EOS SPHERES

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



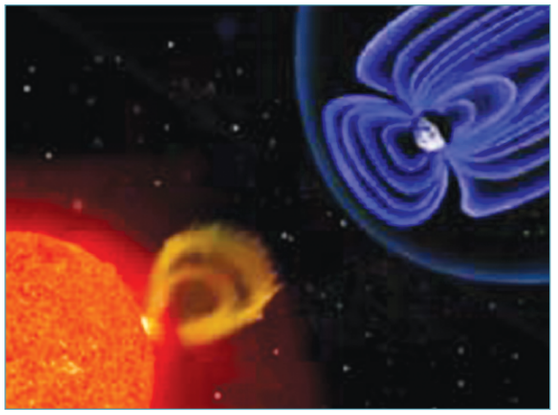
**Winter 2004**

Vol. 3 Issue 1

# M(u)MS the Word

## Two SSC teams compete for a part in NASA's next big Sun-Earth Connection mission

Ask Lynn Kistler to talk specifics about the instrument she's proposing to build for NASA's Magnetospheric MultiScale mission (MMS) and she gets a little cagey. "I can't tell you too much," she laughs after pausing in thought for a moment. The sense of intrigue is a bit tongue-in-cheek but, she adds, "There certainly are things in our proposal that *we* don't want *them* to know about with respect to our strategy, and I'm sure that's true for them as well." It is.



*A coronal mass ejection (on bottom left) streams toward Earth's magnetosphere, which is made up of distinct magnetically organized structures and their boundary layers.* Image courtesy of NASA.

"Them," in this case, is the other Space Science Center (SSC) team competing for a role in the MMS mission, a team that includes colleagues within earshot of Kistler – Roy Torbert and Jack Quinn. (Eberhard Möbius and Amitava Bhattacharjee are on Kistler's team.) The SSC teams are part of two multi-institution proposals that will build different instrument components for four identical satellites. The lead institution for Kistler's team is UC Berkeley; Torbert's team is lead by the Southwest Research Institute. For both teams, the underlying science has already been accepted by NASA. For this last leg of the competition, each team must show precisely how objectives will be met given the money allocated to do the job.

While Kistler is tightlipped about her team's work, Torbert is positively mute. "You can ask me but in many cases I just can't tell you. I'm under legal nondisclosure."

NASA's Magnetospheric MultiScale mission, slated for launch in January 2009, is a four-spacecraft Solar-Terrestrial Probe designed to study magnetic reconnection, charged particle acceleration, and turbulence in key boundary regions of the Earth's magnetosphere — a comet-shaped region surrounding the Earth that shields us from the highly charged solar wind. These processes, which control the flow of energy, mass, and momentum within and across plasma boundaries, occur throughout the universe and are fundamental to our understanding of astrophysical and solar system plasmas. Plasma is a highly ionized gas and is sometimes described as the "fourth state of matter."

– continued on page 2

# "Who's Out There?"

## ZooGene goes global

*A copepod, Euaugaptilus hyperboreus*
*Image: R.R. Hopcroft, Univ. of Alaska*

Ann Bucklin is not looking for ET. She's wondering who inhabits the other dark, cold expanse that remains largely unexplored — the Earth's oceans. Specifically, she expects to lead an effort that will collect, analyze, and catalog the flea-sized, zooplankton mesofauna — "bugs" — she calls them, from around the globe as part of the Census of Marine Life (CoML). The census is a decade-long, international research program assessing and explaining the diversity, distribution and abundance of marine organisms throughout the world's oceans. "It's an effort to know who's out there and how many of them there are," Bucklin says. "The census provides an accurate assessment of marine biodiversity, which we are losing — more slowly than we are losing terrestrial biodiversity, but we are losing it and we don't even know it exists." Therefore, an accurate tally of how many species there are, where they live, and how many of them are out there is critical.

The CoML, now entering its fourth year, has to date focused on what Bucklin calls "charismatic megafauna—big things that people find appealing." Tuna fish, sea anemones, etc. "So for those of us who work on small things like zooplankton, we've basically been on the sidelines." But no more, and this, she says, "is huge." UNH, already active in the

– continued on page 3

EOS SPHERES

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
**Institute for the Study of Earth, Oceans, and Space (EOS)**
Morse Hall, Room 309
39 College Road, Durham, NH 03824
Tel: (603) 862-5369
**www.eos.unh.edu**

**Director:** Berrien Moore III
**Associate Director:** David Bartlett
**Editor:** David Sims
**Graphic Designer:** Kristi Donahue
**Circulation:** Clara Kustra
Printed with soy inks on 100% post-consumer recycled paper, manufactured chlorine-free.

## M(u)MS the Word

*continued from page 1*

Only in the Earth's magnetosphere are these processes readily accessible for sustained study through the *in situ* measurements of plasma properties and the electric and magnetic fields that govern the behavior of the plasmas. But according to NASA, despite four decades of such study, much about the operation of these fundamental processes remains unknown or poorly understood. Enter MMS and its multiple spacecraft approach.

Each of the four satellites, flying together as a tightly coordinated fleet through the magnetosphere, will carry identical instruments and will thus be able to gather a multi-dimensional view of these processes that have eluded previous studies because of their small scale. (Whoever is successful in the competition will have to build four versions of their instrument.)

