LDEO

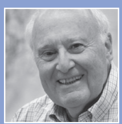
ALUMNI AND FRIENDS NEWS

FALL 11

Issue 18

FEATURE ARTICLE

New Tools for Uncovering Past Climates



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Issue 18
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61 Route 9W, Palisades, NY 10964
Tel: 845-365-8599
E-mail: alumni@LDEO.columbia.edu

Interim Director of the Observatory
Arthur Lerner-Lam

Director for Development
Barbara Charbonnet

Development Officer
Stacey Vassallo

Development Associate
Erika Freimuth

Communications Manager
Dove Pedlosky

Administrative Assistant and
Staff Photographer
Ronnie Anderson

Editor, Dove Pedlosky
Assistant Editor, Erika Freimuth

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Cover image:
Following a 12-inch snowfall in Tasiilaq, southeastern Greenland, William D’Andrea and his research team crossed a frozen harbor by dog sled to sample sediments from a frozen lake.
Photo credit: Raymond Bradley

Eileen Barroso

Letter from the Interim Director

Eileen Barroso

William B. Ryan (right) and Kevin McLain tour the seafloor with Google Earth.

Steve Doo

Bärbel Hönisch collects foraminifers in Puerto Rico, in order to learn how factors such as acidity, salinity, and temperature affect the composition of their shells.

Erika Freimuth

World Science Festival visitors model glacial dynamics with Margie Turrin (left).

Dear Friends,

There is nothing like watching the leaves turn to remind us that our environment is in a constant state of flux. Of course, this is not news to Earth scientists, and especially those at Lamont-Doherty, who have long been at the forefront of research involving environmental change.

Fifty years ago, Lamont scientists produced, in startling detail, the first visual representations of a dynamic, shifting ocean floor. The ocean was *terra incognita* then, a new frontier that geologists knew they needed to investigate.

Lamont-Doherty currently finds itself on another new frontier, poised to take advantage of an energetic young cohort of researchers who are exploring the symbiotic connection between biology and geology. These scientists are studying how life and Earth's environment (soil, water, rocks) have evolved jointly over the planet's long history—in particular, how climate has shaped life on Earth. This issue's feature article describes their novel work in greater detail.

This year also marks 50 years since oceanographer Arnold Gordon first came to the Observatory as a graduate student. Read his profile, which appears on page 4. Arnold's story is steeped in the Lamont tradition of setting out to probe the big unknowns. Because of Arnold we have a much richer understanding of the global oceans, the trajectory of their currents, and their role in the climate system.

In the spring newsletter, I hope to announce the conclusion of our search for a new director. In the meantime, please "like" Lamont-Doherty on Facebook or check our website for news and event highlights. As always, we appreciate your interest in the Observatory.

Warm regards,

Arthur Lerner-Lam

Arthur Lerner-Lam

Lamont Campus Attracts Science Enthusiasts of All Ages

Suzana Camargo

The Ocean and Climate Physics tent was buzzing with activity during Open House.

Months of preparation culminated in another successful Open House on October 1, 2011. Despite threatening forecasts, more than 3,000 visitors flocked to the Lamont campus for science demonstrations, lectures, and panel discussions, many of which were standing room only. Visit the Lamont-Doherty Facebook page for more pictures from the event.

Brian Kahn

Professor Jeffrey Sachs, director, The Earth Institute, spoke to a packed audience in Monell auditorium.

Sparking Interest in Science: From East Harlem to the Far East

On a Saturday afternoon in May, 47 high school students from New York City, Singapore, and the Netherlands launched a fleet of kayaks and canoes into Sparkill Creek, a few miles north of Lamont-Doherty. The students ventured out in the company of their teachers and volunteer scientists to sample the water as part of a weekend full of science activities organized by the International Student and Teacher Exchange Program (ISTEP).

Established in 2009 by Charlene Chan-Lee of the Manhattan Center for Science and Mathematics High School, ISTEP brings together an international group of public school students and teachers each year to conduct authentic field research. Lamont Associate Research Professor Brendan Buckley of the Tree Ring Laboratory, Professor Terry Plank of the geochemistry division, and Adjunct Research Scientist Mike Passow accompanied students to nearby Sparkill Creek and Tallman Mountain State Park to collect water, soil, and forest ecology data. After camping out for the night at the Alpine Boat Basin, the group spent Sunday at the Lamont-Doherty campus analyzing their findings in the lab.

Buckley and Plank also mentor high school students Kujegi Camara and Crystal Burgess in the Manhattan Center for Science and Mathematics' signature Advanced Science Research program. In this program, director Chan-Lee pairs highly motivated students with academic researchers for a period of three years. In partnership, student and scientist work on a protracted research project, which engages them for much of the students' high school years—including two summers spent in the lab.

