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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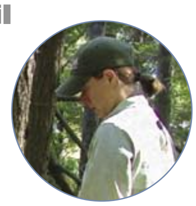

Fall 2005

Vol. 4 Issue 2

At 50, the Space Science at UNH is Golden with Projects

HEPS-ADIS: A New Slant on Ion Detection

AS A KID, had Jim Connell been fascinated with, say, dinosaurs or baseball cards or stamp collecting, it's likely his Angle Detecting Inclined Sensor, ADIS for short, would never have seen the light of day or fly – as it will in the future – aboard the next-generation weather satellites of the National Polar-orbiting Operational Environmental Satellite System or NPOESS.

Artist's conception of an NPOESS satellite. *Image courtesy of NPOESS.*

But the young Connell loved ships, and over time steeped himself in maritime history. Years later, while taking a head-clearing walk from his research at the Laboratory for Astrophysics and Space Research in the Enrico Fermi Institute at the University of Chicago, he drew upon his avocation and came up with a novel, simple, and elegant solution to a space physics problem.

"The last thing I was thinking about was physics," recalls Connell, now an associate professor of space physics at EOS and the Department of Physics. So he thought about math instead, specifically about the mathematics of inclined, battleship armor belts – the angled steel plates that protected ships from enemy shells.

"I was trying to think out the mathematics of the advantage of inclined belts versus vertical belts, and that's when it occurred to me that the principle would apply just as much to space-based energy detectors as it does to armor," Connell says matter-of-factly. Thus was born ADIS. He adds, "I walked back to my office very fast and started in on the equations."

The elegance in Connell's ponderings involved relatively simple things like, "if you incline the armor then it's the secant of the angle of inclination plus the angle of incidence...."

This whole angle conundrum had been percolating for some time in Connell's brain as he and Chicago colleague Bruce McKibben worked with data from the Ulysses spacecraft, which carried their High Energy Telescope on board as it orbited the as-yet uncharted polar regions of the Sun.

The telescope, like many cosmic ray instruments on scientific missions, uses what are called position sensing detectors (PSD) to differentiate between the different species of high-energy particles careening through space. Although highly accurate, a PSD is an electronically complex, power-hungry system that requires labor-intensive mathematical corrections to extract useful data.

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Interstellar Boundary Explorer Mission

IBEX: Mission With a Short Fuse

WHILE THE 28-YEAR-OLD Voyager 1 and 2 spacecraft hurtle towards the edge of our solar system at 35,000 miles per hour, closer to home Eberhard Möbius and his IBEX team are racing in their own way to keep pace with the veteran explorers.

"One of the biggest challenges here is that we have a program with such a short fuse, and we are banking on the mission's synergism with Voyager," Möbius says.

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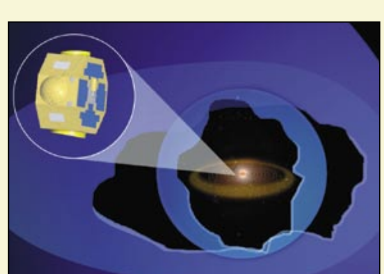

This cutout view shows IBEX (inset), the termination shock (innermost blue), and the heliopause, which separates the domain of the sun from the interstellar medium. *Illustration courtesy of Southwest Research Institute.*

Magnetospheric Multiscale Mission Moves Into Morse

THE LAST TIME these pages reported on the Space Science Center's role in NASA's upcoming Magnetospheric Multiscale (MMS) science mission (see Winter 2004 *Spheres,* "M(u)MS the Word"), two, separate SSC teams were competing for a piece of the MMS pie and neither Roy Torbert or Lynn Kistler – each who headed a team – wanted to say much of anything for fear of disclosing key information.

In May, the competition ended when the Torbert team got the pie slice and, now, things have ramped up and

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EOS Spheres

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From the Director

Milestones of Note for the EOS Community

THIS YEAR, EOS celebrates two significant milestones — the 20th anniversary of the establishment of the Institute for the Study of Earth, Oceans, and Space, and the 50th year of achievements in space science at the University of New Hampshire. This latter "golden anniversary" bears special note.

Back in the 1950s, using the 6,288-foot elevation of Mount Washington, former UNH-EOS professor Jack Lockwood and his colleagues in the Physics Department began making measurements of cosmic radiation and publishing their findings in scientific journals. That tradition of adventure and discovery is alive and well today, and it is one of the reasons that the university is consistently ranked among the top U.S. schools in National Aeronautics and Space Administration funding. In addition, the university garners high numbers in citations of published papers in the geosciences and environmental sciences.

The foundation of excellence and the commitment to seek and communicate new knowledge continues to challenge and inspire all of us. Undergraduate students working side by side with senior engineers building advanced hardware flourish in this spirit of adventure to high places. Our graduate students, from their beginning moments at EOS, share and often lead in the excitement of publishing discoveries and receiving the applause of colleagues. Our faculty understands and accepts the demands of stewardship of this tradition; the lights burn long in Morse Hall on Friday nights.