The main focus of this mission is to look at magnetic reconnection — the basic mechanism by which energy from the sun and the solar wind is transferred into the Earth's magnetospheric system. A blast of this energy can affect satellites, Earth-based instruments and power grids, light up the sky with aurora, and influence "space weather."

Says Kistler, "The better we can understand what it is that starts the process, the better we can predict when it will happen." The focus of the mission, however, is not on being able to predict space weather but, rather, involves understanding the basic physics of magnetic reconnection. And this is right up Bhattacharjee's alley. Bhattacharjee's Center for Magnetic Reconnection is dedicated to studying the phenomenon from a theoretical standpoint. Says Kistler, "It's critical for us to have a theoretical model like the one he generates to understand what we see" when four spacecraft collect the magnetospheric data and paint a three-dimensional picture.

As for the competition, Kistler notes that, technically, SSC scientists are always competing for many of the same proposals. "But we haven't competed before in so direct a way." The teams must submit their final proposals by April 26, 2004. - DS

*From the Director*

## Sustaining Excellence

In the third issue of *Spheres* (Fall 2002), I wrote of speaking at the Forum on Science and Technology within the World Summit on Sustainable Development (held in Johannesburg, South Africa) and the opportunities and challenges that sustainable development posed for science.

In this, our seventh issue, I address another aspect of sustainability—namely organizational sustainability—and specifically the issue of *sustaining excellence*. This is not to diminish or blur the extraordinary social, political, and scientific challenge of the larger issue of sustainable development. Rather, I want to highlight the importance and challenges of creating an environment and organizational context that sustains excellence.

As I noted in the last issue of *Spheres*, from its inception, EOS's charge was to become one of the premier academic Earth and space science centers in the nation. Over two decades, this goal has been achieved. Growth in numbers and reputation places the Institute in the forefront internationally of academic centers conducting interdisciplinary research in Earth and space science. This achievement notwithstanding, we must now rise to the challenge of sustaining excellence and doing so in the context of a changing environment.

We are in a complex and difficult budgetary climate, with large federal deficits and large fixed costs. Advanced instrumentation continues to revolutionize science, but does not come cheap and quickly becomes outmoded. Challenging space missions, demanding field campaigns, and taxing laboratory investigations require an integrated team of skilled technicians, experienced engineers, accomplished financial mangers, and strong scientific leadership. (The ability to create and field successful teams is a challenge not restricted to the world of sports.) Finally, there are real demographic dynamics. As some of our best and brightest reach the retirement horizon, we must train the next generation of scientists while maintaining and enhancing our financial support base in an ever more competitive research market. Thus, the simple strategy of replacing retiring faculty with young assistant professors may not always be the strategy of choice.

We must recognize these challenges and address them. We must address the multiple needs of our technical and financial colleagues in EOS. We must strengthen the fiscal base for instrumentation and apply it wisely. We must allocate our intellectual, technical, and financial resources carefully, and we must focus on where we can make significant scientific contributions. We must bolster our strengths and diminish our weaknesses. We must increase the quality and breadth of our academic program by, among other things, providing a unique educational experience to more undergraduates. And, finally, because we are nearing the limits of size, we must continue to exercise great care in all new appointments.

Achieving excellence is a challenge; sustaining excellence is an even greater challenge. Through teamwork we will meet that challenge together.

— Berrien Moore III

## Roger Arnoldy:
### Looking Forward to the Past

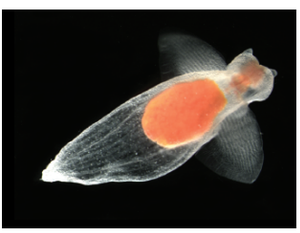
*Photo by Doug Prince, UNH Instructional Services.*

With no more students to teach and no more proposals to write, Professor Emeritus Roger Arnoldy is relishing the opportunity to plow through decades' worth of data he gathered but never analyzed. "I've probably looked at 20 percent of it," he says about the ground-based measurements he made in Antarctica of fluctuations in the Earth's magnetic field. Pointing to his desktop computer he adds, "I've got 15 years on that hard drive right there."

Last October, UNH and EOS honored the long and distinguished career of Arnoldy with a luncheon, a seminar celebrating his research, and a testimonial dinner. But Arnoldy will be adding to his 36 years at UNH for awhile yet as he delves into his data — some of which was logged at a rate of ten times per second. He's got plenty to keep him busy. - DS

## "Who's Out There?" continued from page 1

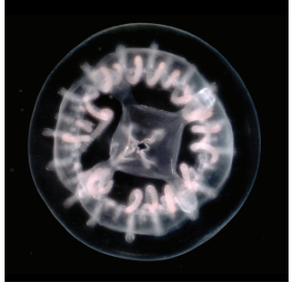
field through the Ocean Process Analysis Laboratory's (OPAL) ZooGene project, will soon be taking a lead role in this global bug census. ZooGene is the UNH-based, international effort to create a zooplankton genomic database of DNA type sequences for two groups of zooplankton. Uses for and research applications of the ZooGene database include defining uniform standards of species' identification, identification of cryptic species, accurate estimation of species' diversity, and determination of evolutionary relationships among species.



