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EOS news (Summer 2010)

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Rewriting the Book on the Radiation Belts
UNH investigators prepare for a NASA dual-satellite mission that will make the first simultaneous, comprehensive measurements of Earth's radiation belts
AT THE DAWN OF THE SPACE AGE in 1958, NASA launched the Explorer 1 satellite with a simple instrument on board built by James Van Allen of the University of Iowa. When the 30-pound spacecraft passed through a region of Earth's magnetosphere it encountered bands of nasty, high-energy radiation and Van Allen's instrument – a Geiger counter built with tubes like an old television set – was flooded with particles.

The "Van Allen radiation belts" – an invisible torus of energetic particles held captive by Earth's magnetic field – had been discovered. The inner belt was 400 to 4,000 miles up while the outer belt was 9,000 to 15,000 miles above the Equator. Both belts curved inward toward the magnetic poles. It was the first major scientific discovery of the new era of space exploration.


van allen belts

In the intervening half-century, various spacecraft, including Explorers 2 and 3 carrying investigations by Van Allen, took measurements in the radiation belts on their way towards more distant reaches of space. And several missions – like the 1990 Combined Release and Radiation Effects Satellite (a joint NASA/Department of Defense mission) and the low-altitude Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) satellite – have greatly increased our knowledge of the region. SAMPEX, launched in 1992, in particular has revealed the belts to be far more dynamic and complex than originally thought.

This image shows the inner and outer Van Allen radiation belts as colored bands for purposes of illustration, but the sizes of the belts are closer to their real dimensions. Courtesy of Geoff Reeves/Los Alamos National Laboratory

But to date, the dots haven't been fully connected between the energetic particles that populate the belts – some of which move at near light speed – and the electric and magnetic waves that propel the particles hither and yon. Given the right circumstances, these particles can have profoundly negative effects on

RBSP Sidebar Story

The Energetic Particle, Composition, and Thermal Plasma (ECT) instrument suite is comprised of six highly coordinated instruments on each Radiation Belt Storm Probe and collectively provides five of the six charged-particle measurements required to achieve the mission's goals.

UNH-based project manager Jim Cravens says work on components for the suite's three main sensors – the Helium Oxygen Proton Electron (HOPE) mass spectrometer, the Magnetic Electron Ion Spectrometer (MagEIS), and the Relativistic Electron Proton Telescope (REPT) – is on track for the mission's May 2012 launch.

The most challenging thing at the moment is the mission's tight schedule," Cravens says, "and part of that is because we're doing research and development while putting the sensor suite together."

ECT components have flown on previous missions (the Combined Release and Radiation Effects Satellite and NASA's Polar satellite, for example), but not in this particular configuration or in

the hundreds of commercial and operational satellites that orbit in the magnetosphere and can pose serious radiation hazards to astronauts and people in aircraft flying over Earth's poles.

So the time was ripe for an investigation dedicated solely to the region – the Radiation Belt Storm Probe mission. Slated for launch in 2012, RBSP is part of NASA's Living With a Star Geospace program to explore fundamental processes that operate throughout the solar system, in particular those that generate hazardous "space weather" (radiation) effects near the Earth and phenomena that could affect solar system exploration. Scientists and engineers from UNH's Space Science Center are involved in the design and construction of instruments on two of the five RBSP experiments on each spacecraft.

rbsp flyby illustration

"The mission's goal is to study radiation belt particles," says Harlan Spence, principal investigator of the Energetic Particle, Composition, and Thermal Plasma (ECT) instrument suite on the mission. Spence, director of the UNH Institute for the Study of Earth, Oceans, and Space, adds, "But we know we can't adequately study the particles in the absence of the things that are causing them to change – wave phenomena and magnetic and electric fields – so with two spacecraft working in tandem we'll be making comprehensive, quantitative measurements in the radiation belts as never before."

Artist's rendering showing two spacecraft representing the not-yet-designerd Radiation Belt Storm Probes that will study the sun and its effects on Earth. Courtesy of Johns Hopkins University Applied Physics Laboraory

Collectively, the ECT suite will provide five of the six charged particle measurements required to achieve the mission's goals (see sidebar story on the ECT instrument suite). Another instrument – the Radiation Belt Storm Probes Ion Composition Experiment being built by a team headed up by Louis Lanzerotti of the New Jersey Institute of Technology – will obtain the sixth critical measurement. (The mission will also include the Relativistic Proton Spectrometer, principal investigator David Byers of the National Reconnaissance Office, which will make particle measurements of the inner radiation belt.)

