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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# Picking the "Low Hanging Fruit" of Arctic Climate Change

WHAT'S IN A NAME? Complexity for one thing.

Take, for example, a two-year, international scientific field campaign called the Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport.

Dubbed POLARCAT for short, it was the most ambitious effort ever undertaken to measure "short-lived" airborne pollutants flowing into the Arctic and determine how they contribute in the near term to the dramatic changes underway in the vast, climate-sensitive region. POLARCAT served as the coordinating umbrella for a host of individual but related research efforts undertaken by scientists from 20 countries.

Photo by Eric Scheuer, UNH-EOS.

*The NASA DC-8 approaches one of the many active forest fires that were sampled in northern Saskatchewan June – July 2008.*

Although global warming is largely the result of the accumulation of carbon dioxide, which can linger in the atmosphere for a century, the Arctic is highly sensitive to short-lived pollutants such as black carbon or soot, ozone, and methane. Forest fires, agricultural burning, primitive cookstoves, and diesel fuel are the primary sources of black carbon; oil and gas activities and landfills are major anthropogenic sources of methane.

Black carbon may account for as much as 30 percent of Arctic warming to date, according to recent estimates. Black carbon can warm the surrounding air and, when deposited on ice and snow, absorb solar energy and add to the melting process.

POLARCAT was conducted most intensively during two, three-week periods in the spring and summer of 2008 in which scientists, including researchers from UNH, analyzed the movement and composition of polluted air masses

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# Launching Undergraduate Success Through Research

Photo by D. Sims, UNH-EOS

*Morgan O'Neill and George Clark worked in the EOS Facility for Optical Calibration at Low Light Levels where they calibrated the star sensor for the IBEX mission.*

WHEN MORGAN O'NEILL AND GEORGE CLARK were seniors in high school, neither put UNH at the top of their college lists because neither of the wannabe scientists thought they'd get the high-level, hands-on research opportunities they coveted.

Now, after four years at UNH, both are poised to begin graduate school in pursuit of their Ph.D.s, and both sum up their success with one word – IBEX – NASA's Interstellar Boundary Explorer mission, which launched in October 2008.

"IBEX is completely responsible, it's *why* I'm going to grad school," says O'Neill who heads off to M.I.T. this fall.

Notes Clark, who will attend the University of Texas at San Antonio and do research at the neighboring Southwest Research Institute working with IBEX principal investigator David McComas, "I can't imagine my resume without IBEX."

Indeed, the mission was the guiding force through their four years at UNH. As freshmen, the physics

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EOS SPHERES

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## Launching Undergraduate Success Through Research

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majors began working with Eberhard Möbius of the Space Science Center and Department of Physics calibrating the unique star sensor for the IBEX mission. The star sensor helps pinpoint the precise direction of the energetic neutral atoms – IBEX's quarry – that are hurtling straight into our solar system from the far reaches of space.

Says O'Neill, "Dr. Möbius has encouraged us all along. He made it possible for me to go to Poland last summer to work on IBEX and sent George to the AGU Fall Meeting last year. This whole IBEX experience has been amazing and has made it easy for us to achieve outstanding things."

And the two have been aptly recognized for those things. Last year Clark was given an Award of Excellence at the Interdisciplinary Science and Engineering Symposium (ISE) for the poster he presented on his star sensor work. And at this year's ISE, O'Neill picked up an award for work she did that will allow the star sensor to add the Moon, with its well-known orbit and brightness, to the library of objects that the star sensor can recognize. (O'Neill also picked up another ISE award, in collaboration with graduate student and Research & Discover fellow Virginia Sawyer, for research on air/sea carbon dioxide flux during hurricanes, which they conducted as part of a graduate-level course.)

"Both students have been a great addition to our IBEX team," says Möbius. "Without their very independent work, we would not have such a well-functioning and well-calibrated star sensor on IBEX. They fully deserve the awards for their work."

Both physics majors chose the astronomy option, which prepares students for professional work as a physicist or astrophysicist, and both wrote a senior thesis on aspects of their star sensor work – the Moon "correction" in O'Neill's case, and Clark's analysis of the Milky Way brightness and its impact on the star sensor.

In addition to the Milky Way's light, an unexpectedly strong source turns out to be the geocorona – a layer of our atmosphere that resides in space and, when hit by sunlight, produces a glow of colorful light as hydrogen atoms are illuminated.

Like the Moon's glow and the light emitted by the Milky Way's billions of stars, the geocorona poses a threat to the star sensor because it reduces the number of bright stars the instrument can isolate through analysis.

