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EOS SPHERES

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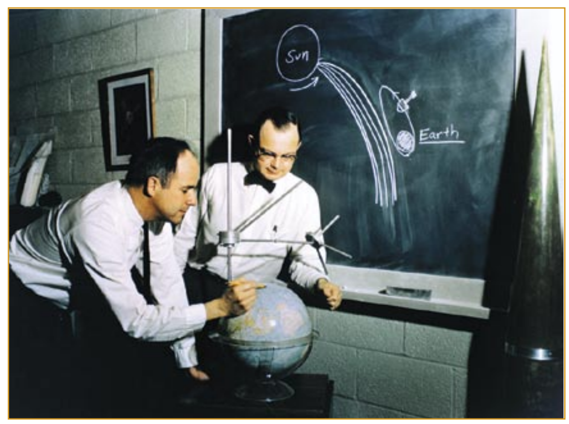
Vol. 5 Issue 1

Space Science at Fifty, EOS at Twenty:
Where Do We Go From Here?

JOHN MACRI, Space Science Center (SSC) senior research project manager, has been around so long that he remembers simpler times when the center resided in DeMerritt Hall, home of the Department of Physics, and had but a few people actively engaged in space research – sometimes *very* actively.



UNH physics professors Larry Cahill (left) and Jack Lockwood in 1962. *Photo courtesy of University of New Hampshire Archives.*

"There are things that we could do in DeMerritt that we just can't do here in Morse Hall," Macri says in reference to the SSC's home since 1986 when it moved into the newly erected building and soon-to-be home of the Institute for the Study of Earth, Oceans, and Space (EOS). "We once assembled an instrument that, no matter how we turned it and angled it, it wasn't going out the door. We could have disassembled something, but we didn't want to. So we just cut the doorframe and repaired it behind us. I'm not sure anyone knows that," Macri says with a grin.

After 50 years of space science research at UNH, and 20 years of interdisciplinary grant-funded research at EOS, it's a safe bet there's plenty that folks don't know. Like, for example, professor Jack Lockwood putting UNH on the map with cosmic ray research in 1956 when he "launched" a detector into a "rather low geostationary orbit" by driving up the Mount Washington Auto Road.

Says Berrien Moore, the director of EOS for 19 of the institute's 20 years, "It was a pretty cheap launch but at least it got you up into the atmosphere high enough for some of the cosmic radiation to get through."

It was largely through Lockwood's cosmic ray work that, when the U.S. began launching satellites to probe the heavens, UNH was ready to blast off. And it has been, and continues to be, quite a ride. From the early days of the Pioneer and Voyager spacecraft through Lockwood's Gamma Ray Observatory work (which kept Macri busy for 20 years) to current solar-terrestrial and deep-space missions, SSC, EOS, and affiliated departments have had numerous scientific payloads aboard spacecraft and tallied an impressive record of success.

"To have the density of expertise in solar-terrestrial physics and a track record of space science missions for a university of this size and funding support is remarkable," says John Aber, UNH vice president for research and public service and

– continued on page 2

We Are Go For Launch, Nearly

The BalloonWinds mission is on the rise

IN LATE SUMMER, during the night above the cool desert sands of New Mexico, a silvery, translucent balloon resembling a long, deflated jellyfish, will lift off the ground tethered to a two-and-a-half ton aluminum gondola crammed tight with a state-of-the-art scientific payload. The balloon will slowly rise to 100,000 feet or "near space," at which point it will have bloated to nearly Superdome size with six million cubic feet of helium.

Here, floating about in the frigid regions of the upper stratosphere – well above the layer of "our" atmosphere where weather happens – the payload will begin its work by firing a laser down towards Earth through the atmosphere at a rate of 50 blasts per second to measure the complex profile of wind velocity. It will do this for roughly 12 hours, gathering and analyzing data at this astounding rate before the balloon is explosively severed from the gondola by a radio command and the payload and gondola descend via parachute to the desert below, an Air Force chase plane keeping watch all the while. The balloon itself, made of material thinner than the garbage bag you haul to the corner on pick-up day, will eventually be disintegrated into a million bits as it rises towards the stratosphere. – continued on page 3

A balloon like this, thinner than a garbage bag and filled with six million cubic feet of helium, will haul the 2.5 ton BalloonWinds payload aloft to 100,000 ft.
Photo courtesy of Holloman Air Force Base

EOS SPHERES

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From the Director

Learning How to Learn More

IN PAST ISSUES of Spheres we have touched upon the many dimensions of the knowledge complex—how it is gained, how it is transmitted, and the creative tension between depth in one discipline and breadth across multiple disciplines. These are important themes; they are echoed in VP John Aber's comments in the cover article, and as the interview with Dean Joe Klewicki notes, we at UNH are still in the learning and evolving process. And the article featuring the Earth System Science course gives me great hope that we are on the right path.

I believe Joe Klewicki captured a unifying theme, which can provide useful steerage in this dynamic time, when he stated, "The most valuable lessons students learn through the course of their education are how to learn more, and how to be more proactive in their own education."