From the high, long road atop Mount Washington to the very edges or our solar system, from the depths of the Amazon rain forest to the hydrothermal vents at the bottom of the ocean floor, the shared sense of commitment to discovery flows through the Institute. When there are difficult passes to cross or cold streams to forge, one knows that there will be willing hands to help carry the load. Over twenty years, we have grown tremendously, evolved with the changing times, and have become a community within the larger university community, and within the even larger human community. Happy Anniversary.

–Berrien Moore III

Space Science

HEPS-ADIS: A New Slant on Ion Detection

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Says Connell, "I'd long been trying to figure out a simpler way to get the data without using position sensing detectors. So this had been in the back of my mind for a very long time." His eureka moment brought it right to the fore.

ADIS will now be the heart of an instrument called the High Energy Particle Sensor or HEPS that Connell and team are building under contract from Ball Aerospace Technologies Corporation of Boulder, Colorado. Ball will provide the Space Environmental Sensor Suite for the NPOESS spacecraft constructed by Northrop Grumman Space Technology. The UNH team will build two identical HEPS-ADIS instruments at a cost of $8-plus million and deliver them in the 2010-11 timeframe. NPOESS will converge existing polar-orbiting satellite programs under a single, new national program. (For more information visit www.npoess.noaa.gov).

Like battleship armor, the working ADIS will also provide protection, but on a slightly smaller scale. In simple, elegant fashion, it will detect the heavy, fast-moving ions – hydrogen to nickel – that can blow out space-based electronics with a direct hit, and which pose a danger to astronauts and aircraft flying over Earth's poles. These high-energy ions are components of what is known as "space weather" – the popular name for energy-releasing phenomena in the Earth's magnetosphere associated with magnetic storms, substorms and shocks.

"When there's a big solar event, nasty things can happen to electronics in space, including satellites dying – satellites that cost hundreds of millions of dollars, so there's an obvious interest in protecting them from these high-energy events," Connell says. HEPS, which unlike most of the instruments on the NPOESS satellites will be looking up into space rather than down at the Earth, will provide something of an early warning system and allow satellites to be reconfigured or put in safe modes in response to a big blast of radiation.

Unlike the complex and math-heavy position sensing detectors, ADIS's three, quarter-sized, oval-shaped, inclined silicon detectors will instantaneously identify what species of ion has passed through their variously angled surfaces. And this simplicity makes the instrument extremely reliable, which in turn makes it perfect for an "operational" mission like NPOESS.

An operational mission – like weather satellites – is different from a science mission, for example, IBEX or MMS, in that it provides a service by gathering data of immediate use. An operational mission also often means there are a series of spacecraft built and launched over time to be put into service as older satellites age or are damaged. This means there is the potential that Connell, his colleagues, and their students will be building ADIS-based instruments well into the future. HEPS is the very first operational mission for the Space Science Center.

"The emphasis on operational missions is continuity and reliability and, unlike science missions, you don't push the envelope," Connell says. He adds, however, that by virtue of ADIS's design, it can and will provide much more than it's being asked to do for the NPOESS missions.

"Because of its simplicity, ADIS can provide a level of data that is far beyond what other instruments on operational missions have been able to provide," Connell says. And this bodes well for the instrument's future, as well as that of the Space Science Center. -DS

Space Science

IBEX: Mission With a Short Fuse

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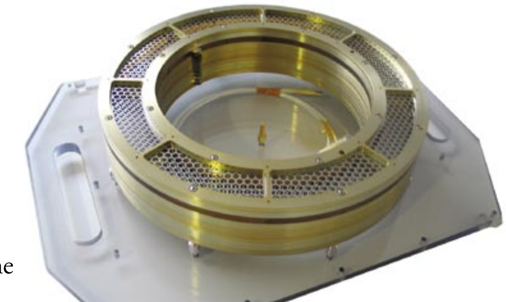
One of the primary goals for the Interstellar Boundary Explorer or IBEX mission is to be aloft when Voyager 2 punches through the region that separates our solar system from interstellar space – known as the termination shock – in the next three to five years. Voyager 1 crossed this boundary at the end of last year. It is hoped that the ultra-high sensitivity cameras on board IBEX, which will contain components built at the Space Science Center, will record the exact point of exit as Voyager 2 passes through the termination shock and into the region where our solar system mingles with the medium that fills our galaxy - the "space between the stars."

But the mission's short fuse is already lit and Möbius, co-investigator Marty Lee, scientists Harald Kucharek and Lukas Saul, engineers Mark Granoff, Steve Longworth, Frank Kudirka, Brian King, John Nolin, David Heirtzler, Stan Ellis, Jim Tyler, Steve Turco, and Mark Widholm will be put through the paces to meet the projected launch date in 2008. The mission is being led by Dave McComas of the Southwest Research Institute in San Antonio, Texas.