"We knew it was out there but we didn't expect it to be so bright," Clark says of the geocorona. According to Clark, study of the geocorona is considered an exploratory science because there is much to learn about this atmospheric feature. Happily, the star sensor, which was never intended for this type of research, will actually provide helpful data.

Says Clark, "Further investigation of the geocorona will provide us with more insight into the Sun-Earth connection, and may even help global climate models since they are dependent on the physical processes that take place in our atmosphere."

Both Clark's and O'Neill's thesis work will eventually be folded into the star sensor's software to provide the needed corrections and make the instrument that much more accurate. They presented their work at the American Geophysical Union meeting in Toronto at the end of May. -DS

For more about the IBEX mission visit www.ibex.swri.edu.

Image courtesy of NASA

*The geocorona, a halo of low density hydrogen around the Earth (center), photographed April 21, 1972 by astronaut John W. Young, Apollo 16 commander.*

From the Interim Director

## A Propitious Time for Our Research Enterprise

Photo by K.Donahue, UNH-EOS

AS *SPHERES* GOES TO PRESS we await word on the selection of the institute's new director. We look forward to the renewed vision and energy that comes with a change in leadership, and our director will arrive at UNH at a propitious time with respect to the university's research enterprise.

In December 2007 UNH President Mark Huddleston established the Presidential Blue Ribbon Panel on Research to, among other things, ascertain what UNH needs to do to ensure the vitality of research, scholarship, and creative activity for the next 10 years, and ensure that research activities are integrally connected to and supportive of our broader academic mission.

The panel, co-chaired by Amitava Bhattacharjee of the Space Science Center, published its findings last October. According to the panel's report, by many measures the growth of research at UNH over the last two decades has been impressive and yet, the reports states, "if UNH is to achieve greater excellence in its research mission over the next ten years, it must do so through synergistic actions at all levels of administration, colleges, and departments on multiple fronts." The report recognizes that budget allocations need to support these actions and be more strategically aligned to promote research.

We have much work to do and can go forward with greater clarity and a renewed sense of purpose in light of the panel's perceptive findings. Here at EOS, we stand ready to join forces with the larger UNH community to engage in the "synergistic actions" that will push our collective research mission to levels of greater excellence. It is indeed an opportune time for us to welcome our new director and chart new horizons.

– Roy Torbert

# Polarcat

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flowing into the Arctic region. The field effort ended last July and researchers have been analyzing their data this past year.

In early June, UNH hosted a four-day data workshop where scientists shared their collective results for the first time, and discussed the next scientific steps and possible policy implications.

"This is a very perilous time for the Arctic and everyone is concerned about doing something to address the situation," says atmospheric chemist Jack Dibb of the EOS Complex Systems Research Center. Dibb, along with CSRC colleague Eric Scheuer, was on board NASA's DC-8 "flying laboratory" last spring and summer sampling plumes of polluted air being transported into the Arctic from lower latitudes and from unexpectedly large biomass burning in the region itself, including large-scale agricultural fires in Russia, Kazakhstan, China, Canada, and the Ukraine.

While there is a sense of urgency to the situation, the complexities facing scientists and, ultimately, governments and policymakers, are daunting. And although there is momentum building to "buy some time" by controlling short-lived pollutants, the science with regard to how these pollutants, and black carbon in particular, are affecting the rate of change in the region isn't in yet. (Controlling carbon dioxide emissions is vastly more complicated, potentially costly, and because of its atmospheric lifetime it takes much longer for the benefits of reductions to be observed.)

All of which makes it difficult to move forward. For example, there is some reluctance on the part of the scientific community to recommend that society pour a lot of time and money into reducing black carbon emissions only to discover that some other action – reducing methane, say – would have provided more bang for the buck. Moreover, says Dibb, "And you certainly don't want to do something that will have the exact opposite effect of what you set out to do."

Indeed, at the data workshop scientists discussed one modeling study that suggests controlling black carbon emissions might actually backfire and lead to further *warming* – although most modeling studies indicate that reductions of sources such as diesel engines will definitely have a positive effect on climate.

Among the POLARCAT scientists it was generally agreed that current models lack the necessary robustness to nail down the science and help with effective policymaking. Moreover, there is still a lack of adequate field data that would allow modelers to "constrain" their models and make them better mirror reality.

For example, models are currently unable to accurately show how much black carbon might be getting "scavenged" out of polluted air masses and deposited on snow and ice, perhaps adding to the overall melting process. And, as Dibb and others point out, while replacing billions of primitive cookstoves in India, for example, would definitely improve people's lives by eliminating the sooty emissions, "whether or not it shows up as a reduction in carbon in the Arctic is not at all clear," Dibb says.