This powerful, broad statement reminds us of our shared responsibilities. EOS is a leading center in research and discovery (i.e., education) about how our planet works, the nature of the environment that we share in living with our star, and the structure of the universe. Therefore, it is our responsibility to participate actively in developing the new generation of scientists and engineers to explore these seas of discovery and, even more importantly, be engaged throughout the university in helping guide the development of the world's next generation of citizens.

On seeing the first pictures of the Earth from the Moon, the poet Archibald MacLeish wrote, "To see the Earth as we now see it, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the Earth together, brothers on that bright loveliness in the unending night—brothers who see now they are truly brothers."

We must remind ourselves each day that, indeed, we all are together on this our Earth. It is where we live, and where we shall die. Understanding this place and our place on it is a shared goal. It is a big goal, but a good goal—we look forward to having Joe Klewicki as one of the needed guides for pathways to this goal.

– Berrien Moore III

Space Science at 50, EOS at 20

– *continued from page 1*

professor of natural resources. Adds Aber, "And it's because for 50 years, strategic decisions have been made to bring excellent people into an environment that fosters continual growth."

The same vision and strategy can be said, of EOS's two decades of growth into a world-class, interdisciplinary, cross-college research facility. Not that it's been easy. The institute's beginnings, in the words of its very first director, Professor Emeritus Roger Arnoldy, "caused a real ruckus on campus, and still does for that matter."

In fact, had it not been for support from the top down – including past university presidents Evelyn Handler and Gordon Haaland, and former vice president for research and finance Len Fisk, among others – EOS never would have gotten off the ground. If the creation of EOS had been put to a vote it would have lost, hands down, says Moore.

Despite the initial controversy, the long-term success of EOS is widely appreciated, and Arnoldy for one tips his hat to the powers that be. "It's much to the university's credit that they stuck it out."

Adds Roy Torbert, director of the SSC, "Due to the efforts of faculty, staff, and students, and to the steadfast support of the university, the Space Science Center is recognized internationally as being in the forefront of the space sciences."

The nascent institute was viewed as a radical step because it was attempting to buck tradition and operate across departments and colleges. Moreover, the move was a gamble in that the institute would fly only if it could pay its own way. Says Moore, "It was a totally Darwinian situation; we either succeeded or failed, and if we failed we would be gone. We depended on each other's scientific excellence and productivity. When EOS was formed there was disbelief that it could possibly succeed because funded research was still a relatively modest enterprise at UNH."

Twenty years later the university itself is going through the expected growing pains associated with the transition from an institution primarily focused on undergraduate instruction to a burgeoning research university with increasing emphasis on culturing a larger graduate population.

Says Aber, "Most serious research universities will have focused institutes, and there's always tension between that focused research mission and the broader teaching mission." The key, Aber and others assert, is to use that tension to push the university forward.

"Integrating the focused and world-class research programs – and now we have several spread across campus – into the broader institutional mission of the university is a key challenge," Aber asserts.

It's key in part, according to Arnoldy and others, because it can help add a critical dimension to a student's classroom experience and broadens the university community in general. As Moore says, "Ideally, all students, undergraduate and graduate, will be deeply engaged in the discovery process."

Macri, who began working with Jack Lockwood in 1976 as a graduate student and research assistant before being hired on as staff engineer, notes just how invaluable and accessible research opportunities are for both graduate and undergraduate students alike who find their way to the Detector Development Lab in Morse Hall.

"I believe it's part of the discovery mission of the university, and I think some of our funding agencies see it that way, too," Macri says. He adds, "Because if you do this, you're giving students a real-world opportunity to make mistakes and figure things out." An opportunity, in the words of Joe Klewicki, Dean of the College of Engineering and Physical Sciences (see story on page 4), to "create" new knowledge – the very heart of what research is all about. -DS

Atmospheric Science

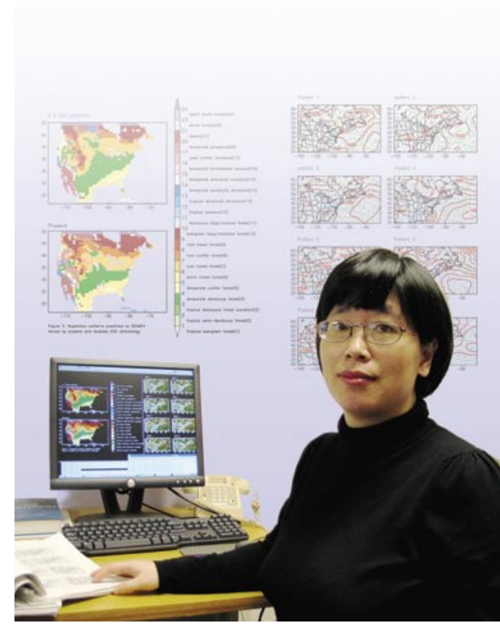
Ming Chen: Model Scientist

IN 1997, Ming Chen, a young, tenured associate professor from the Institute of Atmospheric Physics in Beijing, China, went to the Winard-Starring Center in Wageningen, The Netherlands as a visiting scholar. It was her first exposure to the world outside China and, Chen says, "I was very impressed and attracted." So much so that she started looking for positions in the U.S. and elsewhere and, in 1999, giving up her homeland and her tenured position, she took a job at Pennsylvania State University as a research associate. Chen was drawn to Penn State because it was where the widely used mesoscale meteorological model known as "MM5" was developed.