"From the time we heard we were selected at the end of January to day of launch is less than three and a half years," Möbius says. "And," he adds, "while that may sound like a lot of time, they actually want everything integrated on the spacecraft one year before launch."

Not that the SSC team wasn't prepared for the challenge. IBEX is part of NASA's Small Explorer Program that provides frequent flight opportunities for highly focused and relatively inexpensive missions. Says Möbius, "The small explorer missions are usually done in a relatively short timeframe, and when they selected IBEX they realized the timeliness of this investigation, so we really want to be up there before Voyager 2 goes beyond the termination shock."

IBEX is the first mission specifically designed to map the edge of the solar system where the solar wind collides with interstellar gas forming the termination shock.



The SSC team will build the "collimators," like this prototype, which will accept neutral atoms into the IBEX cameras from just one direction and a very narrow range.

The termination shock is near the boundary of the "huge bubble" known as the heliosphere, which sets the stage for space weather and serves as the first shield against energetic cosmic rays for Earth inhabitants.

Says Möbius, "With IBEX we want to make the first full-sky, three-dimensional map of the termination shock or, more precisely, the energetic particles that are accelerated by the termination shock." Such a map will provide a global view of the interaction of the heliosphere with our neighborhood in the Milky Way galaxy and show where the "hot spots" of particle acceleration are.

This map, derived from the *in situ* measurements made by IBEX, will provide modelers with real-world constraints for how the shock is formed and how particles are accelerated.

In addition to the fast pace of the mission, the IBEX team is contending with background "noise" or the uncorrelated signals being picked up by the ultra-sensitive detectors.

"For a mission where you're looking for a very, very faint glow," Möbius says of the energetic particles at the termination shock boundary, background noise can seriously blur the picture. And while the IBEX instruments are in part heritage from previous missions, Möbius notes that there are serious engineering challenges being presented by the sensitivity required of the cameras, their position on the spacecraft, and the high-voltage needed to repel unwanted ions – the latter which can create the troublesome background noise.

"There is some heritage here with the ACE and Cluster missions," Möbius says adding, "but we are always pushing the limit and that's particularly true in the case of IBEX." -DS

Space Science

Magnetospheric Multiscale Mission Moves Into Morse

– continued from page 1

new people have been brought on board to tackle the $38 million, eight-year project. But Torbert's *still* not saying much; he's too busy.

After all, the project represents UNH's largest, single research award in its history, and the MMS team is tasked with building the Central Electronics Box to integrate six separate instruments built by seven other institutions (from Germany, Sweden, Austria, France, and the U.S.) that will measure the electromagnetic fields around the four identical MMS spacecraft. In addition to this "FIELDS" instrument, the SSC team will construct two Electron Drift Instruments for each of the four identical spacecraft. That's a lot of precision space hardware. Launch date for the $400 million mission – July 2013. In all, the international MMS team is comprised of 12 institutes. The mission is being led by James Burch of the Southwest Research Institute (SwRI) of San Antonio, Texas.

Artists conception of the MMS four-spacecraft mission.

Courtesy of Southwest Research Institute Space Science and Engineering Division.

As NASA's next Solar-Terrestrial Probe mission (http://stprobes.gsfc.nasa.gov), MMS forms a cornerstone to the entire Solar-Terrestrial research enterprise by focusing on a single, but essential scientific problem. Throughout the universe, from galactic nuclei to solar flares to geomagnetic storms, nature finds a way to rapidly convert magnetic energy to heat. This process, called "reconnection," is not understood and, in fact, for a time was thought to be impossible. Extensive space and ground research over forty years has led to the realization that a space mission of multiple satellites, flying in formation more closely packed than ever before attempted, has the best chance of unlocking the mysteries of reconnection. Over the next eight years, the SSC team will help build the keys to the lock. -DS

Faculty Profile

Rob *"Don't Call Me Robert"* Braswell

FIRST, THE NAME.

When Rob Braswell does a web search for papers he's published in scientific journals, he types "Braswell, B*" which, he says, "should give me everything. But it doesn't. It's kind of a drag." Blame it on his roots.

"My family is southern, and I was born Bobby Harold Braswell Jr. I don't know about other parts of the world, but in the south it's not uncommon for people to get named nicknames, and also to have a completely *different* nickname by which they are known," he explains.

Authors of papers, unaware of this regional quirk, have on occasion changed Bobby to "Robert" when listing Braswell as a co-author. And this is why the web search fails to capture the whole enchilada.