*A 'flying' mollusk or pteropod (wing-foot), Cliona limacina*
*Image: R.R. Hopcroft, Univ. of Alaska*

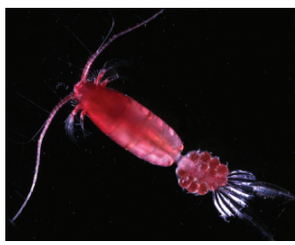
Bucklin is the principle investigator for ZooGene and will be leading the equivalent CoML effort, which will kick off with a week-long workshop in Portsmouth next March. The workshop will involve 25 plankton experts from around the world who will design the new Census of Plankton project. It is likely that the program office for the new census will be housed at UNH where most of the DNA sequencing will be done at the Hubbard Center for Genome Studies. This state-of-the-art facility, reports Bucklin, has high-throughput sequencing capacity "that will allow us to move from sequencing tens of species in the course of a month up to thousands of species."

ZooGene focuses on about 300 species (200 copepods and 86 euphausiids), creatures that represent a significant portion of the sea's small drifters and swimmers in terms of their number and biomass. In comparison, the new census of the plankton will focus on all 6,800 described species of planktonic organisms. But, says Bucklin, "We anticipate finding two to three times as many species among the zooplankton" because the census will boldly go where no one has gone before. Using "ships of opportunity" (fishing boats, ferries, commercial vessels, and other research vessels that are already plying the seas) to economize and broaden the sampling, scientists will investigate parts of the world's oceans that have not been collected from extensively and target groups that are especially difficult to collect because they're too fragile — species of gelatinous zooplankton, for example.



*A Hydrozoan medusa*
*Image: R.R. Hopcroft, Univ. of Alaska*

Says Bucklin, "I call this a value-added project because we're not spending huge amounts of federal dollars, we're simply taking more value out of oceanographic work that's already being done." The CoML is a project spawned by the Alfred P. Sloan Foundation which, Bucklin says, jump starts new fields of scientific inquiry with financial and organizational support and then moves on. "They've targeted biologic oceanography as a field in need of a revolution."



*Paraeuchaeta barbata, a copepod*
*Image: R.R. Hopcroft, Univ. of Alaska*

Like other areas of scientific inquiry, oceanography today is broadening from a historically linear view to a more systems-focused perspective, and the census is part of that evolution. Says Bucklin, "What we really need to do is understand how marine ecosystems work. We're exploiting them for fisheries, we use the seafloor for natural resource mining, oil drilling, and as a dumping ground. We're having an impact on regions of the world's oceans that we have never seen, where we've never been. We need some genuine knowledge about it before it's too late." - DS

*Sea Grant News*

# Zoogene in the Classroom

During her very first marine docent meeting, Linda Coe learned about the ZooGene project (see story above) from Ann Bucklin, NH Sea Grant Director. Bucklin gave a presentation on the project, and Coe introduced herself afterward. "When I described my background in molecular biology, her eyes lit up," says Coe. The two decided to find a way to bring ZooGene into high school classrooms.

There are over 150 members of the UNH Marine Docents, a volunteer program sponsored by NH Sea Grant and UNH Cooperative Extension that provides marine education programs for schools, civic organizations and the general public. During their 120 hours of training, docents learn all about the marine environment and can choose a specific area of concentration. Coe's 12 years working at New England Biolabs was a perfect fit for working on ZooGene outreach.

Bucklin and Coe held a workshop in the summer of 2001 to introduce teachers to the ZooGene project and discuss how it could be used in their classrooms. To provide the necessary equipment to the teachers, she teamed up with Barbara Hopkins, UNH Impact Center Director and founder of Advancing Science, a program that loans scientific equipment to classroom laboratories.


*Concord High School teacher Jane Palisi using a ZooGene lab kit.*

Coe is now working with teachers at Salem and Souhegan high schools to guide their students through the ZooGene protocol. It involves three steps: spinning a copepod (a tiny, shrimp-like crustacean) in a centrifuge, adding certain reagents to cut the DNA, performing a reaction to replicate the fragments, and finally, running the results of the reaction on an electrophoresis gel to identify the fragments.

Adapting the protocol for use in high school labs has had its challenges. The reagents (substances capable of causing a chemical reaction) Bucklin uses in her lab cut DNA into small fragments that allow her to identify specific species of copepods. However, the reagents are too strong to use safely in high school labs, so Coe modified the protocol. "The students," Coe says, "really respond because they can actually see the copepod that they use in the protocol. For many of them it's their first chance to use micropipettes and electrophoresis gels—it's a wonderful opportunity for them at the high school level."

Teachers are excited about the project as well. After attending the summer workshop, Norma Bursaw, a teacher at Salem High School, tried out the protocol with the school's biotech club. "Linda has been wonderful with everything associated with the Zoogene project," she says. "She is so knowledgeable and patient, and she explains things in a very clear manner. We are planning a workshop for next fall to kick-start the program with more teachers and a review of the protocol." —Kathleen Schmitt

# Faculty/Staff News

### Space Science

**Mark McConnell** was awarded $750,000 in NASA funding to continue the development of instrumentation to measure hard X-ray polarization from solar flares. McConnell, as PI for a multi-institution team, also recently garnered a NASA award of $100,000 to develop a concept for the Black Hole Finder Probe mission.