Three years later, Chen joined the Climate Change Research Center at EOS as a research scientist to, in part, expand upon her work in climate modeling using data on chemical compounds critical to the region's air quality collected by AIRMAP's five atmospheric observatories (http://airmap.unh.ed).

Says Chen, "UNH has a wider research area because we conduct both climate and air quality work. The AIRMAP observations are very important for my work because, with model simulations, there are a lot of uncertainties and with the AIRMAP data I have excellent observations to evaluate the model performance."

Building upon the MM5 modeling system, Chen has developed a one-of-a-kind regional climate model that predicts a dramatic shift in indigenous vegetation types, increased precipitation and periods of drying and flooding during the 21st century under increased levels of carbon dioxide. Chen presented her findings at last fall's annual meeting of the American Geophysical Union.



Research scientist Ming Chen

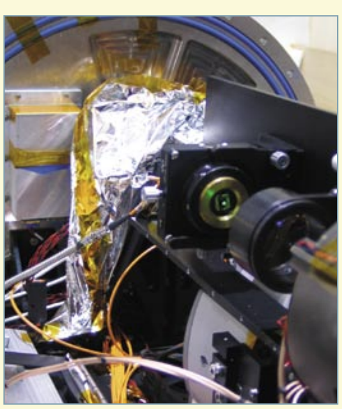
To learn more about Ming Chen's regional climate model and its predictions, read "If You Don't Like the New England Weather, Wait a Hundred Years" at http://www.eos.unh.edu/news/news_list.shtml. -DS

Earth Sciemce

We Are Go for Launch, Nearly

– continued from page 1

BalloonWinds, as the mission is called, will be the first attempt to measure wind velocities at roughly 25 different altitudes, including both high- and low-altitude atmospheric winds, in an effort to vastly improve weather prediction, the tracking of severe storms, and the pinpointing of hurricane landfall.



The heart of the BalloonWinds mission is the interferometer, which will record the spectrum of light retuned from laser blasts at the rate of 50 times per second.

Indeed, the measurement of global tropospheric wind profiles is the most critical missing ingredient in scientists' abilities to make these weather-related predictions according to the National Polar Orbiting Environmental Satellite Systems (NPOESS) program, which will launch a new generation of weather satellites in the next decade. Put simply, the missing measurement is so important because wind brings the weather.

Says Berrien Moore, principle investigator for the BalloonWinds project, "This is something the operational meteorological agencies have wanted to do, but we just haven't had the technology or budget to do it. BalloonWinds is probably the biggest step forward technologically, because this really is a demonstration of a near-satellite mission."

But in something of a new space race, Americans are playing catch-up with European Earth scientists who have already committed time and big money to a satellite mission to measure the winds: the European Space Agency mission, ALADIN, is to launch in the 2008 time frame.

"I think it's important for us to realize the Europeans are way ahead of us, " Moore says. However, he adds that some in the scientific community will downplay the importance of the ALADIN mission because it will not take the ideal big picture of tropospheric wind movement.

Both BalloonWinds and ALADIN will use Light Detection and Ranging or LIDAR technology to measure the winds. LIDAR, which is light-based radar, works by shooting a laser through the air, collecting the "backscatter" or reflected light with a telescope, and then analyzing changes in wavelength using a very sophisticated spectrometer called an interferometer. The analysis provides a "picture" of wind movements and speed in discreet layers of the atmosphere. If two laser beams could be fired off in perpendicular directions this would provide a much fuller, more accurate picture. But the ALADIN spacecraft will shoot its beam in one direction only.

While the BalloonWinds mission will also "simply" shoot a laser beam in one direction, the balloon itself will be rotating and will thereby provide something of a multi-dimensional view. But we're getting ahead of ourselves; there's a mission to fly, technology to prove, and it's all hugely complicated.

"I think it's the most technically challenging thing we've ever done," says Moore. Challenging because of the technological requirements and the science target, and because it is essentially a satellite mission without the big money. Moore notes that Senator Judd Gregg, through his continued support, has championed the balloon mission and the earlier GroundWinds instruments, which have served a proof-of-concept role for the BalloonWinds mission.

"This balloon mission has all the challenges of a space mission but with a total investment of about $6 to $7 million as opposed to $6 to $7 *hundred* million," Moore asserts. He notes that the ALADIN mission could be costing upwards of $1 billion dollars.