But clearly, Braswell, who in his off hours plays guitar in a rock band called "Hateful Little Cakes," is not the kind of guy who spends a lot time fretting about such stuff. "My curriculum vitae says, 'Bobby H. Braswell (Rob),' so either it's confusing, or people don't care, or they just get it – one of the three."

In 1987, Braswell departed Dixie with a Bachelor's Degree from the University of Alabama at Tuscaloosa (after spending his junior year at the University of Massachusetts-Amherst in an exchange program) and landed at UNH. He took a master's in physics in 1990, passed the physics Ph.D. comprehensive exam, and abruptly shifted gears.

"I'd spent a lot of time preparing for the Ph.D. qualifier and not thinking about the fact that I didn't really want to be in physics anymore." The day after he passed the qualifier, he woke up relieved, liberated, and with no clue of what he'd do next.

Braswell ran into another physics fugitive, current Complex Systems Research Center colleague Steve Frolking, and soon thereafter Braswell headed off to Morse Hall. "What Steve was doing seemed interesting, it seemed more related to a world I could see and touch," Braswell says.

At EOS, he began working with Berrien Moore on global carbon cycle modeling. "At the time it was the beginning of international discussions on 'what happens to excess CO_2 in the atmosphere?' and we were part of the initial work in the trenches."

He went on to get a Ph.D. in Earth Science and today his primary research focus concerns biosphere-atmosphere exchange of carbon dioxide in particular. For this investigation, Braswell's primary tools – like many in CSRC – are modeling and remote sensing.

Rob Braswell, Complex Systems Research Center

"We care about CO_2 because it is a greenhouse gas that is increasing in the atmosphere. Understanding how the atmosphere interacts with ecosystems in terms of how much carbon dioxide goes in and out is an important part of the puzzle," Braswell explains. He adds, "We want to know how patterns of changing climate on various timescales – from weather to climate change – and other forces, like human activities, affect the functioning of the terrestrial ecosystem."

While Braswell continues to use mathematical/computer modeling in his work, unlike some of his colleagues who build large and complex models that will be improved upon over time and have a lifecycle, Braswell tends to scavenge bits and pieces of models, tweak this and that, and apply them to a particular scientific question of interest. "My experience with modeling is more of a tool in the toolbox. Like I use a wrench and then throw it back in the toolbox and maybe never use it again." Rather than an end product churned out by a model, Braswell is often more concerned with the methods used to derive an answer and analyzing how well that method worked.

Of modeling in general Braswell adds, "It's a real balancing act between wanting to include important characteristics and processes and knowing that the more complicated you make it the more things could be wrong. And so, what I do can maybe add a little more precision by helping to identify which processes are really contributing some data, and that gives you a little more mathematical leverage." -DS

Faculty/Staff News

Erik Hobbie reports that his paper, "Carbon allocation to ectomycorrhizal fungi correlates with total below-ground allocation in culture studies," was accepted by the journal *Ecology*. Hobbie, the paper's sole author, says, "The findings will allow us to assess at the ecosystem scale the importance of these fungi."

In September, **Cameron Wake** presented information on Climate Change in New England over the past century to the N.H. House Science, Technology and Energy Committee as part of their information gathering efforts in relation to the Regional Greenhouse Gas Initiative (RGGI). Wake also participated in a teacher workshop October 14 in Morse Hall based on the report he authored entitled, "Indicators of Climate Change in the Northeast 2005." The report compiled research findings on a dozen climate change indicator trends over the last 100 years.

New faces on the block are **Frank Kurdirka** and **Jim Tyler**, project managers for both the MMS and IBEX missions.

Frank Kudirka (L) and Jim Tyler (R), project managers for the MMS mission.

Mark McConnell reports that he and **Peter Bloser** recently attended a workshop at Clemson University – entitled "Astronomy with Radioactivities" – where Bloser presented a paper on their MEGA project (a next-generation COMPTEL-type instrument for studying the medium energy gamma-ray sky). McConnell presented a paper on their CASTER project, which is their concept for a Black Hole Finder Probe mission.

Megan Carney, who recently completed her M.S. in oceanography at Oregon State University, joined CCRC to work on two new projects – the "tall towers" program (see "AIRMAP Gets a Lift" on page 6) and the UNH-NOAA Joint Center for Ocean Observing Technology. Carney is tasked with getting the field components for the tall towers project up and running. The goal of the new joint center, which is a collaboration between NOAA, UNH, the Gulf of Maine Ocean Observing System and Atmospheric and Environmental Research, Inc. of Lexington, Massachusetts, is to establish the Isles of Shoals as a testbed for new ocean technology, develop an ocean-land-atmosphere observation system for the western Gulf of Maine, and provide web-based products for specific user communities. **Berrien Moore** is the principle investigator for the project with **Janet Campbell** and **Bob Talbot** as co-investigators.