More than 90 percent of students who graduate from the rigorous Advanced Science Research program choose to major in science, technology, engineering, or mathematics, Chan-Lee reports. More than three-quarters of them receive full scholarships to college.

I'm impressed by how advanced these kids are," says Buckley. He seems equally impressed by Chan-Lee, who has convinced him and others at Lamont-Doherty to volunteer year after year. "She's one of those people you can't say no to."

Dario Martin Benito

ISTEP students from Singapore and New York get a closer look at a garter snake in Tallman Mountain State Park.

Recent Lamont-Doherty Award Winners


Kat Allen


Jenny Arbuszewski


Suzana Camargo


Arlene Fiore


Sidney R. Hemming


Jason Jweda

Kim Kastens and Margie Turrin


Terry Plank

At Commencement, **Kat Allen** was one of three recipients of the Presidential Teaching Award for Graduate Students. The prize recognized Allen's contributions to the popular course, "The Climate System," offered through the Department of Earth and Environmental Sciences. Allen's PhD thesis, a collaboration with Lamont-Doherty geochemist Bärbel Hönisch, involves studying ancient plankton shells to learn about past ocean acidification.

The Goodfriend Fellowship, established by Advisory Board member Florentin Maurrasse (PhD '73) in memory of his friend Glenn Goodfriend, was awarded to graduate student **Jenny Arbuszewski** for her role as lead author on a recent publication in *Earth and Planetary Science Letters.*

The editors of the journal *Geophysical Research Letters* honored Lamont Associate Research Professor **Suzana Camargo** with a citation for excellence for her manuscript reviews.

Arlene Fiore—a recent hire in the Observatory's division of Ocean and Climate Physics—is set to receive the American Geophysical Union's prestigious James. B. Macelwane medal, awarded for "significant contributions to the geophysical sciences by an outstanding young scientist." Fiore, an atmospheric chemist, studies the interplay between ozone pollution and climate change. She is also a lead author on the upcoming Intergovernmental Panel on Climate Change (IPCC)'s fifth assessment report.

The Undergraduate Student Committee in the Department of Earth and Environmental Sciences selected Professor **Sidney R. Hemming** for the academic year's Best Teacher Award. **Jason Jweda** received the Best Teaching Assistant Award.

The Association of Educational Publishers selected *Earth Science Puzzles: Making Meaning from Data* by **Kim Kastens** and **Margie Turrin** to receive its Distinguished Achievement Award in science curriculum for grades 9–12. This award recognizes outstanding new resources for teaching science.

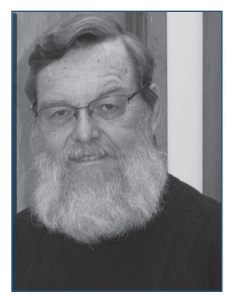
Professor **Terry Plank** was one of a select group of scientists given the title of Geochemistry Fellow this year by the Geochemical Society for major contributions to the field. Plank uses geochemical tools to study the generation of magma, its composition, and the process of crustal recycling at subduction zones.

The American Geophysical Union selected atmospheric scientist **Tiffany Shaw** as this year's James R. Holton Junior Scientist Award winner. The award recognizes the accomplishments of an early-career atmospheric scientist. Shaw joined Lamont-Doherty last fall and holds joint appointments with Columbia's Earth and Environmental Sciences and Applied Physics and Applied Mathematics Departments.

Ewing Lamont Research Professor **Edward R. Cook** and Lamont Research Professor **Robin E. Bell** were both elected Fellows of AGU—a special tribute for those who have attained eminence with major breakthroughs in the Earth sciences.

Lamont Assistant Research Professor **Ben Holtzman** received the National Science Foundation's coveted CAREER award. The prize is given to junior faculty like Holtzman, who exemplify the consummate role of teacher-scholar by integrating outstanding research and innovative education programs.


Tiffany Shaw


Edward R. Cook


Robin E. Bell


Ben Holtzman

Researcher Arnold L. Gordon Celebrates 50 Years at Lamont-Doherty

Eileen Barroso

Lamont Archives

From left, Arnold Gordon with Maurice “Doc” Ewing and Albert Crary, 1966

As a pioneering observational scientist, Arnold Gordon often set his sights on the distant reaches of the planet: the Indian Ocean, Antarctica’s Weddell Sea. It has been a career that has taken him far from Brooklyn, New York, where Gordon spent his childhood. His fascination with the natural world started early—his family’s urban vegetable garden, visits to the American Museum of Natural History, the weather maps that he received daily by mail from the National Weather Bureau.

Gordon attended Erasmus Hall High School in Brooklyn, where he pursued his interest in meteorology, supplementing a course in Earth science by reading about cyclones and clouds. By the time he entered Hunter College in 1957, he had decided to major in Earth science. As an undergraduate, his interest moved toward the oceans’ role in the climate system. A term paper for a geography class afforded a chance for some early creative thinking. “I looked at the meteorology and climate from Newfoundland to Africa and tried to explain the variations based on the ocean. I was self-taught on that subject,” Gordon remembers.