Image courtesy of NASA Earth Observatory

*A river of smoke almost 937 miles wide stretches more than 1,375 miles over the Pacific Ocean from fires in eastern and southern Russia in this Moderate Resolution Imaging Spectroradiometer (MODIS) image from NASA's Terra satellite on May 7, 2003. Plumes of similar scale and impact were seen during POLARCAT.*

But short-lived pollutants are fast becoming the "low-hanging fruit" that, when plucked, might forestall some aspects of climate change. The eight-nation Arctic Council recently agreed to jointly undertake efforts to reduce emissions of black carbon, ozone precursors, and methane in order to slow climate change and ice melt in the Arctic.

> *"This is a very perilous time for the Arctic and everyone is concerned about doing something to address the situation ..."*

"It's impossible to look at the speed of Arctic change and not wonder about what can possibly be done to slow the melting," says Ellen Baum, senior scientist for the Clean Air Task Force, which helped organize the POLARCAT workshop. She adds, "For that reason, reducing short-lived pollutants that have global and Arctic-specific impacts rises to the top, and seems to be one of the only options where benefits can be seen in a timeframe that matters."

And says workshop attendee Catherine Witherspoon, a program consultant for ClimateWorks Foundation (an international philanthropic network "dedicated to achieving low-carbon prosperity"), "It's fair to say that nobody has the definitive answer about when we'll reach irreversible tipping points, but I think a reasonable case can be made to act on short-lived pollutants if those are 'no regrets' actions because we'll be getting health benefits at the same time."

According to Daniel Jacob of Harvard, who served as lead scientist on the NASA DC-8 portion of POLARCAT, there is an increasing push to integrate climate change and air quality/health objectives in the design of environmental policy. And, he says with respect to focusing on black carbon, the Arctic could provide a "backdoor way" of combining the public health and climate change aspects of the debate.

Jacob notes further that POLARCAT data show the sources contributing to pollution in the Arctic are much more diverse than previously thought. "And what that means, from the standpoint of building environmental policy, is that every large mid-latitude nation is contributing and so it becomes more of a collective endeavor – all the industrial countries in the northern mid-latitudes have to pitch in" to help solve the global problem. -DS


***Spheres*** garnered an International Award of Distinguished Technical Communication from the Society for Technical Communication – the largest organization of its type in the world. The winning entries were on display at the 2009 Technical Communications Summit held in Atlanta, Georgia in May.

And, in keeping with the current trend of paperless publications and UNH's strong commitment to sustainability, this will be the final printed issue of ***Spheres.*** Beginning with the Fall 2009 issue the newsletter will go to an online format and will be distributed via email. However, as is the case now, stories will be accessed through the main EOS web page. Readers who wish to subscribe to the electronic version of ***Spheres*** can do so at http://www.eos.unh.edu/Spheres.shtml. -DS

*Terry Forbes — Excellence in Research*

# Pop! Goes the Solar Flare

FOR 30 YEARS Terry Forbes has been pondering the inner workings of a phenomenon that occurs throughout the universe, greatly affects life here on Earth, and is analogous to the physical process that springs a Jack-in-the-Box.

"It sounds whimsical I know," Forbes says of the analogy between a solar flare and the old-fashioned children's toy, "but you have a coiled spring that gets compressed with a crank and then at a certain point the spring releases and, Pop! Goes the Weasel."

And so it goes when the Sun hurls out a coronal mass ejection – "just a fancy name for a solar flare," asserts Forbes, a solar theorist and research professor in the Space Science Center and Department of Physics, and who was recently honored by UNH with a Faculty Award in Excellence in Research.

*Photo by K. Donahue, UNH-EOS*

"What I think happens with a solar flare is, and a lot of people are on the same track, instead of a coiled spring you have a coiled, twisted magnetic field that can store energy in the same way the spring in the Jack-in-the-Box does," he explains.

However, Forbes notes, the puzzling thing is why so many of the magnetic "springs" sit for so long before suddenly flying off in an explosion of plasma.

"You can see the uncoiling going on and do more quantitative calculations related to magnetic theory – so it's pretty clear that the main source of energy for these flares is twisted magnetic fields. What we don't quite understand yet is the mechanism that makes Jack leap out of the box."

Because such flares are rather common on stars in general, and also occur in more exotic things like black holes and accretion disks, understanding the underlying physics of what makes them tick has broader implications than, say, just getting a better handle on how solar flares affect space weather near Earth.