Taking the Pulse of the Coastal Ocean

OPAL scientists are building an extensive dataset on the condition and character of the Gulf of Maine

MID-SEPTEMBER, on board the UNH Research Vessel Gulf Challenger, 42°51.64' N, 69°51.64' W at "Station No. 6" forty miles offshore in the Gulf of Maine's Wilkinson Basin. We have been here for two hours, rocking and rolling above 880 feet of water while the scientific crew takes measure of the sea, and I am hearing new meaning in the old sailor's chant, "Heave away." I have been woozy since Station No. 1 some six hours back and won't find my sea legs until lying flat on the upper deck as we steam full-bore back to land some two and a half hours away.

As the vessel finally heads back to dock at the Portsmouth Fishing Pier, research technician Chris Hunt, lying in repose on the padded bench in the cabin mess area, baseball cap pulled down to his glasses, looks up and says, "You're about to experience the best part of the cruise – the long ride home." No kidding.

These people are exhausted. All day long, the crew of OPAL scientists, technicians, and a graduate student have run through the drill that occurs at each of the six stations – anonymous spots in the deep blue sea located by GPS where we bob about while various instruments, nets, and big water-sampling tubes are flung overboard to gather samples of everything from fish fry to photons. I can only imagine what this routine must be like in January seas, and I plan on *keeping* it in the realm of imagination.

The seaworthy crew scurrying on deck are research scientist Tim Moore, research technicians Rebecca Jones, Chris Manning, Chris Hunt, Mike Novak, Pallavi Mittal, and graduate student Takashi Brown.

These monthly runs or transects are conducted by the Coastal Ocean Observing Center within OPAL in an effort to better understand the complex dynamics of coastal ocean waters, including the role they play in either sequestering or out-gassing carbon dioxide. In addition to the Wilkinson Basin transect, a monthly, coastal transect is made northward along the coast from Portsmouth to the Kennebec-Androscoggin Estuary to gather similar data.

While coastal observing efforts have been ongoing for centuries, Janet Campbell, director of the Coastal Ocean Observing Center, notes that the research has been "localized" and disparate with very little coordination and data sharing.

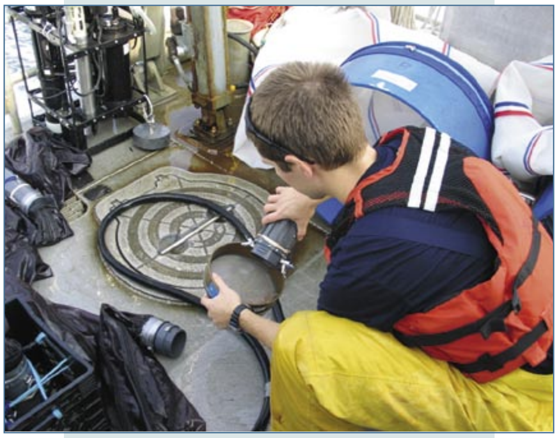
Says Campbell, "The emphasis today is on having a nationally supported, sustained coastal ocean observing program. We need to be making measurements that we can share with other people doing similar work and create a system for seamless access to data sets around the coastlines of the world."

Among the contraptions the R/V Gulf Challenger crew heave overboard at each station are the Multiple Operating-Closing Net and Environmental Sensing System or MOCNESS, Niskin bottles, a hyperspectral profiler, and a cage-like water profiling package that measures everything from temperature and salinity to optical properties, nutrients and chlorophyll.

The MOCNESS and other fine-mesh nets haul up a variety of zooplankton, phytoplankton, and other small critters, which are bottled, preserved and later analyzed. The Niskin bottles – big, grey plastic tubes that are attached to a line at varying intervals – take water samples at discreet depths (an ingenious system of weights and triggers closes them up before they're hauled back on board) providing the researchers with a clear vertical profile of the water, its properties, and constituents.

Making continuous measurements as the Gulf Challenger plies the waters is a flow-through system that samples a horizontal ribbon of water at a depth of one meter providing, as Chris Hunt says, "a thin slice of cheese" of data similar to what's measured at the stations. The flow-through also takes readings of the partial pressure of carbon dioxide (pCO_2) in the water – a measurement not many sea-going researchers are capable of making and one that helps provide a bit more data on the whole carbon puzzle, particularly the air-sea exchange of CO_2.

Says Campbell, "The Gulf Challenger work is collecting data that will help us begin to model ecosystems in our area." She adds, "People used to say they 'validated' a model with data, but more recently I heard someone say you 'confront' the model with data, which I like because the data are the real measure of what's going on and what you want your model to be." For example, scientists want models to be robust enough to accurately show what will happen to the critters that sustain life in the coastal oceans as sea temperatures rise.



Chris Manning and Rebecca Jones at various stages of recovering samples collected by the MOCNESS net system.

