Indeed, notes Albritton, because aerosols are such critical components in both air quality and climate change, and because the science of particle measurement and analysis has come so far, aerosols will be "the issue" of the next decade for atmospheric scientists.

"We suspect, and have made crude calculations to show, that aerosols can change clouds in a cooling direction, and that bright particles, like sulfur particles, can potentially cause as much cooling as CO_2 can cause warming."

Albritton stresses, "But the science community is going to have to do better than that. We're going to have to quantify how those little particles could make clouds brighter, and what that brightness could offer in the way of cooling. That's going to be a terribly difficult problem, but we're making a start on that this summer." - DS

To "Hole to Hell" and Back *continued from page 1*

oceanography at EOS and the Department of Earth Sciences. "The research we're conducting is pure science, it's really to understand better how our planet works." And this understanding will give scientists greater insight into the life cycle of these vents which, in turn, will help them unravel the planet's past and predict future activity.

This broad understanding and systems approach is being driven by the National Science Foundation's (NSF) "Ridge 2000" program, through which Von Damm's research is being funded. The program emphasizes the importance of linking separate fields of scientific inquiry in an effort to better see the big picture. Says Von Damm, "We're trying to understand the system as a whole – the oceanic crust, the magma, the animals, the vent fluids, and to understand how the moves in, moves up, heats the wat animals respond to changes in the

Kim Beers

The March voyage was the first of to occur over the next five years. V was awarded nearly $650,000 fror to lead the expeditions. She and a crew of 21 made 11 dives to phot and sample the hydrothermal syst of 9 North. Of the daily routine V says, "They load you up in the sul the morning, you crawl out 5:30is hour and half to get to the botton or mile and a half down. Von Dar dives, and nine individuals were a down in Alvin for the first time – Von Damm.

For Kim Beers, a 27-year-old juni majoring in earth sciences-oceano working in the hotel industry for work began *after* Alvin resurfaced. others worked in the lab until 3 a

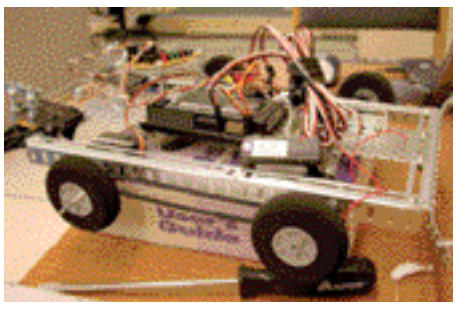
o's on FIRST?

lp from the NH Space Grant Consortium C), the Saint Thomas Aquinas (STA) High FIRST Robotics team received the of the Year award at the Regional Robotics tion at the Verizon Wireless Arena in ster on March 6. The team, which labored and weekends in Kingsbury Hall on the mpus to construct their robot from scratch, 8th out of 51 competing schools across New and Canada. In all, 900 teams from around d took part in the competition. FIRST was by inventor Dean Kamen of Manchester. A team was seacoast New Hampshire's first enter the competition in its 11-year history.

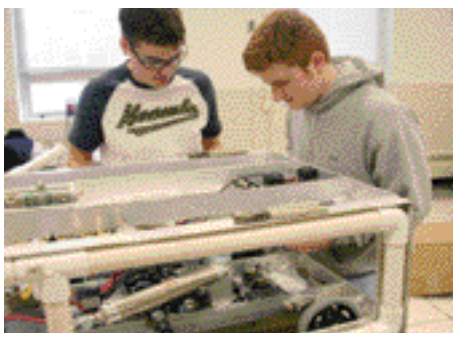
ISGC sponsorship provided the team with o cover the competition's registration fee, the of a couple of starter kits of parts (CPU, notors), and the cost of shipping the finished Manchester. Six UNH "mentors" helped the ool students with various aspects of the esign and construction.