The term "space weather" generally refers to conditions on the Sun, in the solar wind, and within Earth's magnetosphere and upper atmosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can pose risks to astronauts and people onboard aircraft in polar regions.

"For me, the motivation in doing this research is just curiosity, there doesn't need to be any practical application," Forbes says adding, "it's just such a fascinating thing, and when something fascinating happens you want to know why." (Forbes remembers well his own Jack-in-the-Box and, as a child, puzzling over the unseen mechanism that, to the exact turn of the crank, launched the captive puppet.)

Forbes notes, however, that luckily for him and colleagues with a similar scientific bent there are programs to support both the basic science ("the curiosity thing") and the practical applications of solar flare research.

"Most of my funding right now comes from the National Science Foundation and NASA – some of it for basic science and some for the Space Weather Program, which a lot of other people at EOS are involved with, trying to predict these events," he says.

Indeed, Forbes notes that while there are perhaps some 1,000 scientists worldwide doing work similar to his, you can't swing a dead cat in Forbes' EOS neighborhood without hitting a solar flare theorist. "Sitting here it looks like everybody and their brother does solar flares. You're in a hot spot here at UNH."

In a sense, solar flare scientists here at UNH and elsewhere are carrying on work first initiated by English amateur astronomer Richard Carrington in the mid-1800s.

Carrington, who had been faithfully recording sunspots using a telescope to project an image of the Sun on paper, witnessed a tremendous coronal mass ejection in September of 1859 – as did the rest of the world. On that day the entire Earth was engulfed in the Sun's gaseous blast; there were aurora from pole to pole, telegraph systems crashed and electric shocks knocked operators unconscious. It was Carrington who connected the dots, put solar flares on the map, and helped usher in modern astronomy.

But it wasn't until after World War II and the dawn of x-ray astronomy that scientists began to see solar flares more clearly.

Up until that time the natural tendency, based on observations, was to assume the flares originated from the Sun's surface or chromosphere. However, x-ray telescopes revealed for the first time that the solar Jack-in-the-Box appeared to be popping up from the Sun's atmosphere or corona.

Although naysayers remain, Forbes notes, "I think it's pretty clear that it's an atmospheric phenomenon." But that's hardly the end of the story.

Even with x-ray telescopes – like the Japanese Hinode X-Ray Telescope (XRT) mission on which Forbes is a co-investigator, the corona is a tricky area to investigate because of its magnetic nature.

"It's almost impossible to see and that's why there's so much research on this because it's kind of hard to make progress," Forbes says. So he and other theorists spend their time "coming up with various schemes" of how the magnetic field might get twisted, evolve, and eventually fly apart.

It is for his decades-long efforts as a solar theorist that Forbes is recognized internationally as an expert in the field and was recently awarded by the university.

"Terry's contributions to understanding magnetic fields in plasmas and explaining their behavior on the Sun have been truly outstanding," says research professor Phil Isenberg who, like Forbes, is a member of the Solar-Terrestrial Theory Group within the Space Science Center. Adds Isenberg, "Here at UNH, Terry's insights and willingness to work with research colleagues have benefited all of us and, for me, having Terry just down the hall to talk to and puzzle over problems with has been incredibly valuable, both scientifically and personally."

Forbes' efforts at making progress also include discussion with colleagues on the other side of the fence – the experimentalists.

"I always think its not really science unless the theory and experimental people talk to each other," he says adding, "and it's important for the theory people to keep their eye on the observations and not just wander off and come up with some real ivory-tower ideas that come crashing to the ground when compared to reality." -DS