As it such an intense radiation environment. And because of the RBSP's particular science goals, and the complexity of the hardware and software required to gather data and keep the spacecraft components "talking" in sync to each other, doing research and development in tandem with building and testing is required.

Cravens reports the instrument progress thus far: At the University of Colorado, the REPT pre-flight test model (known as the engineering model) is complete and has undergone successful beam testing of both electrons and protons to validate the design; The engineering model electronics for HOPE have been successfully interfaced with the engineering portion of the overall instrument, delivery of flight boards from Southwest Research Institute is expected soon, and detector components are being machined at Los Alamos National Laboratory; Challenges with application-specific integrated circuit chips for the MagEIS engineering model have been overcome, testing is going well, and the team's work is on schedule at The Aerospace Corporation.

A diverse, collaborative and integrated group of 38 scientists from 11 institutions makes up the ECT suite science team, which is led by EOS director Harlan Spence. The team provides the experimental, data processing and analysis, modeling, theory, and space weather application experience

ect on rbsp

happens,

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Lanzerotti, along with Michael Schulz, is author of the definitive work on the Van Allen belts, "Particle diffusion in the radiation belts," published in 1974. Thirty-six years later, the RBSP mission will allow him to rewrite the book

Says Lanzerotti, "This mission takes me back to where my career began in the very earliest days of the nation's space program. I look forward to learning all that we didn't know when we wrote our book about four decades ago."

Prior to SAMPEX the radiation belts were thought of as very simple, static, persistent, donut-shaped regions. Says Spence, "We now know that sometimes the belts disappear almost completely and then come back in timescales of days. The magnetosphere opens up and the particles drain away, they move around, they go away in space. They don't vanish but there are wild variations, orders of magnitude in terms of flux." Not stuff you'll find in the textbook.

required to meet instrument suite and overall RBSP science objectives.

The suite's science goals address the top-level mission objective to provide understanding – ideally to the point of predictability – of how populations of relativistic (high-energy) electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun.

The ECT sensors measure not only the core radiation belt electrons and ions, but also the lower energy charged particles in the inner magnetosphere that control the processes that accelerate, transport, and lead to the loss of radiation belt particles.

All of which is a far cry from the pioneering days when James Van Allen discovered the radiation belts. Cravens, who worked with Van Allen for 10 years, notes that this will be the first time scientists have studied the region so comprehensively since the 1958 Explorer 1 mission that carried Van Allen's simple experiment.

However, because SAMPEX is in a low-altitude orbit skimming through a tip-of-the-iceberg region of the belts "It's not where the action is occurring," Spence notes. "The two RBSP satellites will be right in the heart of it measuring all the waves and particle interactions and analyzing the differences of two regions in time and space."

The mission, in other words, should provide the bigger picture of the Van Allen belts. Working in tandem with ECT is the Electric and Magnetic Field Instrument Suite and Integrated Science or EMFISIS experiment for which Craig Kletzing of the University of Iowa is the principal investigator. Kletzing, a former UNH research associate professor, is collaborating with mission co-investigator Roy Torbert, director of the UNH Space Science Center, who directs a team building a critical component of the EMFISIS instrument suite.

UNH engineers are designing and building the computer that will be tasked with coordinating the timing of the onboard field and wave experiments and "packaging" the data for transmission back to Earth. (See the Winter 2009 Spheres story Braving the Storm.) The Electric Field and Waves Suite experiment, with principal

investigator John Wygant of the University of Minnesota, will round out the field measurements.

Both Kletzing and Spence note that the mission's primary goal is to get at the underlying physics of what's occurring in the radiation belts for basic scientific understanding (i.e., to rewrite the textbook) so that better models can be constructed. More accurate models will, in turn, allow better prediction of space weather and help protect both machine and man from intense radiation events. (All the RBSP science instruments will be surrounded by material 10 times the normal wall thickness of a spacecraft in order to shield the instruments from the full force of their quarry.)