When he left college, Gordon was confident he wanted a graduate degree in oceanography. After being accepted at Columbia, he remembers making what felt like a long journey upstate in February 1961 to the “mountain top”: Lamont Geological Observatory. “I spoke with Jack Nafe, and I said, ‘Are you sure that I can study physical oceanography here?’ because I knew that Lamont at that point was mostly geology and geophysics,” says Gordon.

Gordon didn’t know at the time that director Maurice Ewing had decided he needed a physical oceanographer to teach him how ocean circulation moved sediment around the globe. Ewing had recently attracted renowned German oceanographer Georg Wüst, and they were seeking a student to work with him (Ewing famously said he recruited Wüst to have him explain the “murky mist that keeps me from seeing the bottom”).

Gordon feels he set foot in Palisades at exactly the right moment in the Observatory’s history. “I was instantly swept up by the atmosphere of exploration and adventure that permeated Lamont,” he has written.

In 1963, Wüst arranged for Gordon to travel to the Indian Ocean aboard the R/V *Atlantis 2.* The expedition marked the first time Gordon traveled abroad, and he remembers the excitement of navigating through the Mediterranean, the Red Sea, and into the Indian Ocean. What was impressed upon him, he says, was “how difficult it is to observe the ocean and the extraordinary effort that must be made to collect quality data.”

Gordon received his PhD in 1965 and was appointed assistant professor at Columbia the following year. His research during the late 1960s and 1970s primarily focused on investigating the Antarctic Circumpolar Current (ACC).

In February of 1977, in the middle of the Weddell Sea, Gordon was surprised to discover that the normal layering in the ocean was gone. “Something happened to cause the ocean to overturn, bringing deep-water heat to the sea surface and deterring the formation of sea ice. The sea had abruptly changed from one stable mode of operation to another.” What he observed was the ocean’s role in governing the Weddell Polynya, a persistent winter ice-free region in the center of the Weddell Sea, seen by satellites from 1974 to 1976 but not since.

Determined to learn more of the Weddell Sea, he helped develop a daring field program—a monitoring station positioned on a drifting ice floe along the western boundary of the Weddell Sea. The suite of ocean and atmosphere data from the 1992 Ice Station Weddell, a collaboration with Russia, provided the first substantial depiction of this vital part of the ocean.

In the 1980s Gordon turned to the South Atlantic, an ocean Georg Wüst had studied in the

1920s. In 1983 he made a surprising observation with far-reaching importance: a large pool of Indian Ocean water in the southeast South Atlantic Ocean. As with the Weddell Polynya observations, he first thought the instruments were broken, but the readings proved accurate. Further exploration showed that the water rounded the southern rim of South Africa. The phenomenon became known as the Agulhas leakage, which subsequently has been shown to be of central importance to global scale ocean overturning.

Gordon speculated that Pacific to Indian Ocean flow (the Indonesian Throughflow) must feed the Agulhas leakage in a global pattern of interocean exchange. Work on the Agulhas leakage led Gordon to the Indonesian Seas, where he worked tirelessly with the Indonesians to establish joint research ventures in the region. His persistence—and the seminal work that came out of this collaboration—which, with the Agulhas leakage research, was highlighted by the AGU award committee when it presented Gordon with the Ewing Medal in 1999, continues today.

"Arnold Gordon is one of those observational oceanographers whose work is so original, so clear and timely, that it is invaluable to a theoretician like myself. His body of work on the flow of water through the Indonesian Archipelago, for example, has been a tremendous resource for theoretical thinking on the problem of flow around large islands," says colleague Joe Pedlosky, physical oceanographer at the Woods Hole Oceanographic Institution.

Gordon believes observation of the ocean should never cease. "Ocean observations tell us about the true condition of the ocean; they keep models honest," he explains. The climate, Gordon emphasizes, is changing at an ever-increasing rate. To sharpen global predictions, climate models will need sophisticated representations of regional ocean processes.

Marking his 50th anniversary at the Observatory, Gordon outlines the large number of unknowns still remaining in oceanography. It's a stance that guides his inquiry. "I've never lost the feeling that unexpected discoveries are still lurking out there. The division between known and unknown in science is not a sharp boundary between light and dark but, rather, a murky region full of speculations and few data, a place where imagination rules."

Google Earth and Lamont-Doherty Join Forces

You don't need scuba certification—much less a submarine—to explore the stunning plains, mountains, and valleys of the seafloor. In June, Google Earth unveiled an enhanced topography feature that allows anyone with access to a computer to investigate the ocean depths.