While ship-based sampling provides great precision in the data collected from a scant few areas of water (which good modeling can extrapolate to provide a bigger picture), it's a time- and labor-intensive method, and the trend is to move towards more autonomous platforms like high-tech buoys, robotic instruments, and remote sensing techniques.

"It would be great to have a whole lot of chemical and biological sensors on the Gulf of Maine Ocean Observing System buoys, ten of which are out there now," Campbell says. She notes that OPAL's Ru Morrison, who last April deployed a state-of-the-art buoy in Great Bay, "is helping to push the envelope" of buoys that can provide a wealth of continuous, vital, scientific data. -DS

Atmospheric Science

AIRMAP Gets a Lift

AIRMAP's atmospheric observatory at Thompson Farm in Durham sniffs the air for an impressive array of chemical compounds that comprise the stuff of air pollution. In fact, the Thompson Farm station has been likened to NASA's DC-8 flying laboratory "without wings" so comprehensive is its ability to sample and analyze for some 180 compounds.

And yet, Thompson Farm, like all AIRMAP's five atmospheric observatories and indeed most air monitoring stations around the globe, samples the air at a mere 45 feet above the ground.

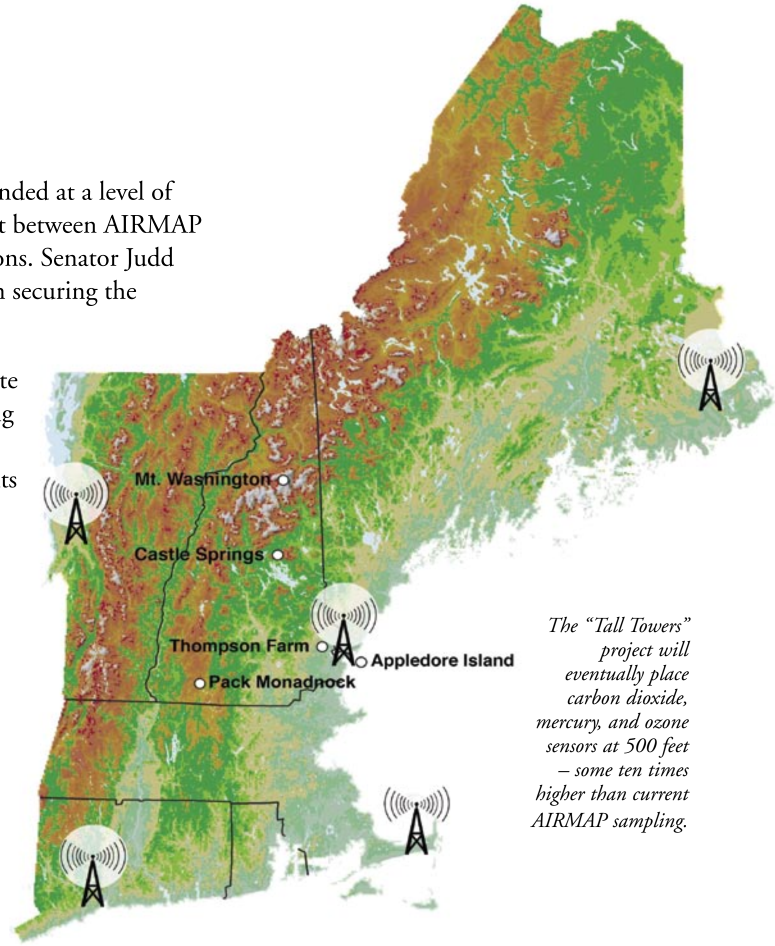
Says AIRMAP director Bob Talbot, "The 'surface' layer of the atmosphere extends up to a couple of thousand feet, and if all the monitoring is done at less than 50 feet off the ground, how representative is that of that surface layer?"

Talbot hopes that question will soon be answered through a new center that will give AIRMAP a lift by placing carbon dioxide (CO_2), mercury, and perhaps ozone monitoring instruments on several tall towers around the region currently being used for cell phone, radio and television communication. At 500 feet above the ground, these sensors will sample what Talbot calls "yesterday's air" that has not undergone the vertical mixing – caused by daily temperature inversions – and turned into a complex soup of chemicals closer to the ground.

The Northeast Center for Atmospheric Science and Policy, housed in the Climate Change Research Center, is a joint venture between UNH and the Northeast States for Coordinated Air Use Management or NESCAUM – an interstate association of air quality control divisions in the six New England states, New York, and New Jersey – and its sister organization the Northeast States Center for a Clean Air Future or NESCCAF.

The new center will be funded at a level of $1.5 million per year, split between AIRMAP and the regional associations. Senator Judd Gregg was instrumental in securing the center's funding.

Says Talbot, "The interstate associations will be looking at what we're getting regionally in terms of results for CO_2 and mercury and trying to interpret that in light of emissions, regulations, and policy. Right now CO_2 is not regulated from fossil fuel combustion. Our data certainly won't turn that around, but it might shed some light on why it should be regulated, or at least why emissions should be reduced."