"Here we are more than 50 years after Explorer 1 still trying to decipher the problem, which is not an easy one to solve," Kletzing says adding, "we want to understand how the entire system works and it involves complicated physics."

At its heart, the mission is aimed at understanding the universal and ubiquitous process of particle acceleration or, more specifically, the acceleration, transport, and loss of particles in magnetic fields. Happily, scientists have a "local laboratory" – Earth's magnetosphere – to explore how the process works throughout the cosmos. And the energy range of particles in our planet's radiation belts does not represent a cosmic sandbox; the particles go from essentially zero energy to those traveling a good fraction of the speed of light.

Says Spence, "We know almost without question that the thing accelerating these particles are electric fields, but electric fields can come in many forms and so we would like to be able to develop our understanding to the point of predictability. Right now we can't predict at any time whether the belts are going to go up or down in intensity or move around this way or that way because we really don't understand all the possible mechanisms that can accelerate or decelerate the particles at any given time. With RBSP, each instrument team will be working together to understand the physical processes responsible for what we're measuring."

James Van Allen did not live to see the mission dedicated to the study of "his" radiation belts. He died on August 9, 2006 at the age of 91, and Kletzing recalls that the tireless, legendary space physicist worked regularly in his Department of Physics and Astronomy office-laboratory up until a month before he passed away.

For detailed information, visit the RBSP mission and instrument pages. -DS

by David Sims, Science Writer, Institute for the Study of Earth, Oceans, and Space. Published in Summer 2010 issue of EOS Spheres.

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An ADVANCE for Women Faculty

UNH steps up efforts to support the advancement and leadership for women faculty in science, technology, engineering, and mathematics

TEN YEARS AGO when Ruth Varner was a postdoc, a new mother, and had a desire to continue her research at UNH, she applied for a National Science Foundation ADVANCE fellowship. The NSF program provided individual, three-year grants for women like Varner who faced the challenges of juggling family duties with a budding professional career in the STEM disciplines – science, technology, engineering, and mathematics.


Ruth Varner
Photo by K.Donahue, UNH-EOS

Varner eventually was able to withdraw her application because she successfully competed for an NSF research grant and, today, notes that the foundation's program of targeting individuals has been replaced with broader institutional grants "that have larger impact on more people."

Indeed, last fall UNH was successful in its bid for a three-year, $1.3 million ADVANCE grant to support the advancement and leadership for women faculty in the STEM disciplines across campus. The NSF grant makes UNH part of a larger national effort to transform institutions of higher learning in areas where women are traditionally underrepresented.

But the ADVANCE Partnership for Adaptation, Implementation, and Dissemination (PAID) program, for which Varner serves as director, is not an "institutional grant" in that it does not seek to implement sweeping, university-wide changes. Rather, Varner explains, "It will focus on specific programs we can implement to make changes over a three-year timescale."

In essence, the effort is a smaller step towards a potentially larger grant that would support institutional transformation. Says Varner, "There are other institutions across the country that have been funded by NSF for these broader grants in which people have looked at specific practices to recruit, retain, and advance women. We don't want to reinvent the wheel but, rather, we'll take some things that have worked at other places, maybe tweak them a little to make them fit at UNH, and focus on specific goals or challenges that UNH has as an institution."

Varner stresses further that the grant wasn't awarded to address overt problems with respect to women STEM faculty at UNH but instead grew out of an informal, grassroots discussion among women faculty and administrators and was then formally championed by the administration – specifically, UNH President Mark

Huddleston, who is the lead investigator on the NSF grant.

“This is more about subtle biases in policy that, in practice, most of us don’t realize are occurring,” says Varner.

Those biases were detected through a detailed “climate survey” that was funded through the provost’s office and sent to all research, clinical, extension, and tenure-track faculty in the fall of 2008. Among other questions, the survey asked about job satisfaction, the climate of respective departments, and perceived treatment by department heads and colleagues.

“The survey also asked questions about leadership, access to leadership roles, teaching and research load, and how productive people felt compared to their colleagues. We were trying to gauge the overall satisfaction of faculty members – both male and female – here at UNH,” Varner notes. The survey found that women did feel somewhat isolated, and less likely to be in leadership roles and have an impact on policies both at the institutional and national levels.