Oceanographers at Lamont-Doherty have provided Google with sonar data collected on hundreds of scientific research cruises from many institutions—spanning roughly three million nautical miles over the past three decades.

These troves of data have been rendered into three-dimensional maps of higher resolution than ever before. With this Google Earth feature, users can travel to the huge Hudson Canyon off New York City, the Lamont Seamounts due west of El Salvador, or the razor-edged 10,000 ft. high Mendocino Ridge off the U.S. Pacific Coast.

Beyond intriguing images, the more accurate data help scientists understand the risks posed by such features as the underwater faults that triggered the tsunami that swept Japan in March. The maps also shed new light on volcanic eruptions, the vast majority of which occur hidden far from view on the ocean floor.

Download Columbia Ocean Terrain Synthesis plug-in on the Google Earth website to experience this rare glimpse of the seafloor!

Sunday in the Park with Lamont


Erika Freimuth

The perceived barrier between science and the public was nowhere in sight on Sunday, June 5, when the World Science Festival (WSF) came to Washington Square Park in New York City.

Lamont-Doherty marked its first year of collaboration with WSF by taking part in its Street Fair, which brings researchers and their tools out of the laboratory and into the streets, giving thousands of visitors access to the marvels of science. Observatory scientists, students, and staff enlivened the sidewalk with demonstrations of glacial flow, digital maps of a submerged Antarctic mountain range, and impressive volcanic eruptions that drew exclamations of awe and delight throughout the day.

Hundreds of visitors stopped by the Observatory's booth to learn about the natural world from researchers at the forefront of the field. Encouraged by the attendance and enthusiasm at the event, Lamont-Doherty plans to expand its participation in the future.

Lamont Summer Interns Investigate the World

By Dove Pedlosky

Natalia Martinez bent over the side of the boat, filling her collection jar with water. It was late July, and weekly sampling of the Hudson River was by now routine as she and her summer research mentor, Professor Andy Juhl, studied the lifespan of fecal bacteria in New York's popular waterway.

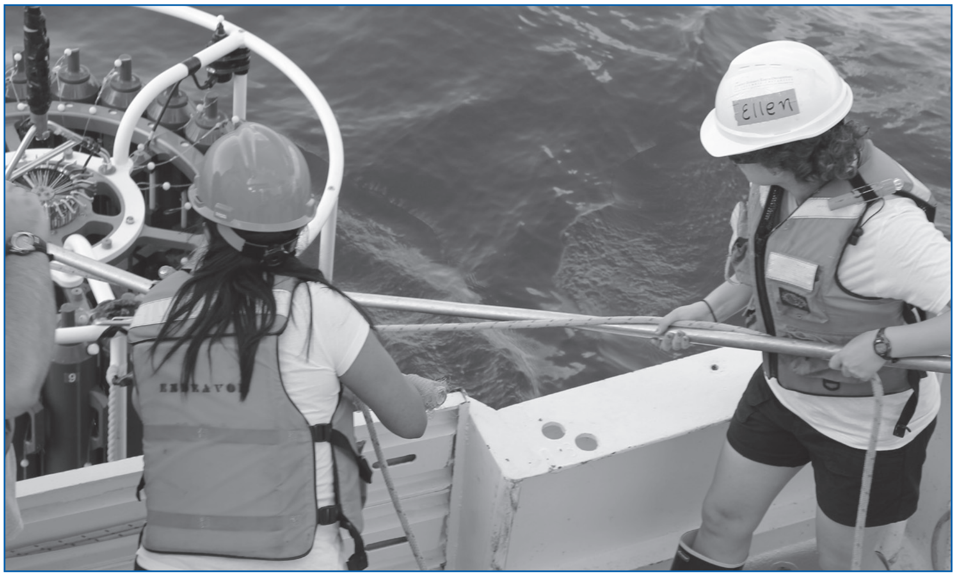
Natalia, a junior at Columbia University, was one of 32 summer interns paired with a Lamont-Doherty researcher as part of the Lamont Summer Intern Program. The program, now in its 22nd year, attracts students from universities across the country. For many of them, the 10 weeks at the Observatory serve as their introduction to cutting-edge lab- and fieldwork.

"I never thought I'd have the chance to make my own decisions, let alone design my own experiments," Natalia says. Fostering this independence is very much the point, explains Juhl. "We want students to mature as scientists and internalize the intellectual thought process necessary to approach a scientific question and then attempt to solve it. That is the most important skill we can teach these undergraduates."

While Natalia investigated the contamination of a local ecosystem, intern Ellen Ward joined her mentor, microbiologist Ajit Subramaniam, for a monthlong research cruise in the Gulf of Mexico. The two formed part of a multi-institutional team studying various aspects of the gulf ecosystem in the aftermath of the 2010 Deepwater Horizon oil spill. Back at the Lamont campus, Ellen was visibly affected by the experience of collaborating from dawn till dusk with a dynamic group of investigators.