O'Meara, a freshman in mechanical ing, was one of those mentors. Like the NH undergraduates, he participated in competitions as a high school student. ed the team design their robot using a er Aided Design (CAD) program – a first TA students. "After the drafting was done, welding at the Space Science Center's shop at EOS," O'Meara says. UNH's O team donated the services of the machine cording to Toni Galvin who is leading the fort for the STEREO mission.

an, a second-year physics teacher at STA, teams' faculty mentor for the project. Dinan years in the computer industry as a ng manager before turning to teaching later This was his first FIRST. Of the experience ays, "We've learned a lot this year, and next ll be in better shape. Some first timers just another group in order to learn the ropes, ust jumped in with both feet." And won ragging rights as a result. - DS



Prototype of STA's FIRST robot.



Mentor Bobby O'Meara (left) with student Sam Gilbert, studying their robot-in-process.

STA team at the FIRST event, preparing to compete.

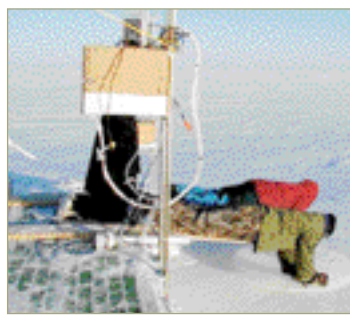
The FIRST competition.

Cold Mountain: Jack Dibb in Greenland

On Tuesday, March 30, 2004, the Climate Change Research Center's Jack Dibb reported that it was a "ve ry pretty day" at Summit, Greenland where he and a team of scientists were in the field doing air-snow photochemistry experiments. At the time, it was minus 50 degrees Celsius. Not bad compared to the previous week when, under sunny skies, the temperature combined with winds over 10 miles per hour resulted in a wind chill of -65C (-86F). At night, with a wind, it had plummeted to -132F.

As the Summit web site (http://summit.unh.edu/) reported, "Miraculously, no one has suffered from frostbite - but it takes constant vigilance, including watching out for each other to be sure they aren't showing any exposed skin, especially during the long walk out to the science camp (1 km)." Science for the faint of heart this is not.

Although Dibb, who is leading the current science team of 13 people from seven institutions, has been to Summit eve ry year since 1989, this is the first time he's been there in early spring to gauge photochemistry as the landscape begins to emerge from months of total darkness.



Top: Berthing tent (left) and Big House (rig Middle: Dibb at his mist chamber sampler housed in the box. Bottom: Jack Dibb and Galbavy of UC Davis lower a group sample the snow surface.

On April 2, Dibb reported from the field, "As expected, most of the ve ry reactive gases we are investigating, for example – hyd roxyl radical (OH) and nitrous acid (HONO) – are much lower now than they were last summer. But they are detectable, implying that the photochemical processing has begun, even with the low solar elevation and ve ry low temperatu We will be watching for changes as the sun climbs higher, and the snow and air start to warm

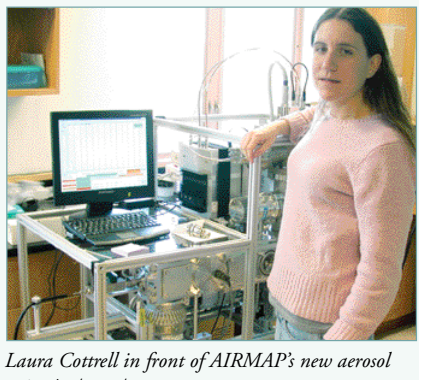
The research Dibb and colleagues are doing was spawned in 1998 when another team led by I discove red nitrogen oxides were pouring out of the snow at Summit. They had expected to fin small amounts of these gases, which, among other things, play an important role in the format ground ozone or smog. But readings taken eight meters (26 feet) above the snow were surprisi high, with readings closer to the snow surface even higher. "Finally," recalls Dibb, "we stuck th right into the snow and the numbers were astronomical."