From that survey the collaborative team of faculty and administrators who crafted the ADVANCE proposal came up with four key goals for the program that were then submitted to NSF. Specifically, UNH proposed to adapt and implement strategies proven effective in increasing the number, retention, and success of women faculty in STEM disciplines by: facilitating their ability to advance successfully through their careers at UNH as leaders in research and teaching; increasing their capacity to influence policy and decisions at the institutional and national levels; increase their satisfaction with resources and research support and minimize feelings of research isolation; and, increase their satisfaction with faculty colleagues, deans, and chairs who mentor them.

Varner asserts that it was the comprehensive climate survey that led to a successful proposal to NSF – this time around. The university applied for an IT or “institutional transformation” grant in 2007 and, according to Varner, in failing to get funding realized that the finer details needed to be worked out, and that a smaller-scale approach to change was a more appropriate path to take.

There will be a follow-up climate survey in a couple of years to see just how well the PAID program is achieving its goals. Additionally, the UNH Institutional Research and Assessment office will collect data to see how effective the initiatives implemented under the program appear to be. Moreover, the UNH Faculty Mentoring and Professional Development Program will also be strengthened in conjunction with the ADVANCE effort.

Janet Campbell

Two specific outcomes of the PAID program are the creation of the Collaborative Scholarship Advancement Awards aimed at enhancing collaboration between research and tenure-track faculty, and the Karen Von Damm Leadership Development Grant, which will provide funds to support campus and off-campus opportunities for women STEM faculty to enhance their scientific or academic leadership. Both will be awarded on a competitive basis.

Research professor Janet Campbell of OPAL and former EOS interim director was instrumental in crafting the ADVANCE proposal and, in particular, champions the novel effort to support tenure-track and research faculty collaboration.

Janet Campbell
Photo by
M.Ross, UNH

Says Campbell, "The creation of seed grants to promote collaboration between research and tenure-track faculty should be embraced by UNH and offered to more faculty. It was an idea discussed at an early meeting of the President’s Blue Ribbon Panel on Research, and seemed to be well received. I am hoping that the university will augment the funds available in our ADVANCE grant to extend this opportunity more broadly across campus."

Karen Von Damm and Ruth Blake

Karen Von Damm and

The UNH ADVANCE office rolled out announcements calling for applications for the awards/grants in February and will announce recipients in early April.

biogeochemistry professor Ruth Blake on a research expedition aboard the R/V Atlantis.

The Von Damm award, named in honor of world-renowned UNH chemical oceanographer Karen Von Damm who passed away in August 2008, will go to women faculty who have taken on a leadership role in their respective field either at UNH or nationally. The funds will help free these faculty members from teaching duties as they pursue their leadership roles.

The collaborative scholarship award will provide seed money to help tenure-track and research faculty members create a joint research project. They will collect initial data and then potentially continue their collaboration by writing another, larger grant to external funders.

“This was created to address the potential isolation that can occur for women faculty, as identified by our climate survey,” says Varner adding, “and this is a way to break down potential barriers and get tenure-track and research faculty working together.”

Varner notes that other universities who have undergone institutional transformation through these NSF-funded programs have found that while the focus may be on advancing women and minority faculty members, ultimately the rising tide lifts all boats. “What they’ve seen is that when you make these institutional changes it pulls everyone up. It may affect women and minorities more directly but it’s about equity across the board.”

The ADVANCE program is part of a larger UNH effort to increase various aspects of the STEM disciplines, which is administered by the Joan and James Leitzel Center for Mathematics, Science, and Engineering Education. Karen Graham is director of the Leitzel Center and chair of the ADVANCE leadership team.

Janet Campbell

Says Graham, “The Leitzel Center is pleased to be able to play a leadership role in this important effort. The ADVANCE grant is part of the center's overall goal of increasing participation in the STEM disciplines by traditionally under- represented groups. Improving the culture and encouraging participation benefits everyone.” -DS

Karen Graham

by David Sims, Science Writer, Institute for the Study of Earth, Oceans, and Space. Published in Winter 2010 issue of EOS Spheres.

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A Match Made in Carbon

Jingfeng Xiao is a perfect fit for the Complex Systems Research Center's work in terrestrial carbon cycling
IT'S JUST COINCIDENCE that the Complex Systems Research Center's newest faculty member replaces someone of the same namesake – Xiangming Xiao – but Jingfeng Xiao's hire from Pennsylvania State University was very much calculated to mesh with and extend the reach of the center's extensive work investigating the terrestrial carbon cycle.