**Eberhard Möbius** and **Marty Lee** were among the investigators selected for the next stage in NASA's recent Small Explorer Missions (SMEX) competition. They are co-investigators on the Interstellar Boundary Explorer (IBEX) proposal — one of five proposals selected from a field of 36. IBEX will image the boundary between the heliosphere and the interstellar medium. The team, led by Dave McComas of the Southwest Research Laboratory, received $450,000 to conduct a five-month implementation feasibility study.

**Charlie Farrugia** and **Harald Kucharek** served as guest editors of a special edition of *Planetary and Space Science,* entitled "Key problems in space physics: Thin magnetospheric boundaries." The edition arose out of a symposium Farrugia convened at the Spring Meeting of the European Geophysical Society 2002.

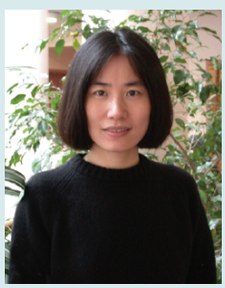
### Earth System Science

An article by **Ivan Dors** entitled "Computational Fluid-dynamic Model of Laser Induced Breakdown in Air" was published in the November 2003 issue of *Applied Optics*. The paper was based on work Dors brought to UNH from the University of Tennessee.

**Jack Dibb** reports ISI Essential Science Indicators, the group that tracks citations, identified a paper Dibb co-authored for *Geosciences* as a "New Hot Paper" for the month of September. The paper was titled, "Vertical fluxes of NOx, HONO, and HNO3 above the snowpack at Summit, Greenland."

The Environmental Protection Agency awarded major funding to the CCRC for work using an integrative approach of measurements and modeling to investigate the impacts of future climate change on biogenic emissions and air quality. **Huiting Mao** is the PI, with colleagues **Robert Talbot**, **Rob Griffin**, **Ruth Varner**, **Barkley Sive**, and new arrival **Ming Chen** involved in various aspects of the project. Dr. Chen, previously with Penn State University in the Earth System Science Center, joined the CCRC December 4 to lead AIRMAP efforts in regional climate modeling of the Northeastern U.S.

*Mark McConnell*



*Huiting Mao*

# Space Grant News

The New Hampshire Space Grant Consortium (NHSGC) has been steadily growing for more than a decade, but the years since 1999, when the NASA-sponsored program was elevated to its highest status, have been the most expansive of all.

Since 1999, NHSGC Director David Bartlett reports, the consortium has added UNH Cooperative Extension, the Christa McAuliffe Planetarium, FIRST Place, the New Hampshire Community Technical College System, and Plymouth State University to its ranks. (UNH and Dartmouth College were the founding members of the consortium.) "In the process," Bartlett says, "we have greatly expanded our programs, tripled the number of fellowships and scholarships awarded to students, made significant strides in NASA's diversity goals, and focused attention and resources on undergraduates."

As of last year, almost 100 fellowships and scholarships had been awarded statewide by NHSGC, including 50 to the community college system alone.

Says Bartlett, "The community college portion has been very gratifying. These are students who are often older than the norm, often in need of financial assistance because they are supporting themselves or are single parents."

The availability of these awards was broadened by allocating NHSGC funds to the Community College Foundation, which in turn attracted more sponsors and raised more money. For example, beginning this year, Public Service Company of New Hampshire put up $60,000 in matching funds over three years, "which allowed us to give fifty $1,000 scholarships last year," Bartlett says.

While graduate and pre-college students were initially targeted, the number of undergraduates brought into the program has about tripled over the last five years. Moveover, during this same time period, much effort has been put into increasing the number of women and minorities receiving awards. More than 40 percent of the scholarships and fellowships went to women as part of NASA's effort to increase the diversity of those studying science and engineering. Women are under-represented in science and technical fields by and large.

*David Bartlett, Director, NH Space Grant*

This current emphasis is the realization on the part of NASA and other agencies that the American workforce is not only unrepresentative of the general population but is also aging. Roughly half of NASA's current crop of scientists and engineers are eligible for retirement in the next five years.

Says Bartlett, "For a relatively small investment I think we're having a big impact on the community college system, which is the major supplier of technical workers."

For example, one community college student who graduated is now pursuing a bachelor's degree in mechanical engineering at Florida Institute of Technology, and hopes to co-op at the Kennedy Space Center and eventually work for NASA. Another, an Hispanic woman, will graduate this year and go on to Keene State to get a degree in computer science. "Both are first-generation college students who translated the NHSGC support to (at least) accelerate their program, if not make it possible. In both cases, they didn't enter the workforce (after graduating from community college) but went on to four year degree programs, which is, of course, an objective of this program as well," Bartlett says.