This discove ry, and a similar, serendipitous find by a different team at the South Pole later that year, opened up a new avenue of scientific inquiry. "The whole issue wasn't even on anybody's screen before the late '90s. The thinking was that when it rained or snowed these reactive gases taken out of the atmosphere and that was the end of the story." But the story continues, and I team will continue to read into it at Summit through early May. - DS

and thermal measurements of eruption processes, focusing on volcanological sites in Antarctica, Kamchatka, Italy, Hawaii, Washington, Guatemala, Mexico, Chile, and Ecuador. As such, our team is now producing the next generation of numerical models, which integrate field measurements to more accurately simulate eruptions."

Research scientist **Laura Cottrell**, who also arrived in January, has been readying AIRMAP's new aerosol mass spectrometer (AMS). The state-of-the-art, $260,000 instrument will be used at the UNH Thompson FarmOb s erving Station and provide continuous data collection on aerosol size and composition. According to Rob Griffin, with acquisition of the instrument, "AIRMAP will really establish itself in the aerosol game," which promises to be the issue of the next decade in atmospheric sciences. The AMS will also be used in conjunction with Griffin's newly constructed smog chamber as well as at the Duke Forest in No rth Carolina as part of an EPA air quality/regional climate change study being led by Huiting Mao of CCRC. Cottrell comes to UNH from SUNY Stony Brook where she took a master's in marine and atmospheric sciences.

The UNH STEREO/PLASTIC team has installed a cleanroom in Morse 145. It encloses a high vacuum chamber that will be used to test and calibrate two flight instruments scheduled to launch in early 2006. The structure is required by NASA to avoid the "cross contamination" of an optical instrument onboard the STEREO spacecraft.



Laura Cottrell in front of AIRMAP's new aerosol mass spectrometer.

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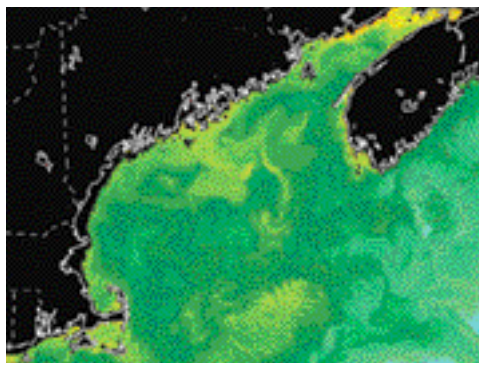
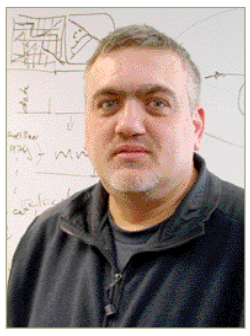


This image shows the chlorophyll concentration in and around the Gulf of Maine derived from data acquired by the MODIS-Terra sensor.



Balazs Fekete

vas Terra (1999), ied five remote he most comprehensive being Another EOS satellite, Aqua, n 2002, also carries a MODIS e satellites orbit the Earth every 90 with Terra passing over the same spot e time every morning and Aqua n the afternoon. This pattern allows , short-term changes to be recorded.

joined the MODIS team in 1996. compete, she proposed a MODIS ll concentration product analogous nly successful one produced by the g Wide Field-of-View Sensor or project.

bell, "The SeaWiFS sensor has been small but highly successful operation data since 1997. It has operated and the products have been right out available to people on the web." But, she notes, "SeaWiFS is not going to last forever. It was almost turned off this year, but we've got it for another year."

Fekete believes his proposal was successful because it gives NASA the opportunity to achieve more with less. River discharge measurements, he says, "are a very tedious calibrating process" involving time-consuming and expensive field measurements.