The tools he brings to the job include remote sensing, ecological modeling, model-data fusion, and geographical information systems.


Ruth Varner
Jingfeng Xiao
Photo by K.Donahue, UNH-EOS

"I have a variety of interests and use different methods in my research so there's a lot of overlap with other researchers in the center. Many of us, including myself, focus on the terrestrial carbon cycle and climate change," Xiao says.

Notes CSRC colleague Steve Frolking, whose work includes investigating the role peatlands play in the carbon cycle, "Collectively the center has a very multidisciplinary approach so there's great potential for collaboration, which is one reason why his name floated to the top of the list."

Another reason for Xiao's successful candidacy was that he was able to step in and fill the void created by the departure of research associate professor Rob Braswell, who left late last year to take a job in the private sector. At the time, Braswell was the principle investigator of a DOE-funded modeling project.

Because of his background and expertise Xiao was able to seamlessly take over the project, which serendipitously provides him funding for the next two years as he establishes himself at UNH.

A particular research interest for Xiao – and one that should lead to collaborative efforts with Complex Systems' George Hurtt, Scott Ollinger, Frolking, Mary Martin, and others – is to better understand the impacts of climate variability and change, land use and land cover change, and disturbances (e.g., fire, hurricanes, insect defoliation) on the terrestrial carbon cycle.

"The terrestrial carbon cycle is a hot research area right now because of its connection to climate change and climate policymaking. Terrestrial ecosystems play an important role in regulating the atmospheric CO2 concentrations through photosynthesis, respiration, and the combustion of biomass," Xiao says. He adds, "One of my main interests is to combine a variety of techniques to examine the magnitude, distribution, and

mechanisms of the terrestrial carbon sinks and sources, particularly year-to-year variations, at regional to global scales."

In other words, Xiao will bring additional expertise to the already substantial work within CSRC aimed at getting a clearer big-picture view of the terrestrial carbon cycle puzzle.


Ruth Varner
Terrestrial vegetation map caption needed here
Photo courtesy of ??????????

The atmosphere's role in the carbon cycle is well measured and fairly well known, and as a result scientists have a fairly high degree of confidence in models that simulate climate change from an atmospheric perspective. However, there is less confidence in terrestrial numbers.

Of the terrestrial carbon budget Frolking says, "In the broad sense we know what's going on but it's the details we don't understand. We don't know deforestation that well, we don't close the carbon budget well, we don't know what CO2 fertilization effects are on vegetation productivity very well, and we don't know the fate of high-latitude carbon with respect to permafrost."

In a 2001 Science paper, Princeton University's Stephen Pacala et al (George Hurtt and Berrien Moore were among the co-authors) estimated the magnitude of the carbon sink for the coterminous terrestrial ecosystem in the U.S. between 1980-89 to be 0.3-0.58 petagrams per year (a petagram equals about 2.2 trillion pounds). Notes Xiao, "What we're trying to do is to better understand the relative and combined impacts of various factors such as warmer temperatures, increased precipitation, CO2 enrichment, extreme climate events, nitrogen deposition, ozone pollution, and disturbances on ecosystems and thus to reduce the uncertainties associated with these estimates."

Unlike the atmosphere and the global ocean, which are both well-mixed fluids, the terrestrial biosphere doesn't become homogenized. Thus, the variables that affect the carbon cycle in terrestrial systems can change a great deal from one spot to another.

For example, in a parcel of forest there is variation in soil minerals, roots, fungi, and decomposing plant litter and things often look different if you move to a spot just 50 feet away. And, says CSRC terrestrial ecologist Scott Ollinger, "There's the imprint of disturbance and past land-use history, which also don't get blended together as they would in air or water. And the result of all this creates a sampling problem. There's a tremendous amount of complexity to account for and no one method offers a perfect solution."

Which comes back to Xiao's use of multiple approaches in his research. Among other projects, ongoing work of Xiao's involves "upscaling" carbon flux measurements from eddy covariance flux towers across North America to the continental scale using wall-to-wall data gathered by the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard NASA's Terra and Aqua satellites and modeling approaches.


Ruth Varner
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Photo courtesy of ??????????