*For more information, see*
**www.nhsgc.unh.edu**

## Around the Hall . . . *EOS News Briefs . . . EOS News Briefs*

The **AIRMAP** program recently installed a Total Gaseous Mercury (TGM) analyzer at its Thompson Farm facility. TGM is an important element in the atmosphere to understand and monitor due to its potentially harmful impact on human and ecosystem health. Mercury is not measured in many places because the technology is very expensive and relatively new. The Thompson Farm instrument cost nearly $40,000. TGM is one of the contributors to the bioaccumulation of mercury in animals and humans. Recent reports have rekindled the awareness of the hazards associated with this toxic metal.

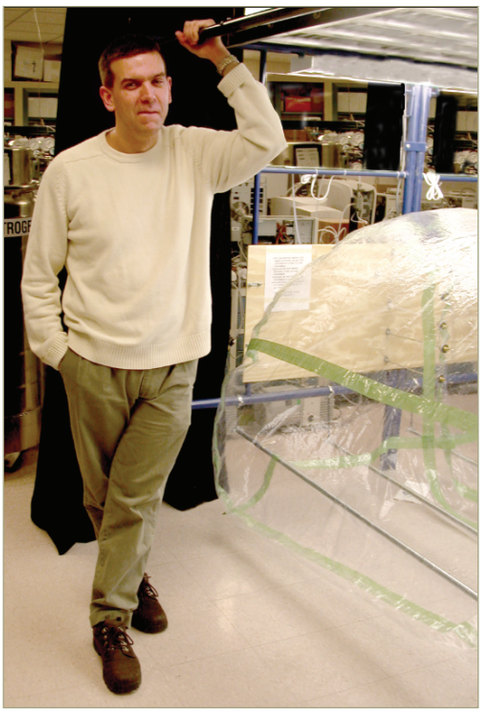
Says AIRMAP's Kevan Carpenter, "Currently it is too early to say much about the numbers (gathered so far) except they are what one might expect for this region. Certainly some of the elevated levels are interesting but I would not want to speculate about sources for those at this time."

Carpenter adds that by combining this data set with AIRMAP's other measurements, the program hopes to shed some light on the source of periodic elevated levels of TGM and supply a long-term record of TGM for the region.

# Bad Air in a Bag

THE STAGE IS SET, THE BLACK THEATER-GRADE CURTAINS ARE DRAWN. CHLORINE, LIGHTS, ACTION!

Rob Griffin is making smog. Or, more precisely, he and his students are trying to "simulate atmospheric secondary organic aerosol formation" in a big plastic bag filled with gas (the atmosphere), a rack of fluorescent lights (the Sun), and a dash of chlorine.



Griffin and company built their smog chamber to help determine how chlorine atoms from sea salt contribute to organic particle formation in coastal settings. That is, at least, the first task of the newly installed smog chamber, which will eventually be used in a host of EOS research activities.

Says Griffin, "There are a lot of reasons why we're interested in particulate matter (or aerosols) — climate change implications, human health effects, visibility degradation, the list can go on and on." Smog — comprised of ozone, aerosols, and other chemicals — is a perennial problem in seacoast New Hampshire during the summer months.

Certain types of aerosol particles form when volatile organic compounds or VOCs (such as unburned components of gasoline) react with a photo-oxidant (like chlorine from sea air, swimming pools, or cooling towers). Some studies have shown that chlorine released from sea salt reacts with VOCs and can lead to increases of up to 10 parts per billion (ppb) of ozone in coastal areas.

"In models for air quality in Los Angeles they're showing that ozone increase could be happening because of this chlorine release from sea salt," Griffin says. What's more, in what he terms "a vicious feedback," ozone and its products can lead to a surface reaction in sea salt and that, in turn, leads to more chlorine release which leads to more ozone, and so on. This process is highly dependent upon what other pollutants are present in the air.

*Xuyi Cai, a Ph.D candidate, and undergraduate students Natasha Hardy and Michael Diamond, and Rob Griffin.*

Particulate matter can be either primary or secondary. The black soot belched out of a diesel truck's exhaust pipe is a primary particulate because it's emitted directly to the atmosphere in a condensed phase. However, Griffin says, "Secondary aerosols are formed in the atmosphere by some sort of gas-to-particle conversion process, and this is the process we're most interested in."

In a typical experiment, a gas-phase organic compound — toluene, for example, which is emitted from a car tailpipe — is injected into the chamber. "The curtains would be closed so it's totally dark in there," Griffin explains. The initial conditions (prior to any photo-chemical reaction and formation of aerosols) are measured using a gas chromatograph. Then the chlorine source is pumped in, the Sun is flipped on, and the whole mixture is cooked. After the chemical reactions take place, the air is sucked out of the chamber into a series of tubes, nozzles, and instrument "boxes," where lasers, volts, and various processes will determine how many particles were created and what size and type they are. "It's important for us to understand how chlorine as a photo-oxidant affects ozone and particulate matter because these are two of the criteria pollutants for the National Ambient Air Quality Standards," says Griffin.

Some outdoor chambers, particularly those in Europe, are fifty times as big as Griffin's contraption and have a retractable roof. Says Griffin, "They're studying similar processes but most are focusing on biogenics (e.g., naturally occurring VOCs like the pinenes that make a pine forest smell the way it does) and their reaction with ozone. Nobody else as far as I know is looking at chlorine or bromine from sea salt."