"In our proposal, we asserted that we can establish the relationship between the surface area and the river discharge without having to do the ground measurements, and this apparently caught NASA's interest," Fekete says. This means that for areas where little or no physical discharge data are available (parts of Africa, for example), remotely sensed data could be used to give accurate discharge estimates by comparing them with data from a well-calibrated site. This, in turn, would add significantly to our knowledge of the global hydrological cycle. - DS

er at a consulting firm," she says. "But hat sitting on a drill rig down at some , drilling wells to see if the soil was ted, wasn't the thing for me." Adds w a research assistant professor in the ystems Research Center, "When job, I was also advised not to dress ause you're going to be out there at six ning on these rigs with a bunch of men oing to ask you out.'" Enough said.

landed at EOS in 1993, she worked cian with former director of CSRC ill (now at Stockholm University) chromatography to study methyl yet another hot environmental topic. e, the compound, which is a powerful pread fumigant used to kill nematodes was targeted to be banned because of destroying atmospheric ozone. (A ban developed countries is slated for 2005 ish administration recently requested ion for American farmers and Use of the gas has been cut by 70 industrialized countries since 1999.)

er, "The ban spurred all this research ethyl bromide is doing in the natural ent. It's in the atmosphere at really low ions from wetlands, salt marshes, rice gi, and the ocean, which is both a source and sink. So there's a lot of natural exchange of it and this keeps the concentration pretty constant in the atmosphere. But it was increasing because we were adding more via fumigating things like strawberries, grain, and golf course sod."

Although her work has diversified over the years, Varner continues her research into natural emissions of methyl bromide. Currently, a three-year project funded by the National Science Foundation seeks to gauge fungal production of the gas, and, at Sallie's Fen (named for Sallie Whitlow of CCRC) in Barrington and sites in the UNH College Woods, Varner continues to measure methyl bromide exchange in order to establish fluxes and controlling processes in a temperate ecosystem.

"It's my favorite gas, so I'm going to try to keep studying it as long as I can. I think there are still a lot of questions about how it's produced naturally," she says.

As for her choice to forego the drilling rig for the rigors of research, Varner has no regrets. "This is a great place to work. I wasn't encouraged to go into science at all, I was actually discouraged on a number of occasions by teachers and professors. Patrick was the first person who ever really encouraged me to continue in research. He said, 'You're good at this and you should stick with it.'" Varner, it would seem, has a knack for taking sound advice. - DS

EOS Field Notes

Michael Keller Advises Senator McCain on Amazon's Role in Climate Change

Last January, in the Brazilian rain forest, Michael Keller, had the opportunity to give a presentation on the Amazon's role in global climate change to the man who is arguably the country's most influential spokesman on the issue—U.S. Senator John McCain. Joining McCain were senators Susan Collins of Maine and Lindsey Graham of South Carolina. Keller, of the U.S. Forest Service and EOS affiliate faculty, is the NASA project scientist for the Large Scale Biosphere-Atmosphere Experiment (LBA) in Amazonia—a Brazilian-led interdisciplinary effort to study the role of the Amazon in the global climate and biogeochemical system. McCain is Chairman of the Senate Committee on Commerce, Science, and Transportation, which oversees NASA.

In January 2003, McCain and Senator Joseph Lieberman introduced the Climate Stewardship Act—a bill that sought to take the first steps toward limiting heat-trapping gas emissions that are contributing to global warming. The measure ultimately failed but was characterized as a step forward on the issue. McCain chaired another Senate hearing on climate change in March.

In Brazil, says Keller, "Senator McCain said it (global warming/climate change) was a major concern and that the U.S. shouldn't be ignoring the issue. He wanted to know the relevance of the Amazon to this story. I informed him about the Amazon's role in planetary energy, carbon, and moisture budgets, the importance of land-use changes on the carbon budget, and how NASA's Earth observations using long-term and well-calibrated satellite sensors were critical to understanding that record, and diagnosing what's going on."

Keller says he stressed the importance of having this long-term sat observation of the Amazon. "We could the same things by flying a video camer around the world. You need a quantitat way to compare time A against time B this is why you need a calibrated instru as opposed to something that just takes picture."