*Changsheng Li – International Engagement*

# Simulating Nature to Improve Life on Earth

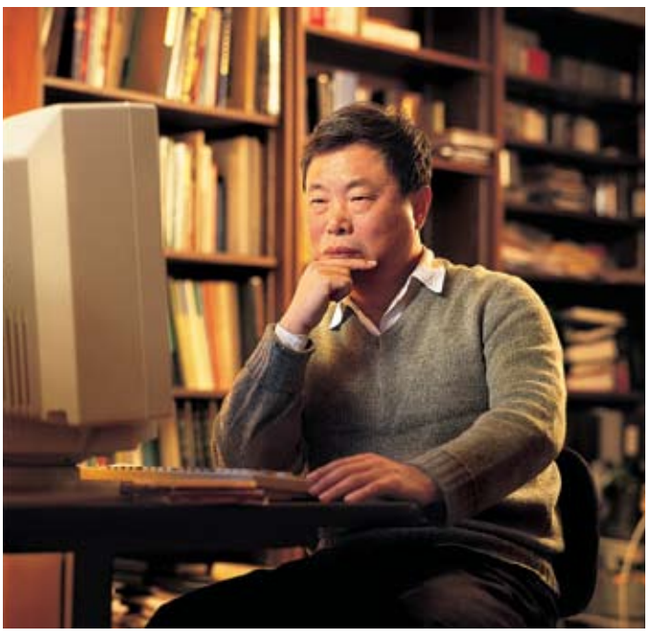

Photo by Perry Smith, UNH Photographic Services

CHANGSHENG LI has spent 22 years building a single, mathematical ecosystem model. So it's a bit surprising to hear him say that the discipline is just getting underway. "Modeling for ecosystems is really in the very early stages of development because natural ecosystems are so complex and therefore very difficult to simulate," says Li of the Complex Systems Research Center.

Since 1987 Li has been trying to simulate the soil biogeochemical processes occurring in agricultural systems throughout the world with his DeNitrification-DeComposition or DNDC model. And in order to put all the modeling puzzle pieces together, he has traveled the globe to talk with field researchers and gather the data they have gleaned.

For this, Li has been honored by UNH with a Faculty Excellence in International Engagement award.

Although the foundation of a mathematical model such as Li's is constructed on basic physical, chemical, and biological equations to create a virtual ecosystem, without real-world information to run on, a model is virtually useless.

Says Li, "That's why I've had to leave the ivory tower and go out into the field to talk with the field researchers, get them to share their observations and experience, show them how the model works, and let them use the model. Through this kind of feedback and use the model gets calibrated and validated."

And, eventually, it becomes a tool that can be applied to vastly different regions around the world. Li has collaborated with scientists in Canada, China, Japan, India, Germany, France, Italy, the United Kingdom, Russia, Belgium, Finland, Spain, Australia, and New Zealand.

His globetrotting has been essential because, he notes, researchers are understandably reluctant to share hard-earned data for nothing in return.

"You can't just email someone asking to use their data, there must be something mutually beneficial, that's fundamental to international collaboration," Li says. He adds, "Of course, the basis for offering something is that you want to improve the environmental quality of the planet in collaboration with other scientists."

Li has dedicated his scientific career in the service of planet Earth's health. Specifically, after all these years of development and refinement, the DNDC model can precisely simulate greenhouse gas emissions (e.g., nitrous oxide, carbon dioxide, and methane) across a variety of terrestrial ecosystems, under any climatic condition, anywhere in the world – almost.

The DNDC model is currently used only in temperate zone environments. However, Li is hopeful that a proposal currently in the works will be funded and allow the model to be used for the high-latitude Arctic regions where things are changing very rapidly.

Indeed, with the growing possibility that thawing permafrost will release prodigious amounts of methane – a far more potent greenhouse gas compared to carbon dioxide – being able to accurately model emissions in the region would be a significant step forward scientifically.

> *. . . the basis for offering something is that you want to improve the environmental quality of the planet in collaboration with other scientists.*

Recently, researchers in New Zealand who use Li's model established the DNDC Global Network (www.globaldndc.net) that links users worldwide and allows them to make modifications to the model to suit their specific needs.

Explains Li, "There are so many users worldwide and they raise lots of questions and suggest modifications. I only have one post-doc working with me and so I simply can't handle that kind of workload."

So users make changes to the model's source code or input parameters to accurately mirror their region's ecosystem characteristics, and that model becomes their own. There is now a DNDC model for Canada, the UK, Europe, China, and New Zealand.

Just as 1+1=2 is true anywhere in the world, the model is applicable across pasture, forest, wetland, or agricultural ecosystems because it's built on fundamental, classic principles capable of predicting the biochemical or geochemical reactions of carbon and nitrogen driven by common environmental factors like gravity, temperature, moisture, pH, etc.

While the model lends itself to international use because of its universal foundation, oftimes there are language barriers to overcome when Li travels overseas to confer with field researchers. But, Li says, he's found that because everyone is working toward the same cause there is a common language that guides discussions.