Griffin's chamber is the product of a National Science Foundation (NSF) "Career Award" — given to young scientists early on in their academic career. With three years of funding remaining, and the chamber just now up and running, there will be plenty of time to brew and bake mock atmospheres and, it is hoped, help unravel some of the complexities of atmospheric chemical processes. -DS

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

Work for the **BalloonWinds** experiment moves forward on all fronts, including gondola design, charge-couple device (CCD) camera modifications, and design of the stainless steel enclosures that will protect electronics and instrumentation as the balloon rises from the hot desert sands to the icy edge of the Earth's atmosphere. Although the gondola must be designed to safely carry a 4,000-pound payload (including the laser and telescope that will perform the science) into near space, one determining factor in its design is decidedly more down to Earth: the whole unit must fit onto a trailer so that it can be trucked around the country. The 90-inch width of the gondola is largely due to this consideration. The platform's length and height are still open to question. Says project manager Steve Turco, "Once we have the gondola design nailed down, we'll look for a trailer." The trailer will be emblazoned with UNH/BalloonWinds graphics when the science is ready and the rubber meets the road. First stop, the Bartlett, N.H. GroundWinds station where comparative testing will take place; final destination, Holloman Air Force Base in New Mexico, home of the Stealth Fighter.

*Fully inflated at high altitude, the BalloonWinds payload will resemble NASA's Ultra Long Duration Balloon (ULDB).* Image courtesy of NASA.

*EOS Field Notes*

# Into the Wilds

Indiana Jones he is not, but when Mike Prentice starts to talk about his latest research expedition to the highland wilds of Papua New Guinea you can't help but envision the lanky, bespectacled, soft-spoken scientist in the signature fedora, bullwhip in hand.

"This last trip I got to know many of the locals in the highlands, survived a lot of difficult situations, and came away with a better sense of the turmoil these people are in because of rapid climate change, among other things. There is major work to be done there and I'm now convinced that it is doable. But it is a difficult place to operate," Prentice says with a grin. The locals included leaders of the Huli and Chimbu tribes and plane-flying missionaries who assisted Prentice with the difficult logistics of doing modern science in a land that in many ways is removed from the 21st century.

*A house in the highlands of Kerinda, Papua New Guinea, which served as overnight lodging for Prentice. Smoke from a central fire blackens the roof.* Photo courtesy of Mike Prentice.

Prentice has been working on and off for years in Papua New Guinea (PNG for short) and the western side of the island, Papua (part of Indonesia), researching sediment records for clues into past climate change in the tropical region. But on his last trip in September, it became clear that he needed to expand his research to include a meteorological focus to better understand current climate change, which he asserts is contrary to what some data show.

According to Prentice, satellite and balloon data indicate that the tropical lower troposphere (2-8 km altitude) has cooled down over the last 25 years or, at least, has not warmed despite the rise in surface temperatures. "This, to me, is one of the biggest mysteries in the global warming debate. It doesn't agree with many model predictions that commonly indicate warming should increase with altitude." Moreover, he asserts, when this tropical cooling is factored into the global average for the lower troposphere, "it has a significant effect and leaves you wondering how much atmospheric warming has really occurred."

It is Prentice's assertion that the troposphere over the New Guinea highlands has, in fact, been warming, not cooling. Evidence for this warming comes from plants like coconuts, which were once restricted to the lower, warmer climes but are now found growing in the highlands. What's more, on a previous trip to the Indonesian side of the island, Prentice gathered evidence for the recession of glaciers up at 15,000 feet. "The run-away, long-term retreat of New Guinea glaciers in the high alpine terrain is shocking and has to reflect warming."

But in order to nail down such assertions Prentice needs meteorological records from the highlands that have not been gathered for decades. Some records were kept until the early 1970s by the Australian Bureau of Meteorology (Australia administered PNG until independence was declared) but because of a lack of government funds and vandalism, meteorological measurements ceased. Of the shiny, modern equipment placed in the remote highlands region Prentice says, "If it looks valuable, it's gone." But he thinks he's found a way around that, and that's where the locals come in.

A coalition of people including representatives of the national weather service, two universities, a tour operator who owns tourist "huts" in strategic highland locations, the missionaries, key mining companies, and tribal leaders have agreed to help reestablish atmospheric observations. What Prentice hopes to do, he says, is create in the PNG and Indonesian highlands a modest version of AIRMAP to collect and analyze atmospheric data.

The seeds for this cooperative effort were sown sitting around huge fires that the locals stoked up to last through the night as they regaled Prentice (through a translator) with stories. "They talked about increasingly severe droughts, crop failures, and fatalities on a large scale. Before long, people were coming long distances to our camps to talk about the future. 'What's going on with the weather? How do I adapt my agriculture?,' they would ask." Prentice convinced them that, with their help, answers might be found.

Says Prentice, "This group could not have been put together from a distance. You've just got to forget the risks and go talk with people to try to unify what you think is important with what they think is important." And this is an approach that is just fine with a guy who relishes mixing science with adventure. -DS

*Faculty Profile*

# The Iceman Cometh: Mark Fahnestock

The exploration phase of Antarctica is drawing to a close or, as glaciologist Mark Fahnestock of Complex Systems Research Center puts it, "The white sheet of paper is filled in, there are no big new features left to discover anymore. We now have 50-meter resolution imagery of the whole ice sheet. And with this increased resolution we have found evidence of rapid changes in flow. We now need to figure out what produces these changes, and that's what we're in the process of doing."