Eddy flux towers are micrometeorological stations that measure the turbulence or "eddies" of air above treetops for minute amounts of CO2, water vapor, and energy between the biosphere and the atmosphere. The only means of scaling up the data to look at variability across a continent is via remote sensing (like the MODIS imagery, for example, which gives continuous coverage over space and time), and/or through modeling.

Xiao's efforts will help broaden the terrestrial carbon cycle picture and, in time, he plans to push the data to the global scale. "By quantifying the amount of carbon sequestered or released by ecosystems over regions, continents, or the globe we can better understand the feedbacks between the terrestrial biosphere and the atmosphere. This knowledge is essential for facilitating climate policymaking and projecting future climate change," he says.

This will dovetail to some extent with another current effort aimed at policymaking ¬– work being done by George Hurtt, who specializes in ecological modeling. Hurtt is lead investigator for a project aimed at using

satellite data to reduce uncertainties in forest ecosystem modeling and, ultimately, improve policies crafted to mitigate climate change. NASA's Terrestrial Ecology Program funds the project.

Central to Hurtt's project is the Ecosystem Demography Model (ED) he co-developed. For the project, ED will be coupled with a socio-economic model in an effort to simulate strategies for mitigating climate change, including strategies that involve biofuels and changes to wood production rates and usage under altered climate conditions.

"By combining ED with the economic model we can now explore with greater accuracy and process detail the potential for afforestation or bioenergy crop production to help stabilize atmospheric CO2," Hurtt says.

Adds Ollinger, "Enacting policy in a meaningful way means we need good numbers. If a state or country is going to claim a certain amount of carbon credits because it protected some forestland, we need to know what the carbon budget of that forestland really is. Presently, the numbers we have are murky at best."

Eventually, these efforts could lead to collaboration between EOS researchers and social scientists – something Xiao and others are hoping to explore. Such collaboration would be a required part of any attempt to predict future changes in land use and land cover – an enormously important part of the terrestrial carbon cycle but one that is equally difficult to address. -DS

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Small Fisheries, Big Dataset

Doctoral candidate Lina Maria Saavedra-Díaz returns from Colombia with rich information on small-scale, traditional fishing practices

A YEAR AND A HALF AGO, as Lina Maria Saavedra-Díaz was poised to depart for a handful of fishing villages in Colombia, she and her Ph.D. advisor, Andy Rosenberg, had occasion to worry about her safety. After all, Saavedra-Díaz was a young woman who would be working alone in remote, sometimes roadless regions in an effort to study traditional or "artisanal" fishing communities. Many of these small villages are struggling to survive, and all of them will soon be in a similar fix unless serious thought is given to managing their fishing resources – the subject of Saavedra-Díaz' dissertation work.

Happily, it turned out that the only fearful aspect of her journey came when she was hunkered down in the bottom of a small wooden boat that sloshed through an angry sea while Saavedra-Díaz did her level best to keep all her work from becoming sunken treasure.

"It took an hour moving from the main port to one of the villages, the waves were huge and the boat was full of water. I had my laptop with all my data and paper copies of the hundreds of interviews I'd conducted. I spent the whole time praying," Saavedra-Díaz says.

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Photo by asdf asdf aasdfads

Not only did she survive the boat ride but she successfully finished her field work last August and arrived back at the Ocean Process Analysis Laboratory with all her data intact. She's now plowing through the nearly 300 interviews and the data collected from 27 community hearings – nine on fisheries problems, nine on fisheries management, and nine on historical analysis – conducted in each of the nine fishing communities on both the Atlantic and Pacific coasts.

"From the beginning, my Ph.D. committee and I knew there would be too much information from the way I conducted my field research," Saavedra-Díaz says. "The committee wanted me to study just one coast but I explained that to really understand what's going on with the fisheries I'd have to do both coasts, which are different and have different problems, and my results show that."

These are hard times for the artisanal fishermen and their families whose very lives and way of life depend on what they're able to catch from the sea using traditional, low-tech methods ¬– from small, wooden boats to seine nets cast from shore. For her study, Saavedra-Díaz integrated the environmental, social, and economic aspects of these subsistence communities in an effort to, eventually, help them help themselves.