The "Tall Towers" project will eventually place carbon dioxide, mercury, and ozone sensors at 500 feet – some ten times higher than current AIRMAP sampling.

Mercury, high on the EPA list of toxic compounds and studied mainly in New England in terms of how it cycles in lakes and is taken up by fish, is poorly understood from an atmospheric perspective. "We need to learn about where it's coming from and about the large-scale processes influencing the amount of mercury in the air," Talbot says. He adds, "There has not been a lot done to understand what its reactivity in the atmosphere is, how it's transported, and what controls its atmospheric levels."

The instruments placed on tall towers will provide a whole new perspective for AIRMAP. Unlike current sensors at Thompson Farm and other monitoring stations, the CO_2 and mercury instruments will give a better perspective on the air that is flowing in and out of the New England region, which is confounded by local processes in ground-level air. Says Talbot, "We'll know what this air looked like before it mixes down, and that's going to have multiple purposes for AIRMAP and other projects as well."

Because of the high price of the instruments, two tall towers will initially be outfitted to measure CO_2 and mercury. The three-year plan, for which the center is currently funded, is to eventually have five or six instrumented towers strategically located around the region. -DS

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

After four years of design, building, and troubleshooting, STEREO-PLASTIC has left the building. PLASTIC Flight Models (FM) #1 and #2 were successfully delivered to the Johns Hopkins Applied Physics Laboratory (APL), bolted down to the two STEREO spacecraft, and are now being tortured with various, ongoing testing – practice "Comprehensive Performance Tests" as rehearsals for upcoming spacecraft environmental testing, and "Mission Operations Simulations" for practicing post launch instrument commissioning.

Over the summer, there was much tag-team travel by a dozen SSC researchers down to APL as testing ensued. And, says UNH STEREO-PLASTIC principal investigator Toni Galvin, "The PLASTIC travelers appreciate the work of Kathy Giberson and Christine Williams, as well as Sue Roy and the SSC accounting office, for all their help on travel arrangements." Work on FM #1 and #2, and some travel down to APL and the Goddard Space Flight Center, will continue as the spacecraft undergo further testing.

Back on the home front, two junior physics majors, Jay Carroll (pictured, foreground) and Andrew Gustafson, helped SSC data analyst Dave Heirtzler put together a 70-foot high-voltage cable assembly that will be used at NASA's Goddard Space Flight Center during the thermal balance and thermal vacuum testing of STEREO-PLASTIC.

Jay Carroll and Andrew Gustafson

Student Profile

Sarah Silverberg

Sarah Silverberg uses a portable infrared gas analyzer to measure soil carbon levels at the Bartlett Experimental Forest.

TACKED UP ON Sarah Silverberg's office wall is a green bumper sticker that reads, "Don't treat your soil like dirt!" It's apt advice from a master's student who spent her summer – among other scientific tasks – collaring little plots of soil with 10-inch rings of white PVC pipe and measuring the levels of carbon being respired by the soil using a portable infrared gas analyzer.

Silverberg, working with CSRC's Scott Ollinger and M.L. Smith of the U.S. Forest Service, has been tending plots in the Bartlett Experimental Forest in the White Mountains as part of the North American Carbon Program (NACP) research Ollinger and Smith have been conducting for over a year.

Silverberg started working with Ollinger two summers ago when she arrived at EOS as an undergraduate Research & Discover intern from the University of Vermont. Now a master's student in the Department of Natural Resources (Ollinger is her advisor), Silverberg is the very first Research & Discover intern to do both the undergraduate and graduate components of the program.

NACP study sites have different levels of intensity, and at Bartlett, a top-level "Tier III" site, remote sensing, field measurements, and an eddy flux tower are used in an overall effort to come up with a total ecosystem carbon budget for the site. (An eddy flux tower rises above tree canopy level and measures the turbulence or "eddies" of air for minute amounts of, among other things, carbon dioxide.)

"My part of the study is looking at how much carbon is being allocated belowground and how that contributes to the overall carbon budget of the area around the eddy flux tower, which is one square kilometer," Silverberg says. She adds, "So I'm doing litterfall collection to gauge the amount of carbon going into the soil. I use laundry baskets to collect leaves and big tarps to catch branches and twigs, then dry and weigh them."

By taking all the litterfall (both leaves and branches) she's collected for one year, and subtracting that from the amount of respiration coming from the soil, she is able to gauge the amount of carbon going into the soil that year.

Because each forest plot, subplot, soil collar, basket and tarp has a specific, known surface area, and because most living things are half carbon, Silverberg can do a bit of math, average her values, and extrapolate her measurements over the total one kilometer surface area.