"I've learned that most people living on the planet are looking for a better life and are holding out hope. So we need to improve the atmosphere to let global study advance, because we are dealing with global issues." Li adds, "If we develop these kinds of mutually beneficial friendships, there is great hope to stop the degradation of our environment. That's why I think it's worth spending my life on modeling work in collaboration with worldwide researchers and friends." -DS

*Eberhard Möbius – Distinguished Professor*

# Herr Distinguished Professor

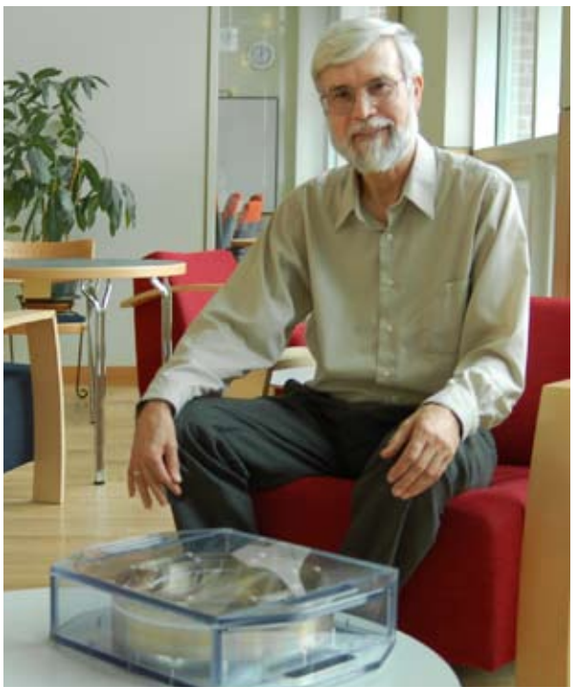

Photo by K. Donahue, UNH-EOS

LAST YEAR, THE UNH Physics Department established an awards committee to bolster the department's chances of getting people nominated for faculty, staff, and student recognition – something that had not been happening on a regular basis.

It didn't take long for the move to pay off in an unexpected way. Eberhard Möbius, who was appointed chair of the Physics Department last year, was nominated for and selected as the 2009 UNH Distinguished Professor – the first Physics Department faculty to be so recognized in 20 years.

The long-time EOS and Physics Department faculty member talks about the honor with characteristic modesty, but those who work with Möbius say the award is richly deserved given his distinctive record of research, teaching, and service since coming to UNH from the Max Planck Institute for Extraterrestrial Physics in 1990.

In a letter of support for Möbius' nomination, Space Science Center colleague Marty Lee noted, "Put simply, Eberhard is outstanding not only as a compassionate teacher and conscientious mentor or supervisor, but also as a world-class researcher in space physics and exemplary leader of his team of experimental researchers."

The award comes at a time when Möbius feels his research career has come full circle – from the first space instrument he built in Germany to the current Interstellar Boundary Explorer (IBEX) mission, which launched this past October and for which he is the UNH principal investigator.

On the 1984 Active Magnetospheric Particle Tracer Explorers (AMPTE) mission, Möbius made the serendipitous discovery of "pick-up" ions that are created when atoms from the interstellar wind flow in from outside our solar system. The finding marked the first time scientists could study particles that stem from the local interstellar environment.

Some 25 years later, with IBEX, this same work is culminating with "seeing" directly the neutral gas flow of the interstellar wind. Says Möbius, "Back then we were only able to see some secondary particles in the form of the pickup ions. And, today, we have also developed the ability to produce the first full-sky map or image of the boundary between the solar system and our local galactic neighborhood." He adds, "What we're doing with IBEX is opening up yet another window for astronomy."

Looking back through history, the first "window" of astronomy was the visible light seen with the naked eye. Then, in the World War II era, radio telescopes were invented to detect radio waves from outer space, which can penetrate Earth's thick atmosphere. With the dawn of the space age several more windows opened to include the entire electromagnetic spectrum.

The neutral atoms being measured by IBEX are yet another window because they offer a view of the edge of our solar system; scientists know they have traveled in a straight line from those far distances thanks to the evermore sophisticated "time-of-flight" instruments Möbius and colleagues have built (and placed on the Cluster, FAST, and STEREO missions) over 25 years.

But stellar research alone does not a Distinguished Professor make; successful nominees must receive recognition from colleagues across campus – not just their affiliated college or department.

In that regard, Möbius' long-time involvement in a cross-disciplinary seminar entitled "Cosmology and Our View of the World" may have helped matters.

"I've been doing this seminar for a long time now with colleagues from philosophy and life science and I think that might have contributed to the award," Möbius speculates.

The seminar or "preceptorial" is open to students at all levels and majors and, through a format of open discussion, "explores the sources and limits of human knowledge concerning the origin of the universe, the origin and distribution of life in the universe, and the mystery of our consciousness," which allows us to be aware of ourselves and the universe. No run-of-the-mill GenEd course this!