Eileen Barroso

Rebecca Miller in the lab at Lamont-Doherty



Ajit Subramaniam

Aboard the R/V *Endeavor,* Ellen Ward (right) helps retrieve a sensor from the Gulf of Mexico.

"Everybody aboard the ship was completely engrossed with the research," Ellen says. "I'm accustomed to lab exercises at school where the teacher already knows the answer. But when I conducted fieldwork this summer, I wasn't just studying something in a petri dish. We were living in the ecosystem and formulating new questions in response to our observations."

Kyle Monahan expresses similar enthusiasm about his summer research, which involved trying to account for the presence of marine microfossils embedded in ancient samples retrieved from deep below the Hudson River floor. Did a major tsunami sweep the microscopic organisms up the river? Was it a hurricane barreling in from the South? "This summer I learned that being a scientist is much more creative than many people think. I felt like a detective trying to uncover the truth about the region's history—following the evidence wherever it led me."

Oceanographer Dallas Abbott, who directs the program each summer, believes the Lamont-Doherty program is unique.The variety of Earth science research that takes place on campus exposes students to the vastness of the field.

"Sometimes the interns discover that what interests them most is not what they did as a research project but what one of the other students did. They comprehend the multitude of scientific questions that still remain unsolved."

Microbiologists Helga Gomez and Joaquim Goes make it clear that it is not only the intern who benefits. One of their interns, Rebecca Miller, monitored the growth of a harmful new algae—perhaps the result of climate change—in the Arabian Sea with NASA satellite imagery. At the start of the summer, Goes didn't think the *noctiluca* could be detected via satellite, but Rebecca discovered a way to differentiate *noctiluca* blooms from other species. Both Gomez and Goes believe Rebecca's summer research will be published in a leading journal.

Rebecca and her advisers describe their summer as a period of shared adventure—even though many days were spent in front of computer screens. Rebecca recounts animated phone calls to keep her parents abreast of her progress: "Mom, my data sets line up!" she'd exclaim into the phone.

"It's exceptional what Rebecca has done. She's managed to analyze huge data sets in only six weeks. It's work that would constitute a master's thesis," says Goes.

Alumnus Returns to the Field

Aaron Lebovitz (front, far left) joined his former mentor Mark Anders (standing, sixth from right) and graduate students in Wyoming this summer.

"The first time I went to Idaho as Dr. Mark Ander's intern, I came back with a shaggy beard, a big gash on my shin, and a wide-eyed appreciation for rattlesnakes. When Mark invited me this summer to tag along on a field expedition that included time on the Snake River Plain, my mind flashed back to 1991. I immediately accepted, though it took me 18 months to arrange the trip. Despite having no plans to grow a beard, fall out of a pickup truck, or recoil from venomous fangs, I was pretty happy to be headed back.

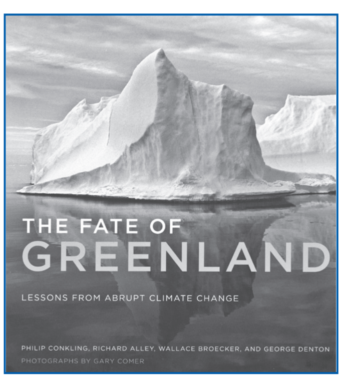
I continually return to my summer in the Lamont Intern Program both as a practical guide and as inspiration. That summer I learned some of the harsh, practical realities of scientific research. Over time, I see that they differ in form but not substance from the harsh, practical realities of life. I learned that those challenges are regularly drowned out both by big ideas and by small discoveries—also not so different from the experience of adult life. As a summer intern I read Karl Popper for the first time, which inspired my first deep understanding of what science really is, as compared to the body of scientific knowledge commonly taught.

In the few days I spent this summer with some of Columbia's current graduate students, I managed to avoid accident and injury. More importantly, I was able to renew my feelings about the strength of Lamont-Doherty's mission, reconnect with the smart, curious, and welcoming people it attracts and mentors, and realize that my time at Lamont-Doherty was the single best element of my academic career."

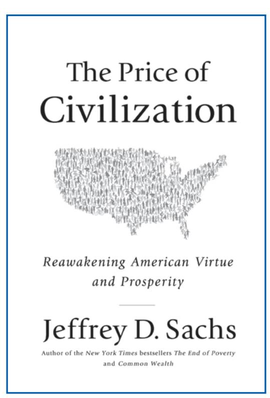
—Aaron Lebovitz, Principal, Infinium Capital Management

On Our Bookshelf

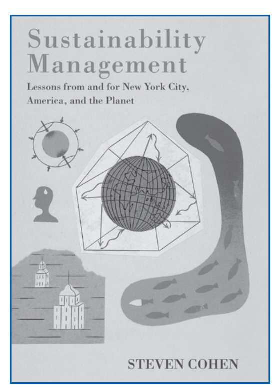
The Fate of Greenland: Lessons from Abrupt Climate Change
By Philip Conkling, Richard Alley, Wallace Broecker, and George Denton
MIT Press
The Fate of Greenland documents Greenland's warming in simple, articulate detail and is accompanied by the dramatic color photographs of the late Gary C. Comer. The coffee table book comes from a pioneering team of climate scientists who have investigated Greenland's environmental history for clues about what happens when the climate changes abruptly.