Ultimately, the hope is to be able to take these carbon measurements and apply them to the larger landscape or regional level using remote sensing techniques in a fashion similar to what Ollinger has done measuring nitrogen in leaves.

So Silverberg, as part of her master's work, will be looking at nitrogen mineralization next to her soil collars to explore the coupling in the belowground cycles of nitrogen and carbon.

Says Silverberg, "Scott and M.L. have done work showing that foliar nitrogen can be estimated using remote sensing techniques. And if nitrogen is directly related to belowground carbon, then maybe we can use remote sensing techniques to estimate carbon and map soil carbon over the larger landscape." And that would provide just one more little piece of the "where's-the-carbon" puzzle.

Of his student and former R&D intern Ollinger says, "Seeing Sarah move along through the R&D process is a sign that the program has started to mature. Sarah is a very talented student who had opportunities to go to graduate school at several other well-known universities, but decided that this was the best choice." Ollinger adds, "And, for me, it's always nice to be able to work with students for long enough to see them develop intellectually and become more confident in their ideas and abilities." -DS

Student News

Three new Ph.D. students, **Tzu-Ling Lai** of Taiwan, **Su Youn Kim** of Korea, and Massachusetts native **Shannon Davis**, have joined the Climate Change Research Center.

CCRC's **Jennifer Hegarty** received a NASA Earth System Science Fellowship for the 2005/2006 academic year with a possible additional two-year renewal. The title of her proposal was "Investigating the North American Outflow Using Aura Measurements." Says Hegarty, "I will be using the Tropospheric Emission Spectrometer aboard the Aura satellite launched last summer to examine the three-dimensional structure of the pollutant plumes exported from the North American continent. I also plan to compare results from a chemical transport model with the satellite observations."

Jennifer Hegarty, Climate Change Research Center

Jason Legere, a graduate student of Mark McConnell, successfully defended his master's thesis and will take a staff position with the astrophysics group. Legere's work involved the development of an X-ray polarimeter for studying solar flares and gamma-ray bursts.

Eberhard Möbius reports that four College of Engineering and Physical Sciences undergraduates are helping with the simulation, design, and testing on the IBEX mission. They are senior **Michael Borrelli**, junior **Kevin Hamer**, and freshmen **Morgan O'Neill** and **George Clark**.

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Earth Systems Science

Climate Change on the Worldwide Web

EOS-WEBSTER has rolled out a new dataset on climate change. The "Climate Changes in the 21st Century" collection is intended as an easy-to-use resource for general inquiries into the potential impacts of low, medium and high levels of atmospheric CO_2 on the climate. All of the EOS-WEBSTER data collections have on-line documentation – a "data guide" – about the data sources and methodology used. This new collection is the result of a partnership between EOS-WEBSTER and the National Center for Atmospheric Research (NCAR). The data, generated by the NCAR Community Climate System Model, will be a key part of the 2007 Intergovernmental Panel on Climate Change (IPCC) Assessment Report.


ARCTIC THAW: Climate Changes at the Top of the Earth Will Affect Us All

In addition to the data, a collection of climate change resources, links, and visualizations have been added to EOS-WEBSTER's "Climate Change Resource Center." A new feature of this site, called "Impacts at a Glance," is a series of concise, illustrated reports. The first of these reports focuses on changes in the Arctic. Says EOS-WEBSTER's Denise Blaha, "We think these case studies will give a richer context to the model projections and could be another way to showcase EOS' contribution to global change research." To view the new features, visit http://eos-webster.sr.unh.edu. -DS

NH Space Grant News

SMART Move Lands Undergraduate at JPL

DURING THE SUMMER of 2004, Heather Briggs, a high school junior from Shrewsbury, Mass., participated in the Space Science module of the University of New Hampshire's Project SMART (Science and Mathematics Achievement through Research Training), which is funded by the New Hampshire Space Grant Consortium.


Heather Briggs at NASA's Jet Propulson Lab

Briggs' project involved the analysis of data collected by a UNH-NASA flight mission called the Advanced Cosmic Explorer or ACE. In addition, as part of her Project SMART experience, Briggs was introduced to the use of "remotely sensed" satellite data to map and monitor differences in land cover and land-use changes on Earth. This experience, in turn, led Briggs to NASA's Jet Propulsion Lab in Pasadena last summer for a day working with Dr. Bonnie Buratti looking at remotely sensed data of Saturn's largest moon Titan from the Cassini-Huygens mission. Dr. Buratti is a research scientist at JPL working with imaging systems on the Cassini spacecraft, with a special focus on Titan.

Said CSRC's Barry Rock, who accompanied Briggs to JPL where he once worked as the group leader for the Geobotanical Remote Sensing Program, "What Heather has done is an exciting way to bring planetary science and Earth science together, it's a way of bridging a gap, plus it has such wonderful educational benefits." -DS