The U.S. did have a mission that would have launched a wind-measuring LIDAR instrument, but that was cancelled due to significant cost overruns. And so, for the U.S., its technology development in this area rests upon the shoulders of BalloonWinds and sister aircraft missions at NASA. And if the BalloonWinds mission is successful, says Moore, "It would show we're not as far behind as we thought, and that with a robust technical investment we could probably get a mission in space that made the full two-dimensional wind profile measurement in five to six years." -DS

Go Big, or Go Home

JOE KLEWICKI, THE NEW DEAN of the College of Engineering and Physical Sciences and former chair of the Department of Mechanical Engineering at the University of Utah, talked with *Spheres* about the challenges ahead, the relationship between CEPS and EOS, and what he sees as big possibilities for UNH as it evolves into a full-fledged research university.

There is some historical tension among EOS and CEPS and other departments, in part due to the research and instruction missions of the university.

To me, the opportunities far outweigh any historical tension between CEPS and EOS, and I think we need to stay focused on that. In the atmospheric, Earth sciences, and environmental areas there are tremendous opportunities.

I think a bigger challenge for UNH, this is my impression thus far, is that it's still finding out how to be a research university. I think there was strategic investment that got EOS and other centers up and running, but the full integration of the research within an overall academic mission is something that the university is still getting its arms around. These are just the natural growing pains that schools go through as they make this transition.

You came from the University of Utah, which also went through a transition from a largely undergraduate teaching institution to a research university.

A decade ago, Utah, in a number of respects, had a similar profile as UNH. It had a mixture of faculty from a previous era when it was predominantly an undergraduate institution, and people actively engaged in research. Utah has transitioned, at least at the engineering school, into an institution that has a much more integrated mixture of graduate and undergraduate programs and, therefore, more of a mixture of research and instruction into an overall academic environment. So I've been through that transition and know some of the pitfalls.

Is UNH on a path similar to Utah's?

Yes, but I don't think Utah's trajectory was quite as steep as UNH's – this place is taking off like a rocket. Last year the university grew by 15 percent from previous years in terms of research. I don't know of too many places that are growing in double-digits on a percentage basis, and I think we can all be proud of this. The challenge is aligning those research efforts with the academic mission. That is, how do we best involve and engage students and really have them see the benefit of the research endeavors? And that's something that requires both a cultural shift and structural changes, so it takes time.

Were you thinking about this dynamic when you accepted the position at UNH?

Actually, the inquiry-discovery theme that is core to the university's mission was one of the things that attracted me to UNH. I saw the growth in research as something very exciting. One of the things I did as a department chair at Utah, and I realized I had some talent with, was working on the challenge of building academic programs that integrate the research effort.

At schools that get it right, freshmen realize there's a Ph.D. program and they see the benefit of having that. Similarly, the graduate students interact with undergraduates in meaningful ways so everyone sees their participation in the overall academic environment as positive and interrelated. By growing a strong and vibrant graduate program the undergraduates benefit.

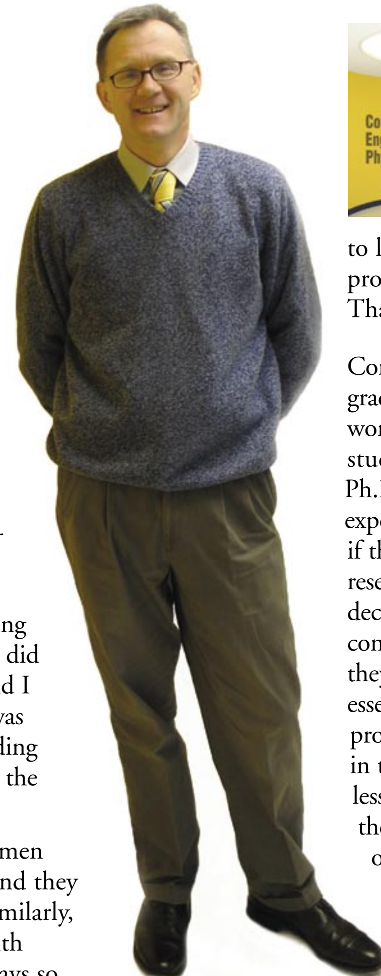
You mentioned the "pitfalls" of making the transition to a research university. Drawing on your experience in this regard, what do you think UNH needs to focus on?

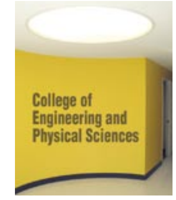
One of the tensions I see is that there are some people who view the academic mission and the research mission separately. To me, that's not the way to think about it – instruction and research are both components of the overall academic mission. And so the trick is to integrate and combine those two in creating the best academic environment for everyone.

Why is it so important to have this marriage between research and instruction?

Pedagogically what it has to do with is the real promise of a research institution. To me, there are two components to education: knowledge dissemination and knowledge creation. Dissemination is typically more predominantly felt in instruction. Creation is a set of skills that you hope every student is able to integrate into their view of education, and it's core to research, that's what research is all about – creating new knowledge.

When you have undergraduates actively engaged in research, it fundamentally changes the way they think about their own education. The most valuable lessons students learn through





the course of their education are how to learn more, and how to be more proactive in their own education. That is where research comes in.