The Price of Civilization: Reawakening American Virtue and Prosperity
By Jeffrey D. Sachs
Random House
By taking a broad, holistic approach—looking at domestic politics, geopolitics, social psychology, and the natural environment—Earth Institute Director Jeffrey Sachs reveals the larger fissures underlying our country's current crisis. The leading economist looks at the crisis in our culture, in which an overstimulated and consumption-driven populace in a ferocious quest for wealth now suffers shortfalls of social trust, honesty, and compassion.



Sustainability Management: Lessons from and for New York City, America, and the Planet
By Steven Cohen
Columbia University Press
Can we grow our world economy and create opportunities for the poor while keeping the planet intact? Can we maintain our lifestyles while ensuring the Earth stays productive and viable? Steven Cohen, the Earth Institute's executive director, answers these questions and argues for environmentally sustainable business practices and policies to foster long-term economic growth.



Songbirds on the Tundra

By Mary Beth Griggs

Heather Greaves

Natalie Boelman (right) with colleagues in the Atigun Valley of Alaska's Brooks Mountain Range

Tree sparrows, dark-eyed juncos, and American robins are regulars at backyard birdfeeders across North America. But few people know that these familiar avian visitors are actually intrepid Arctic travelers. Some songbird populations head north to the Arctic tundra every spring, anticipating thawing temperatures and the glut of insects that accompanies the change of season there.

Natalie Boelman and her team of researchers are investigating the ways in which migratory songbird populations are coping with an environment altered by climate change.

"Some of the species we see at our birdfeeder every winter travel 3,000 miles every summer to the tundra to breed. If this ecosystem changes, then who comes back to your feeder every year will change too," Boelman says.

Different factors affect the health of the Arctic's migratory songbirds, many of which are familiar sights in the Northern Hemisphere's lower latitudes. With few predators and diverse food sources, the Arctic tundra has long functioned as the perfect breeding ground for migratory songbirds.

Songbirds begin their northward journey when the days begin to lengthen, determining the start of their journey by the amount of light in the sky. Like clockwork, the birds fly annually to the Arctic in late May, regardless of weather. Usually, this schedule means they arrive just as vegetation and insects begin to emerge, and they lay their eggs in time for their fledglings to take advantage of peak insect season.

Warming climates could upend this perfectly balanced cycle. Unlike migratory songbirds, the ebb and flow of life in the tundra is determined by heat instead of light. If spring continues to emerge earlier each year due to global warming, there is a chance that bugs will arrive and taper off long before the bird eggs hatch—depriving the newly hatched birds of a valuable high-protein food source.

Boelman, along with her collaborators Laura

Gough (University of Texas at Arlington) and John Wingfield (University of California, Davis), is trying to uncover the extent to which climate warming is affecting the bird populations. They are gathering data about the changing ecosystem at Toolik Lake Field Station on the North Slope of Alaska, spending the summer collecting and counting insects, monitoring the songbird populations, recording their bird calls, counting eggs, drawing blood to measure stress hormone levels, and measuring what types of vegetation are most prevalent in the breeding areas.

The five-year research project funded by the National Science Foundation is now in its second year. The program has to extend for multiple years because even with the slow and steady rise in temperature caused by global warming, spring in the Arctic can be tryingly temperamental. While a long-term rise in temperature can drastically affect populations over the long term, weather variations from year to year can have immediate effects on the health and strength of bird populations. Boelman expects that during the next few years they will witness everything from bitter snowstorms to warm and early springs. “We’re looking at how this huge interannual variability affects stress levels and, ultimately, the reproductive success of the birds, which will give us a good idea of how they will cope with the longer-term changes in climate that are occurring,” she says.

Boelman’s PhD work focused on developing remote sensing methods to monitor vegetation changes in the Arctic, and she became increasingly interested in the multi-trophic impacts of climate change, wanting to examine how changes to one aspect of the food chain can affect other levels of the food hierarchy. “I wanted to understand how these vegetation changes would impact things with heartbeats,” Boelman says.

For Boelman, the Arctic tundra is the front line of climate change research. “It’s sort of a bellwether for climate change. It’s changing quite rapidly in response to climate warming, more so than any other ecosystem on the planet. So we think of it as the canary in the coal mine,” she says.