Fahnestock has himself done some of the "filling in" over the years, investigating ice flow mechanics and surface conditions on large ice sheets, including Antarctica. His research is aimed, in part, at better understanding how climate change and ice sheet dynamics relate to each other and what this will ultimately mean to sea level rise.

One of the key questions Fahnestock has been probing involves the internal flow of ice sheets. Large ice sheets have "ice streams" that move much faster than the ice around them due to a thin layer of underlying water. Says Fahnestock, "Normally you have this slow, spreading flow, just like pouring syrup on your table, but if the bottom of the ice sheet were at the melting point (the syrup had a layer of water underneath it) so it could slip over the table rather than be stuck to it, it would move much faster. In such a case, the ice can move hundreds of meters per year instead of tens of meters." The mechanisms underlying ice stream flow are likely to determine the way they respond to a warming climate. Currently, sea level rise is about a millimeter and a half per year globally. "But if it went from millimeter per year to centimeter per year, that would start to cause some significant problems for people," Fahnestock says.

And that's the sixty-four thousand dollar question, and a big "concern," according to Fahnestock. "How ice flow changes as things warm up, and what mechanisms control how fast ice can flow off the continent will determine how rapidly sea level responds." Given all that, the irony of having recently moved his family from Washington, D.C. to seacoast New Hampshire to get back to "real" winters is not lost on Fahnestock. - DS

## Student News

*Manoel Cardoso*

Among a herd of students attending the AGU meeting in San Francisco December 8-12 was EOS's **Manoel Cardoso**, who presented results from a study on the relations between land-cover transitions and fire activity in Amazonia. The work, entitled "Land-Cover Transitions as Predictors of Fire Activity in Amazonia," was co-authored by George Hurtt, Michael Keller, and Berrien Moore. Other AGU participants included EOS's **Amy Frappier**, **Emily Fischer**, **Rachel Russo**, **Yong Zhou**, and **Kevan Carpenter**, all of whom gave poster presentations on data compiled during AIRMAP's summer 2002 field campaign. **Linsey DeBell** and **Eric Scheuer** also participated in poster work but did not attend the meeting.

**Brian Pellerin**, a Ph.D. student working with Charlie Vörösmarty and Bill McDowell (Natural Resources), presented a poster on his research at the LTER (Long Term Ecological Research) All Scientists meeting in September in Seattle. His poster title was "Role of developed land use and wetlands on hydrologic dissolved organic nitrogen losses from northeastern U.S. watersheds." Co-authors included Wil Wollheim, another Ph.D. student working with Vörösmarty. A paper based on this research was also recently accepted in the journal Limnology and Oceanography.

*Student Profile*

## Hui Feng

When Hui Feng decided to pursue his advanced graduate degrees in oceanography after working in the field of ocean remote sensing for ten years in his native Shanghai, China, he knew he was U.S. bound.

"For one thing," says the Ph.D. candidate in the Ocean Process Analysis Laboratory (OPAL), "all the big programs organized by NASA, NOAA, and the National Science Foundation have data that are in the public domain, they're on the web." In other words, vast amounts of scientific data generated by federally funded programs are readily accessible for researchers to download and work with.

Feng graduated in 1983 from East China Normal University in Shanghai with a degree in physics and worked for ten years at the university's Institute for Estuarine and Coastal Research. But knowing that the field of ocean remote sensing was much more advanced in the U.S., he started looking for opportunities and, eventually, was offered and accepted an assistantship at UNH. He got a Master's in physical oceanography — "the more traditional kind of oceanography," he says, and in 1996 started working with Janet Campbell towards his Ph.D. in ocean color remote sensing. He is currently a member of Campbell's Bio-Optical Oceanography Group (BOOG).

Ocean color remote sensing uses optical observations from satellites to interpret biological processes in the sea such as primary productivity and chlorophyll concentrations. For his thesis, Feng is trying to develop algorithms to determine optically active constituent concentrations, such as the concentration of chlorophyll and suspended sediments in coastal areas. Bio-optical oceanography is a sub-discipline of oceanography that concerns itself with the physics of light (optics) and its interaction with biological and biogeochemical processes in the ocean. Bio-optical oceanography is the foundation upon which ocean color remote sensing is based.

After completing his Ph.D. coursework and thesis qualifications, Feng took two and a half years off to work as a software developer — work unrelated to his chosen field but very beneficial nonetheless. "In remote sensing work you need a lot of computer skills. You have to process a lot of data, and do a lot of modeling," he says. As he finishes up his thesis work Feng works full-time for Hampton University in Virginia as a research associate. The principle investigator for the project is visiting NASA scientist Doug Vandemark. Feng and Vandemark are doing some work on ocean altimetry (satellite-based radar) to measure physical aspects of the ocean like sea level heights and current patterns. Feng hopes to finish his Ph.D. work next spring. - DS

## William Lenharth: Ph.D., Gearhead


Bill Lenharth may be Director of the Research Computing Center (RCC) and its InterOperability Laboratory (IOL), he may be an Associate Research Professor in the Department of Electrical and Computer Engineering, but give him a talking cop car and he's giddier than a kid on Christmas morning.