"In the end we want to propose the baseline for a small-scale fisheries management plan and, in order to do that, we need to understand how the fisheries have changed in these communities over time," Saavedra-Díaz says. "And since we don't have the scientific knowledge about that I've had to glean this information through their local knowledge."

Her study, entitled "Towards Colombian Small Scale (Artisanal) Marine Fisheries Management," identified a host of problems affecting artisanal fishing in each of the nine communities ¬- ranging from overfishing, pollution, deforestation, and climate factors to the lack of government oversight and involvement in a workable fisheries management plan.

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"There is no regulation, no fisheries management plan, everyone just does what they want and there are too many fishermen," Saavedra-Díaz says. "It's total disorder and the government isn't involved. They 'manage' fisheries from an office in the capital of Bogotá and they don't know what's going on."

But the government is aware of her work and Saavedra-Díaz has been keeping them in the loop. After she completes the analysis of her data, she plans on returning to Colombia late in 2010 to hold an "expert hearing" with a local leader and fisherman from each village and some 20 national fisheries experts. It is her hope that officials from the Colombian government will also participate.

"I hope to validate the study through the expert hearing because this is based on local/traditional knowledge and sometimes there are misunderstandings, so I need to make sure what we present for the document is accurate," she explains. Potential misunderstandings were compounded by the fact that the villagers spoke their native Indian languages and so Saavedra-Díaz had to work through a translator. Saavedra-Díaz, who grew up near Bogotá, speaks Spanish and English.

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Her research was funded by a grant through Conservation International (a Washington, D.C.-based nonprofit that Andy Rosenberg recently joined as a senior scientist) and supplemented by the UNESCO-L'OREAL Women in Science Fellowship Saavedra-Díaz was awarded in 2008 (see Spring 2008 Spheres story). With Conservation International and fellowship money, Saavedra-Díaz was able to hire four undergraduate research assistants – two from the University of Magdalena, with which she is affiliated, and two from other Colombian universities. The students, Yina Villamil (Externado University), Christian Llanos (Valle University), and Jorge Sanchez and Alejandro Suarez (both of Magdalena) have helped her gather secondary historical information produced over decades through government and academic research projects – reports, manuscripts, books – related with marine artisanal fisheries in Colombia. "So far the students have found 700 documents," Saavedra-Díaz reports. She adds, "Through the analysis of these references we will be able to detect 'weak points' on which to focus new research in order to support fisheries management in the future."

"We have information from as far back as 1950 so I think we'll be able

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to tell a good story, based on the local knowledge, about what has happened to the fisheries and the fishermen." She adds, "I have to find the minimal requirements that each of the communities must have to start implementing fisheries management, which must involve the government otherwise it won't work."

That her project worked came as something of a pleasant surprise to Díaz, whose biggest fear was that the people of the artisanal fishing villages would be reluctant to cooperate with an outsider/scientist.

She says, "The most difficult aspect was to convince them that the project was for them. I mean, here I was just another foreigner they knew would eventually leave. I had to tell them that the analysis would take awhile to complete but that I would come back. They'd say things like, 'Oh, when you come back we'll be dead' because some of the communities are struggling that much with their fisheries."

But not only did the villagers open their arms to Saavedra-Díaz they opened wide a window into their lives and livelihoods. "I think they felt they had to be listened to and be heard. After spending time in their houses with their families, going fishing with them and seeing how they work, I understand what their reality is." She adds, "The good thing is that not only did they point out their problems but they analyzed them as well – the causes, effects, and some possible solutions."

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Indeed, in two communities where Saavedra-Díaz worked fishermen have already begun establishing some basic rules to improve the fisheries. "In one community they can now only fish with a specific size of mesh, and if they find someone using a different size they burn the net. So they're already doing fisheries management, even though they don't call it that."

And she found other reasons to be hopeful. For example, on the Pacific coast while one community near the equator is overpopulated and the surrounding sea is overfished and polluted, just north up the coast is a community that has instituted their own fisheries association, has a conversation going with officials of the government, and fishes for tuna in an environmentally friendly, sustainable manner. "In this community they are in conversation with the industrial tuna fishing vessels in order to establish separate zones – those for only small-scale fishing and others for the larger-scale, industrial fishing." -DS

by David Sims, Science Writer, Institute for the Study of Earth, Oceans, and Space. Published in Winter 2010 issue of EOS Spheres.