Indeed, Cosmology and Our View of the World is intended to "serve as an expression of a shared desire to delve deeply into the mysteries of our existence as conscious beings in a vast universe."

The 90-minute class is the only one Möbius has encountered where students don't get restless in their seats when, as it were, the bell rings. "In other classes when you run over by couple of minutes, immediately there's this restlessness in the air. That just doesn't happen." To wit: this past semester the instructors finally had to pack it in an *hour* after class was officially over while the students stayed behind and kept the discussion going into the night. "If you can ignite a discussion like that you know your goal has been achieved," Möbius says.

But as Marty Lee notes, Möbius' teaching experience is deep, wide, and highly valued by students – who find both the subject matter and the man accessible.

"Eberhard has excelled as a classroom educator, from teaching the undergraduate Introduction of Modern Astronomy to an elective graduate course on heliospheric physics, his specialty, and contributing to a graduate course on Space Instrumentation and a graduate seminar," Lee says.

As part of his undergraduate teaching, Möbius has made it a habit to take students to the McAuliffe-Shepard Discovery Center in Concord, N.H., for which he has also developed educational outreach programs about our space environment in an effort to bring the mysteries of our universe down to Earth for the average citizen. And that's just one aspect of the public service part for which he is being recognized as the 2009 Distinguished Professor. -DS

For more on Cosmology and Our View of the World visit www.ssg.sr.unh.edu/preceptorial.

*Barry Rock – Outstanding Public Service*

# Rock-Solid Public Service

AT UNH AND BEYOND, Barry Rock is well known for his extensive outreach and public engagement activities. What's probably less well known is that he actually began this aspect of his professional career way back when he was an undergraduate at the University of Vermont where he developed a 4-H club with local elementary and middle school students.

"Over time it's evolved into working with K-12 students and teachers at the regional, national, and international level," Rock notes.

Through programs like Forest Watch, Watershed Watch, Project SMART, and the Global Learning and Observations to Benefit the Environment or GLOBE program, Rock has taken his outreach scholarship far, wide, and deep, both as educational tools and as sources of data for use in his own research.

For that he was honored this year by UNH with a Faculty Excellence for Outstanding Public Service award.

Rock is not resting on his laurels. He's currently embarked on a new effort – called World Ocean Watch or WOW – that will be launched first in Florida. It will use the same tried-and-true principles of programs like Forest Watch but take them offshore to explore and collect data on coastal marine issues, river pollution, harmful algal blooms, etc. He will also use satellite data to engage WOW students, introducing them to the use of satellite imagery in connection with coastal processes and the terrestrial watersheds that contribute to these processes.

WOW, Rock notes, is the brainchild of one of the original teachers affiliated with Forest Watch – Phil Browne of Concord High School, himself, and Florida entrepreneur/educator Patxi Pastor.

He's working with Miami Dade County school district personnel, two city commissioners – coastal awareness, environmental affairs – university researchers, and three high schools to get this program up and running. At meetings held in Miami Beach in late April, the WOW organizers decided to focus on sharks, sea turtles, coral reefs and dolphins, in each case connecting coastal processes known to affect these marine organisms.

Says Rock, "They see me as someone who's put together an outreach program that has longevity – Forest Watch is now in its 18th year – and as a person who can communicate science in English to the general public."

Julie Williams would certainly agree with that assessment. Williams, UNH associate vice president for research and outreach scholarship, nominated Rock for the Faculty Excellence award.

Photo by K. Donahue, UNH-EOS

"Barry is one of our stars here at UNH. His work exemplifies the very best of what it means to be a faculty member and an outreach scholar at a community engaged university like UNH," Williams says. Rock, Williams adds, engages his students in meaningful study and by hands-on learning inside and outside the classroom. "He engages with external partners to make a genuine difference in the world and he collaborates across multiple disciplines and universities with his colleagues from around the nation and the world."

Adds Rock, "UNH has been a tremendous supporter of my outreach and public engagement activities and outreach has become such a major theme here at the university. And outreach is, I think, becoming a major contributor to the way many of us do science." -DS

## Student News

Master's student **Katelyn Dolan** and Ph.D. students **Maria Hunter** of CSRC and **Deb Goodwin** of OPAL were accepted into the NASA Earth and Space Science Fellowship program for the 2009-10 academic year. Additionally, Dolan was awarded a one-year fellowship from the Natural Resources and Earth System Science (NRESS) program and will begin pursuing her Ph.D. beginning this fall. NRESS fellows are students who indicate an exceptional potential to excel as doctoral students. **Nat Morse**, currently a master's student in the Water Systems Analysis Group and starting his Ph.D. with the group this fall, was also awarded a NRESS Graduate Fellowship.