Conversely, when you put an undergraduate in a graduate lab and they work under the tutelage of a Ph.D. student it's very good for the Ph.D. student to have that mentoring experience. But for undergraduates, if they're actually engaged in real research, then they have to make decisions that can have immediate consequences, and this requires that they think *actively*. And that is essential to the knowledge creation process. I've seen it happen, and back in the classroom these students are less passive, they're asking questions, they're used to immediate feedback on something that has real relevance to actual consequences.

Joe Klewicki

A lot of the undergraduate research being done here at UNH I think is really valuable but I also think that it can be leveraged even better. I think EOS is an underutilized piece of the puzzle and we need to strengthen our interaction. As I was saying to Berrien (Moore), what you really want is an electron cloud of graduate students that pervades the overall environment. In my experience, when it really works well, everyone begins to feel like they're colleagues, it's not a strict hierarchy, and everybody feels they're pulling the wagon in the same direction.

It seems there is a natural evolutionary trend towards a more interdisciplinary, systems-based approach and there's momentum in that direction here at UNH, which includes greater integration of research into the overall academic mission. Do you see your arrival as an important piece to solving the puzzle?

Well I hope so. While I'm trained as an engineer, I think I'm a bit more of a physicist and I have a real appreciation for interdisciplinary work. The problems of our future are very complex and will require an interdisciplinary approach.

I like trying things. I had a student who is a very accomplished rock climber and he had this phrase, "Go big or go home," and I think that's a good one, especially in academia where you don't get criticized too much for trying. To me, in a place like this, why not try big things. Certainly over in EOS, they started from very humble beginnings, took risks, and now they're internationally known. So conceptually that's a very good model. -DS

They've Got the Whole World in Their Hands

Students of Earth System Science (EOS 867) Get a Rigorous, Big-picture View of Life on Earth

WHEN MASTER'S STUDENT Quinn Thomas was flying back from last December's annual meeting of the American Geophysical Union in San Francisco, he peered down at snow-laden Earth and pondered what fraction of sunlight was being reflected back into the atmosphere by the cold, white surface – the planet's "albedo." He thought about the theory of "snowball Earth," which proposes that some 600 million years ago our planet hurtled through space like a cosmic snowball frozen from pole to pole. He saw Earth below and, in his head, pictured the equation-filled boxes, arrows and connecting lines that comprise a mathematical model representing the complex system of feedbacks that make the world go 'round – a picture that had been hammered home in the Earth System Science class he would finish upon return to UNH.

The former Dartmouth College undergraduate – who had presented his senior, honors thesis work on tropical tree mortality at AGU – says that while he has always thought of things scientific in such a "systems" way, it wasn't until he took the Earth System Science course taught last semester by Cameron Wake and George Hurtt that he saw the forest for the trees. And the clarity of this newfound vision was provided most powerfully by the rigorous exercise of building a mathematical model from scratch with some of his classmates.

Says Thomas, a 2005-'07 Research & Discover fellow, "One of the reasons I came here to UNH and to EOS is that modeling intimidated me as an undergraduate and I wanted to overcome that. If I'm going to be limited by anything I want it to be my own ability to think, not an inability to use tools." Mission accomplished.

Ask any of the 14 graduate and undergraduate students what the most challenging, intellectually stimulating, and exasperating aspect of the class was and you'll get one answer – the modeling.

"It was *very* challenging, and you never know if you're right," says Elizabeth Burakowski, a Wellesley College graduate and master's candidate. She adds, "The quote at the top of every single one of our lab handouts was, 'All models are wrong. Some are useful.' – and to know that your model is wrong is very frustrating." The oft-cited quote from statistician George Box encapsulates the inherent ambiguity of mathematical models. And for students accustomed to having their knowledge evaluated as "right or wrong," to spend an extraordinary amount of time and effort building a model only to come up short was a new educational experience indeed. However, Burakowski notes, "This was a lesson Cameron and George were looking to teach us."

That is, these students, in modeling very real, very complex Earth system issues such as "The Effects of an Urban Environment on Cloud Formation and Temperature" or "Permafrost and Carbon: Source or Sink," were challenged to come up with real-world data to obtain original, meaningful results.

Graduate students Liz Burakowski and Quinn Thomas

Earth System Science, designed by Wake and Hurtt, was awarded NASA grant funding through the Universities Space Research Association (USRA) Earth System Science Education for the 21st Century Program or ESSE 21. The New Hampshire Space Grant Consortium and EOS also contributed funds for the class, which has been offered twice now, doubled in size from its initial offering and, for this last go-round, included students from each of EOS's four centers and a variety of departments – from physics to economics.

ESSE 21 is a collaborative undergraduate-graduate education program that offers small grants to colleges and universities to engage a diverse interdisciplinary community of faculty and scientists in the development of courses, curricula and degree programs. In addition to a rigorous, ongoing assessment process that Hurtt and Wake built into the course itself, USRA has its own assessment process, which is carried out by program evaluator David Reider. In mid-November, Reider sat in on Lecture #17.