"I love this stuff, this is the best," Lenharth says as he watches a newly crafted video featuring his pet project, his hobby, CATLab's "Project 54" — more commonly known as "Car 54" after the 1960's television comedy series, "Car 54, Where Are You?" The video clip Lenharth is reviewing will be shown at a police convention in Philadelphia where the high-tech cop car will be showcased.

Project 54 has installed embedded mobile computing equipment, wireless networking, and voice-activated technology in 83 New Hampshire state and local police cars. The system allows an officer to do a host of tasks without taking his or her hands off the wheel or eyes off the road. More than half a dozen states have expressed interest in the technology.

The $4 million-a-year project started in 1999, with funding from the U.S. Department of Justice (thanks to Senator Judd Gregg) and now takes up two-thirds of Lenharth's time. "And then some," he says. But he's not complaining.

"I've always been a gearhead, I can't help it. Cars, trains, machines, that's me. I worked my way through school as a machinist and draftsman," he adds.

Lenharth came to UNH as a graduate student in 1973 after working for the Navy for three and a half years. He took a Master's in mechanical engineering and a Ph.D. in systems engineering in 1977. He worked for a computer company in Durham, Prime Computing Services, until 1979 when the company was sold and, he says, "UNH essentially bought all the equipment in the offices, and me." This became Research Computing, and Lenharth has been here ever since. RCC, which has grown from three to 12 people over the years, supports all the sponsored research on campus by providing network design and support, system administration and security, web services, etc.

In addition to his computing and Car 54 duties, Lenharth teaches a graduate level course in data and network communications with professor Tom Miller of electrical engineering. He also taught courses on, of all things, the architecture of Frank Lloyd Wright for the UNH Department of Art. Says Lenharth, "As an undergrad I took a year in the architectural program because I thought I might really like to do that." But, alas, he realized he was denying his inner gearhead, and the rest is history. - DS

UNIVERSITY of NEW HAMPSHIRE

Institute for the Study of Earth, Oceans, and Space
Morse Hall
39 College Road
Durham, New Hampshire, USA 03824-3525

800280

*Spring Spheres Concert Series*

## Music a la Carte

Greetings to our growing audience of concert goers and welcome to those of you who have yet to experience the EOS Concert Series!

Our indispensable concert coordinator, Lynda Copeland, has arranged yet another season of music to reach deeply into the musical preferences and diversity of the university community for our Spring 2004 Series. From the blues-tinged gospel and soulful ballads of Mighty Sam McClain and his big band...to the technical mastery and intensity of the Adaskin String Trio in their original interpretations of Brahms and Schubert...to the innovative Infinities Wind Quintet, which juxtaposes Mussorgsky's composition "Pictures at an Exhibition" with an art exhibit installed along the atrium's balconies, this season promises to deliver to one and all.

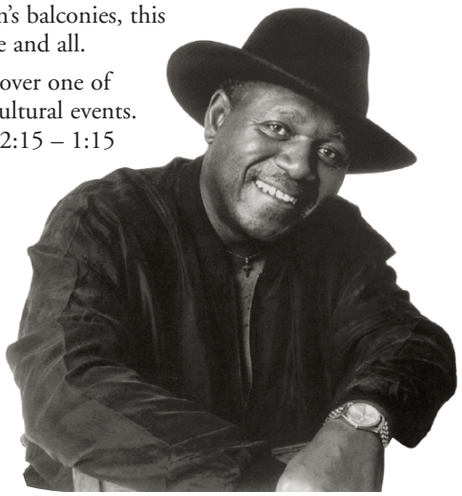
If you haven't already, come discover one of the university's most enjoyable cultural events. All concerts are on Thursdays, 12:15 – 1:15 in the Morse Hall Atrium.

**February 19**
**Mighty Sam McClain**

**April 15**
**The Adaskin String Trio**
Music by Brahms and Schubert

**May 13**
**Infinities Wind Quartet**
*Pictures at an Exhibition*

*For more information, see*
**www.eos.unh.edu**



*Mighty Sam McClain*

## GIS Day Draws Crowd

On November 19th, the New Hampshire Space Grant Consortium and Complex Systems Research Center hosted their Fifth Annual International Geographical Information Systems (GIS) Day Conference. Over 800 people attended.

More than 250 high school students and hundreds of geo-spatial science professionals, university faculty, staff, and students participated in the event. New Hampshire maps from the Library of Congress Historic Map Collection exhibition was this year's special attraction. The collection featured over 100 large antique reproductions including over forty circa 1890 panoramic maps of cities and towns throughout the state. The exhibition depicted the evolution of cities and towns by illustrating the development and nature of economic activities, educational and religious facilities, parks, street patterns, and transportation systems.

Other attractions included geo-spatial science related talks and presentations, an extensive modern professional cartographic exhibition, a geo-spatial science college fair and tours of CSRC's state-of-the-art GIS and remote sensing laboratory.