Ph.D. student **Erika Washburn** of OPAL was awarded a National Sea Grant College Program Dean John A. Knauss Marine Policy Fellowship for 2009-10. The one-year, paid fellowship matches highly qualified graduate students with "hosts" in the legislative and executive branch of government in the Washington, D.C. area.

**Amanda Plagge** of OPAL was awarded a NASA Graduate Student Researchers Program Fellowship.

Ph.D. student **Rich Woolf** of SSC won a third-place award at the IEEE International Conference on Technologies for Homeland Security Conference in Waltham, Mass. for his presentation on using the Fast Neutron Imaging Telescope to search for clandestine nuclear material.

**Allison Jaynes**, a Ph.D. student working in the SSC Magnetosphere-Ionosphere Research Lab, and **Samuel Meacham**, an incoming master's student working in CSRC with Barry Rock, were awarded 2009-10 NH Space Grant Consortium Graduate Fellowships.

This summer, the **Research & Discover** program has five first-year undergraduate interns working on projects at EOS, three second-year interns at NASA's Goddard Space Flight Center, and seven graduate fellows at EOS.

In July, **Project SMART** – a UNH program for high school students interested in developing careers in science – hosted 21 students from around the country in the program's Environmental and Space Science modules with input of many EOS faculty. Support for this year's session was provided by funds from NASA's Magnetospheric MultiScale mission (MMS), for which UNH is playing a lead role, and longtime program sponsor the New Hampshire Space Grant Consortium.

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# Round Five, and IPCC Rolls With the Punches

AS THE JUGGERNAUT OF CLIMATE CHANGE outpaces predictions, the leading scientific body charged with taking measure of the risks associated with human-induced climate change will move into a new, solutions-based mode for its next round. Additionally, when the Intergovernmental Panel on Climate Change (IPCC) issues its Fifth Assessment Report in 2014 it will include for the first time both the complex carbon and biophysical impacts of land use change on the climate system thanks to Earth system modeling work from a team headed by George Hurtt of the Complex Systems Research Center.

The UNH effort is supported by a grant from the NASA Interdisciplinary Science Program entitled "Advancing our Understanding of the Earth System Through Coupled Carbon-Climate Modeling and Observations."

The "land use harmonization" modeling work Hurtt and colleagues have done smoothly combines historical land use data with future land use projections making it possible to include the effects of altered surface land cover into climate models. For example, changes in surface albedo or reflectivity and soil rooting depth – which affect energy balance and, in turn, further influences climate – will provide a much more comprehensive picture of climate change past, present, and future. The new data is a critical addition to the solutions-based approach.

Hurtt, along with co-authors Steve Frolking and Louise Chini of CSRC, published a paper on the land use harmonization work in the June issue of the Integrated Land Ecosystem-Atmosphere Processes Study or iLEAPS newsletter. iLEAPS is the land-atmosphere core project of the International Geosphere-Biosphere Programme or IGBP. (See http://ileaps.org.)

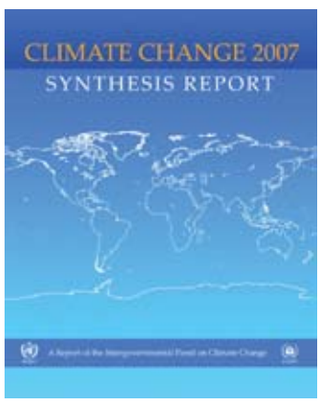


*Image courtesy of IPCC*

*IPCC Fourth Assessment Report*

The Fifth Assessment Report will also differ from the previous four by taking what Hurtt calls a more "proactive, multidimensional" approach. That is, instead of simply making projections of different climate change scenarios in the future, this assessment will create "mitigation pathways to development" from which society can select the most practical, sustainable approaches to growth in the face of differing levels of potential climate change.

"This fifth round is forcing modelers to operate in a solution mode. The mitigation pathways are an attempt to find approaches to reduce the problem to different extents," Hurtt says.

He notes that this next round will also be the first time the IPCC assessment will be built on the back of Earth system models rather than strictly climate models. This adds an entire new level of modeling complexity and potential clarity of what lies ahead.

Says Hurtt, "Uncertainty is paralyzing to a policy debate. The goal of science should be to reduce uncertainty and provide as accurate an assessment about the future as it can." The fifth round of the IPCC is intended to be the clearest assessment yet. -DS