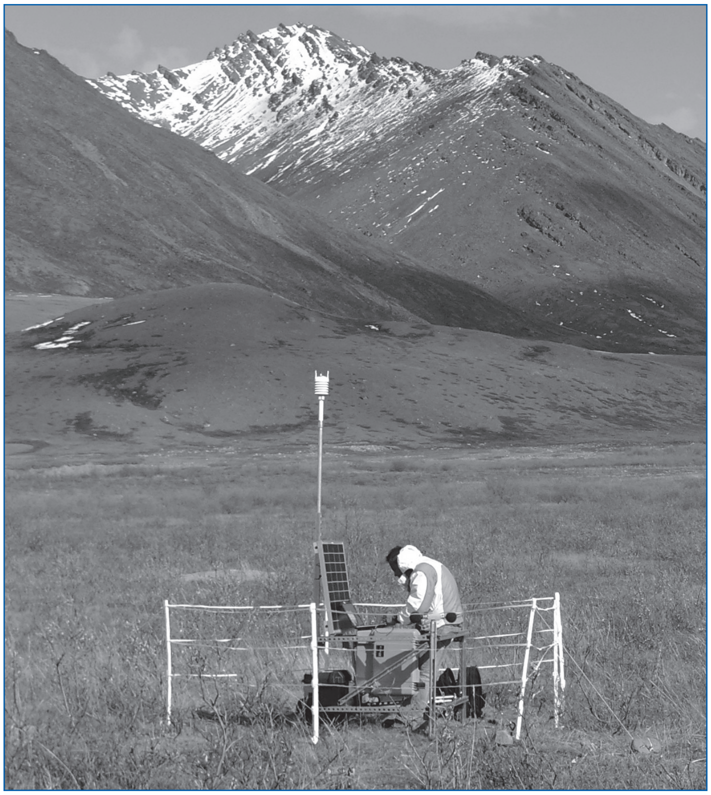
With such a swiftly changing ecosystem, there is always more to study, and Boelman is poised to explore more of the Arctic ecosystem in future years. She plans to partner with other researchers to analyze fragments of ancient songbird DNA preserved in the permafrost and to study the impacts that increased wildfire conditions will have on the reindeer and caribou habitats.

Even with so many projects on her plate, Boelman still believes in taking the time to explain her work to the general public. Boelman chronicled her summer field season online for the *New York Times’ Scientist at Work* blog. Though it was a challenge to write and research simultaneously, Boelman says that the outreach benefited her as well: “It was nice at the end of the day to think about what we’d done, what it means, and then communicate that to the general public.”

Read Boelman’s notes from the tundra at: scientistatwork.blogs.nytimes.com/author/natalie-boelman/


Heather Greaves

Horned lark fledgling on the North Slope of Alaska, July 2010


Natalie Boelman

A meteorological sensor, bio-acoustic recording unit, and snow camera collect data behind an electric fence, intended to keep grizzly bears and foxes away.

New Tools for Uncovering Past Climates

By Susan L. Young

Jessica Tierney with a guide and a colleague in the Rwenzori Mountains of East Africa

In the heart of East Africa lies the second deepest lake in the world, Lake Tanganyika, where small changes in temperature may be having a big effect on the lake's ecosystem. This productive giant is a major source of food and employment for the people who live near its shores, yet fishing nets are not as full as they used to be. Instrumental readings over the past 90 years indicate the water has warmed enough to slow the cycling of nutrients from the lake's bottom, which limits the growth of plankton. In turn, fewer fish survive. With only a century's worth of temperature records, scientists have debated whether man's modern lifestyle could account for the changes in Lake Tanganyika's ecosystem. Recent data suggest the damage is indeed our own doing.

By hunting down clues hidden in the sediments at the lake's bottom, Jessica Tierney, a postdoctoral researcher at the Lamont-Doherty Earth Observatory, was able to look back to a time before thermometers existed. From the microscopic remnants of organisms that have long inhabited the lake, Tierney built a 1,500-year history of the water's temperatures.

CLIMATE SCIENTISTS ARMED WITH BIOLOGICAL THERMOMETERS

Tierney is one of a handful of new researchers at Lamont-Doherty who are leveraging recent advances in biology and chemistry to address pressing questions about Earth's climate. She and other organic geochemists study hardy remnants of organisms buried deep beneath oceans and lakes for clues about past environmental conditions.

The "molecular fossils" sought by these organic geochemists cannot be seen with the naked eye and must be chemically sorted from a slew of other compounds. Researchers use sophisticated instruments to determine the identity and chemical composition of the biological molecules. "The analysis of biomarker compounds can be very time intensive," says Tierney. "But it's worth it, given the information we gain about past climates." Advances in the last decade allow scientists to examine even the weight of atoms in organic molecules for hints about past water cycles—information that has proved difficult to reconstruct.