"To me, George and Cameron are doing precisely what I believe the grant should fund. They're collaborating, co-teaching, so they're bringing in specific expertise at the instructor level from very specialized domains, they're creating a joint curriculum, and certainly the students benefit from that," Reider says.

Reider notes that such an approach also provides professional benefit to the instructors themselves, particularly when this "systems" course is taught in a systems way. Given a collaboration between two professors with distinctly different research interests, and a research institute (EOS) working within the academic structure, Reider asserts, "You have all this cross fertilization going on that seems to be working. To me, there's nothing better in higher education than for that to happen."

Currently, Hurtt and Wake are extending the reach of Earth System Science. "The lessons learned in developing and teaching the class are being disseminated to the broader community in a variety of ways," Wake says. This includes a paper describing the class and the student evaluation process that will be published in the *Journal of Geoscience Education,* and the eventual dissemination of all class materials via NASA's education web site. Wake and Hurtt are also part of a team, which includes UNH's Leitzel Center and faculty from Elizabeth City State University in North Carolina, that has been funded by NASA to train faculty at Historically Black Colleges and Universities on how to develop and teach Earth System Science.

Says Wake, "The educational experience of many science students is one of increasing specialization through their university education. A class like Earth System Science, while it builds on students' disciplinary strengths, encourages students to broaden their horizons and examine how their specific discipline fits into the larger system."

From his perspective, Quinn Thomas believes that, in addition to the rigors of building a mathematical model to investigate the dynamics of snowball Earth, the reams of papers from professional journals used as required reading put him in good stead for his future scientific endeavors.

"We read scholarly papers that disagreed with each other, and I even heard some of these authors speak at AGU. One of the things you need as a climate change scientist, or someone working to bring it to the forefront of public attention, is an understanding of the limitations of the known science because if you don't, you can't effectively educate the public." -DS

A Cup of Coffee, With a Side Order of Cosmology

IF YOU SEE BEN CHANDRAN down at the local coffee shop scribbling with pencil and paper or tapping away on his laptop, it's likely that he's not jotting down a grocery list or cruising the Internet. Rather, he's probably doing mundane stuff like calculating the mass density of the universe.

Chandran, an astronomical plasma physicist, is "old school" in the sense that he doesn't need supercomputers or, even, a computer at all to plow through the numbers that will, someday, reveal such weighty cosmological questions.

"I do a lot of theoretical physics and math using pencil and paper trying to understand these kinds of problems," Chandran says adding, "I do some numerical computation but most of what I do can be done in the library, at coffee shops – it's a nice aspect of this work."

Chandran, who came to UNH from the University of Iowa, works primarily in the area of plasma physics as it relates to astronomical objects such as clusters of galaxies. (Plasma is the basic stuff of the universe – hot, ionized gas that fills space and is sometimes referred to as the "fourth state of matter.")

In clusters of galaxies, there is a huge amount of diffuse, low-density plasma between the member galaxies, and understanding the evolution of that plasma turns out to be important for a number of reasons. Explains Chandran, "That plasma makes up most of the 'baryonic matter' or the ordinary matter of a cluster, and the study of these plasmas tells us about cosmology and the properties of the universe at the largest scales."

In other words, if scientists like Chandran can nail down some of the mystery behind these clusters by grinding through the theory and crunching the numbers, this can be used in conjunction with the "observable signatures" of the clusters – like temperature and X-ray luminosity – to deduce aspects of the bigger picture.

"If you do the theoretical exercises to make that connection you'll have a powerful sort of probe for determining cosmological parameters, such as the fraction of the universe's mass that is in the form of some type of 'dark matter' that we can't see," he says.

Chandran wasn't always interested in such far out matters. While in graduate school at Princeton he figured his training in plasma physics would lead him into the field of thermonuclear fusion (fusing atoms together as opposed to splitting them apart to create energy) – a field that attracts many plasma physicists with its promise of a clean energy source. Since the trick of nuclear fusion is something akin to keeping a boiling star inside a box (trying to contain plasma at 100 million degrees while it does its best to escape), there's plenty of hard work to go around. But as his studies and career progressed, Chandran's head was increasingly in the stars and he gravitated more towards the astrophysical side of plasma physics.

Ben Chandran

"It took many years to pick up the astronomical lore and learn astrophysics at the level needed to do research. Having done my thesis more in the plasma physics area, it was almost a second training period while I was a post-doc and even as a professor at Iowa," he recalls.

The Amherst, Massachusetts native is happy to be back in New England and glad also to rejoin his former Iowa colleague Amitava Bhattacharjee in the Space Science Center. Like Bhattacharjee, Chandran also works in the area of turbulence theory, specifically as it applies to the so-called "coronal heating problem." The problem is that the Sun's surface is about 6,000 degrees Celsius while the corona, which enshrouds the Sun, is 1 million-plus degrees C. And this is counterintuitive since the heat supplied to the corona comes from the Sun's cooler surface.