Of the senators he adds, "They asked lo questions and were interested in how lo process of Amazon deforestation had be on. They wanted to know how long it w to be completely deforested at the curre Keller told them that it would take a rel long time, something like 200 years, bu that a linear time scale is not necessarily model to use. "If you multiply today's ra some number of years, you get the end but that doesn't work for your bank acc it doesn't work for the Amazon," he says just as interest rates change, so do land-u

Keller and his Brazilian colleagues talke particular challenges being faced – like t proposal to pave a highway from Santar Cuiaba, a process that historically doom

Student Profile

Kathy Reeves: Probing a Burning Quest

On its surface, our Sun doesn't make sense. As she pursues her doctorate in solar physics, Kathy Reeves is doing her small part to unravel the mystery of the "coronal heating problem." It is *the* big unsolved problem in her chosen field.

Says Reeves, "The surface of the sun, the photosphere, is a region that's about 6,000 degrees Celsius, but if you go out into the corona, which is the outer atmosphere of the sun, that part is 1 to 3 million degrees C. And on the face of it, that just makes no sense."

In trying to make some sense of this, Reeves is focusing her attention on a different, but related aspect of the Sun. She spends her days calculating the temperature of the "nested loops" that occur during solar flares related to coronal mass ejections (CMEs). These flare loops (pictured) are the site of "magnetic reconnection" where energy is converted from magnetic to kinetic and thermal. And these reconnection events may be key to the heating of the corona.

Explains Reeves, "It's been pretty well established that the big flares don't cause the global coronal heating but there's one theo 'nanoflar to observ magnetic heat ene

Reeves g with a m to work Cambric X-ray Te and prog (TRACE

"I looke her facul really int project," granting

Says Ree here— t can reall

UNIVERSITY of NEW HAMPSHIRE

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Earth, Oceans, and Space Symposium

The Earth, Oceans, and Space Symposium, part of the week-long Undergraduate Research Conference 2004 (URC), took place April 28 in Morse Hall. The symposium featured student research that contributes to or benefits from an interdisciplinary scientific perspective.

UNH senior Meredith A. Bailey (pictured) presented a poster about her thesis research on "evidence for cryptic speciation" in a type of copepod (small zooplankton) found in estuarine waters of the NewEngland region. Using DNA sequencing techniques, she was able to determine that the copepod was, in fact, "in the process of diverging into two separate species." Bailey had previously presented this poster at an AGU conference where, she says, "many of the professors and scientists I met were very impressed that I was able to pursue this level of research as an undergraduate." Bailey got her start in Ann Bucklin's molecular oceanography lab during her freshman year. - DS

Meredith Bailey was awarded a Summer Undergraduate Research Fellowship (SURF) to study the calanoid copepod Acartia tonsa, a species of zooplankton.

New Class: NR 797/897; ESCI 795/895; EOS 895

Earth System Science

How can people change the world? Does biodiversity matter? Why is El Niño important for forecasting climate months in advance? How did the growth of the Himalayas change sea level?

These and many more questions will be addressed in a new course being offered in the Fall Semester 2004. Earth System Science provides an introduction to the study of Earth as an integrated system.
The 4-credit course will introduce the major components, interactions, and concepts for characterizing the contemporary Earth system. Labs will focus on building computer models of key Earth system interactions. Research scientists from NASA's Goddard Space Flight Center (GSFC) will present guest lectures. The course was created and will be taught by Cameron Wake and George Hurtt, who credit NASA's Earth System Science Education for the 21st Century Program, the New Hampshire Space Grant Consortium, and EOS for funding the effort. "This is an interdisciplinary, cross-college offering," Wake says noting that the course is intended to appeal to a wide range of students from COLSA, CEPS and EOS. "We anticipate students from very different backgrounds, and this will be a strength—there will be a lot of peer-to-peer learning." The course is intended for juniors or seniors with a science background, as well as incoming graduate students.

For more information, contact Hurtt (george.hurtt@unh.edu) or Wake (cameron.wake@unh.edu). -DS