From observations of the corona, astrophysicists infer that there are high-frequency waves that might be related to this coronal heating. Explains Chandran, "More traditional or existing models of turbulence, more standard models, can't account for these high-frequency waves, and one of the main areas of my research is pushing the theory of this turbulence further."

In water, turbulence consists of complicated, chaotic motions characterized by a large range of length- and time-scales, for example, small eddies nested within larger eddies. In plasmas, there are additional complications due to the charged particles and electric and magnetic fields.

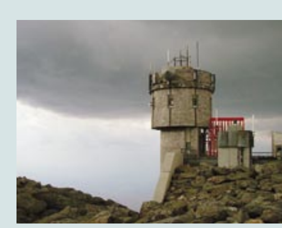
Other questions that Chandran asks as he puts pencil to paper and pushes the envelope on turbulence theory run along these lines: can random, violent flows emerging in the vicinity of a solar flare lead to turbulence that generates high-frequency waves that, in turn, accelerate particles to very high energies?

"We can observe these very high-energy particles but understanding what generates them is an unsolved problem." He adds, "And if we can figure out the Sun, we will learn much about stars everywhere in the universe." -DS

Mount Washington Observatory Joins Space Grant Consortium

The New Hampshire Space Grant Consortium (NHSGC) has added a new affiliate. The Mount Washington Observatory will join UNH, Dartmouth College, Plymouth State University, the NH Technical Community College System, the Christa McAuliffe Planetarium, and FIRST Place in the NASA-funded program that fosters interest in and learning about science, math, and technology.

MWO will use its initial NHSGC funding to start a rotating internship program. According to MWO Chief Scientist Alex Pszenny (also a research associate professor at EOS), the interns will cycle through the year on a trimester basis working in association with Pszenny and the observatory staff scientists on various aspects of their three research areas: the long-term climate record from the summit; regional air quality (in conjunction with AIRMAP); and global atmospheric chemistry.



Mount Washington Observatory

Student Profile

Tim Moore: Defender of Phytoplankton

Tim Moore

IT'S A LITTLE DIFFICULT TO IMAGINE Tim Moore, "defender of phytoplankton" as he jokingly refers to himself, as a civilian engineer with the Department of Defense installing computers on board nuclear submarines. But indeed, that's what the man once was, and it was that experience – surrounded by the sea at the Naval Station in Newport, Rhode Island – that helped put salt in his blood and propel him to his other life's work.

These days, the Ocean Process Analysis Laboratory research scientist, Ph.D. student, and former computer engineer is part of an extensive effort being taken by colleagues in OPAL and its Coastal Ocean Observing Center to "map" the dynamics and characteristics of the western Gulf of Maine using remotely sensed ocean color satellite imagery, in-water sampling, and computer modeling.

For his part, Moore is trying to characterize in detail the Gulf's phytoplankton community to improve the bio-optical, primary-productivity, and marine-ecosystem models that are needed to help understand, manage, and protect this unique ecosystem.

"We're making measurements that other people only dream of," Moore says in reference to data being collected by the UNH Research Vessel *Gulf Challenger*. "To have this complement of data is absolutely incredible." And the picture, Moore says, is just now starting to emerge after many long months of data synthesis and analysis.

From carbon cycle and air-sea flux components, to optical properties, nutrients, zooplankton and phytoplankton – in addition to the satellite imagery – the collected data will for the first time allow scientists to better focus the big picture of the western Gulf of Maine and, in turn, improve the ability of mathematical models to simulate the Gulf's past, present, and future. Specifically, key to that sharper focus are the improved algorithms that Moore and others in OPAL are developing based on their rich dataset.

An algorithm is a mathematical program, or series of steps the program goes through, that provides a model with the information it needs to derive an answer; the more accurate the algorithm with respect to it representing the real world, the sharper the model's results will be.

Says Moore, "To build algorithms you need real measurements, you can't develop an algorithm just on what a satellite is seeing – the satellite needs something concrete to relate to." Which is why he and others have been collecting boatloads worth of data on monthly cruises into the Gulf of Maine for the last two years.

Moore's phytoplankton research is a case in point. Not much work has been done on the phytoplankton community in the western Gulf of Maine, and given the variety, vastness, and importance of these one-celled, microscopic plants in the dynamics of the ecosystem, this absence of information represents a big hole when it comes to the ability of a satellite to correctly interpret what it's reading from the ocean's light field.

That is, Moore explains, "Currently, the phytoplankton are seen as a 'black box' – one big organism – and that's not really the case." In reality, each species of phytoplankton has it's own unique properties in terms of its chlorophyll concentration (a key characteristic needed for ocean color remote sensing work) and pigmentation. And unless these specifics are known for each species, the satellite imagery and, in turn, the modeling algorithms they rely on, are little better than guesswork.

"A lot of the phytoplankton ecology is a mystery – you can't see them, the water's moving around, it's hard to get a sample. That's why the sampling program we're doing is very useful. We're going out often enough to capture the seasonal dynamics of the phytoplankton community," Moore says.

Beyond improving the algorithms, a better understanding of the phytoplankton community will help answer questions about the role these ubiquitous plants play in the marine ecosystem, how the whole marine ecosystem is interconnected, and how changes in the phytoplankton community propagate throughout the ecosystem.

And, Moore says, even though the work he and the others are doing in their little corner of the Atlantic Ocean might seem only remotely related to the big picture, it all "filters back up" to the central questions like what the ocean's role in the global carbon cycle is, how its changing over time, and how it's responding to changes in the Earth's climate.

Big picture aside, Moore simply enjoys his work or, more specifically, his quarry. "I'm just kind of interested from an aesthetic point of view how this microscopic world is functioning. It's cool to look through the microscope and see how these phytoplankton are changing. They all have different shapes and sizes. And that microscopic world is doing so much – affecting the rest of the food chain, which has global climate consequences. We can detect them from satellites and observe changes in them. It's really quite remarkable." -DS

Faculty/Staff/Student News

Jimmy Raeder notes that ZAPHOD, the recently acquired supercomputer in Morse Hall, is now fully operational and that EOS researchers may request computing time by filling out and submitting a form on the web site http://www.zaphod.sr.unh.edu.

Joe Souney (pictured) joined CCRC as a project director working on the West Antartic Ice Sheet Divide Ice Core Project with Mark Twickler in the National Ice Core Laboratory-Science Management Office.

Joe Souney

Co-authored with his father, John Hobbie of the Marine Biological Laboratory, a paper by CSRC's **Erik Hobbie** will appear in the March issue *Ecology*. The paper deals with carbon and nitrogen flux rates in Arctic tundra.

Scott Ollinger gave a kenote address to the American Meteorological Society's 8th Annual Conference on Atmospheric Chemistry entitled, "Interactions and Consequences of Air Pollutant Cycling in Ecosystems."

As a Co-PI, **George Hurtt** was awarded a new NASA grant as part of the synthesis phase of the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA).

Student News

Research and Discover Fellows **Mariya Schilz** and **Quinn Thomas** both gave oral presentations at the 2005 AGU Fall Meeting in San Francisco. Notes their advisor, George Hurtt, "Only a small subset of the best presentations are given oral slots."

The Space Physics and Aeronomy (Magnetospheric Physics) Section of the American Geophysical Union selected Ph.D. student **Hyomin Kim**'s research paper for an Outstanding Student Paper Award at the AGU meeting. Kim's research concerns the low-frequency pulsations in Earth's magnetic field caused by solar activities. SSC's Marc Lessard is Kim's advisor.

Cary Girod submitted her master's thesis work funded by the Department of Homeland Security to the journal *Earth Interactions* for consideration.

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Space Science

STEREO-PLASTIC: Never a Dull Moment

HOUSTON, we have a problem, er, rather, an unexpected "feature."

As STEREO-PLASTIC was being put through paces at the Goddard Space Flight Center, Lorna Ellis of the Space Science Center's data analysis center happened to notice some weird numbers being returned from UNH's instrument.

In a nutshell, the weirdness was coming from a hard-coded, state-of-the-art microchip called a field programmable gate array, ACTEL for short, and the "feature" was serious enough that the ACTEL would have to be swapped out with one newly coded by UNH engineers. Thus began an "immense race" before the vacuum chamber doors at GSFC were again sealed shut.

As UNH's principle investigator on the mission, Toni Galvin, noted in an e-mail to the STEREO-PLASTIC team after they successfully crossed the finish line, "This answers the age-old question: How many engineers does it take to change an actel?" Too many to list in this space. Look for more on STEREO in the next issue of Spheres as launch day draws ever closer. -DS

Space Science

AGU Appoints Amitava Bhattacharjee Senior Editor of Space Physics Journal

AMITAVA BHATTACHARJEE, Paul Professor of Space Science within the Institute for the Study of Earth, Oceans, and Space (EOS) and the Department of Physics, has been appointed Senior Editor of the American Geophysical Union's *Journal of Geophysical Research-Space Physics.* The premier archival journal for the space physics community, JGR-Space Physics publishes over 600 peer-reviewed papers per year.

Bhattacharjee's reputation within the space physics community, his wide range of research interests, including solar-heliospheric, magnetospheric and plasma astrophysics, and his desire to expand the reach of JGR-Space Physics during his four-year tenure as Senior Editor were noted factors in his appointment. Rounding out the journal's top-tier editorial team are Wolfgang Baumjohann, European Editor, and Zuyin Pu, Asian and Pacific Editor. Clia Goodwin, who holds a Ph.D. in English from the University of Illinois-Urbana, will serve as Editor's Assistant at EOS's Space Science Center (SSC).

Bhattacharjee notes, "I owe a great debt to the space science community for what it has taught me, and a lot of the learning has actually come from the pages of JGR. So this is my way of returning some of what I have been given by the community." He adds, "And it's a matter of pride for UNH, now the home of JGR-Space Physics. Space physics has always been so central in the life of this university, and this is another feather in the cap of the SSC." -DS