Tierney recognized that fatty molecules made by lake microbes could serve as chemical time capsules, carrying a long-concealed record of Lake Tanganyika's temperatures. While a graduate student at Brown University, she isolated large lipid molecules known as glycerol dialkyl glycerol tetraethers (GDGTs) from cores of sediment drawn up from the lake's depths. These lipids reside in the cellular membranes of aquatic microbes. The microbes adjust the shape of their GDGT lipid molecules in response to changing water temperatures. This acclimation process helps the microbes maintain their cellular membranes at a proper density. Organic geochemists can use this temperature-responsive phenomenon as a proxy to study changes in past water temperature.

Proxies such as the shape of the lipid molecules chronicle the climate conditions of the time in which they were formed and can function like an organic archive of past environmental changes. "We would prefer it if someone had set up a thermometer thousands of years ago, but in the absence of that, we use proxies for temperature," explains William D'Andrea, a climate researcher at Lamont-Doherty.

By analyzing molecules in sediments from Lake Tanganyika, Tierney was able to infer temperature changes extending far beyond the modern instrumental record. Her work clarified the man-made nature of the lake's troubles: The warming trend over the last century is unlike any fluctuation in the last 1,500 years.

"The Lake Tanganyika data provide an independent confirmation that contemporary warming is unprecedented relative to the most recent geologic past, even in this remote region of Africa," says Peter deMenocal, professor and chair of the Department of Earth and Environmental Sciences at Columbia University. "What's doubly useful about this study is that it documents how such changes affect fisheries and the human communities that rely on the lake for survival."

FATS ARE FOREVER

Most biological molecules cannot stand the test of time. Sugars, for instance, are quickly broken down by hungry bacteria. But some molecules, such as fats, waxes, and other lipids like the GDGT compounds, resist destruction and remain intact for thousands, even millions, of years.

Oil and coal are the natural byproducts of ancient lipids, and modern organic geochemistry stems in part from fossil-fuel surveyors curious about the origin and quality of fuel deposits. In the 1930s, scientists realized these natural energy sources had a biological origin. But it wasn't until the 1960s, when scientists paired two powerful analytical instruments, the gas chromatograph and the mass spectrometer, that organic geochemists began to isolate molecular fossils and determine their chemical composition. In the last decade or so, machines and methods have improved, and now even the relative weights of different forms of carbon and hydrogen atoms in the molecular fossils can be used as records of past climate conditions.

Heather Ford

Pratigya Polissar samples equatorial Pacific algae aboard the R/V *Melville.* This research is helping develop tools to reconstruct the history of ocean temperature and carbon dioxide in the atmosphere.

Molecular fossils found underneath lakes or oceans are naturally organized by time. As dirt and the detritus of life sink to the bottom of bodies of water, each compacted layer is older than the one above it. Scientists can harvest this presorted collection by sending hollow coring tubes deep into the sediment. Researchers journey far and wide to gather samples, from frozen Arctic landscapes, to humid African jungles, and high Andean plateaus.

As climatologists reconstruct historic climate patterns from many areas of the globe, they are able to predict future climate conditions with increased confidence. "Right now we are conducting an experiment on the planet," says D'Andrea. "By adding carbon dioxide to the atmosphere, we know for a fact that the average tempera-


Eileen Barosso

Jessica Tierney uses this Accelerated Solvent Extractor to isolate organic compounds from sediments or organic material such as leaves and algae.

Raymond Bradley

D'Andrea's research team was ferried across a fjord from a fishing village in Greenland called Kuummiut. The group then lowered a snowmobile onto the sea ice for the last leg of the journey to their study site.

ture of the globe will increase. But if we want to predict regional changes, we need to improve our understanding of past climate changes in specific locations."

D'Andrea works in the Arctic, including Greenland, Norway, Alaska, and Canada. He uses molecular fossils produced by algae to study how temperatures above the Arctic Circle have changed over the last few thousand years. Like the microbes that Tierney studies, D'Andrea's algae also alter the structure of certain lipids in response to changing temperatures.

> As researchers at Lamont-Doherty and beyond continue to integrate biology into their study of Earth, they will see more clearly how climate change will influence life on this planet in the future.

The algae live in the frigid waters of lakes that are sometimes covered with thick ice—a good thing in D'Andrea's mind. "Coring is much easier when the lake is covered by ice. You can land a helicopter right on the ice so all your equipment is right there," he says. "After drilling a hole in the ice, you can be pretty confident that you will find the same spot to sample each time."

Analyzing cores collected from lakes in western Greenland, D'Andrea discovered that over the last 5,600 years, average temperatures in the region have undergone extreme fluctuations, sometimes changing by several degrees in mere decades, and profoundly impacting the settlement patterns of the local inhabitants.

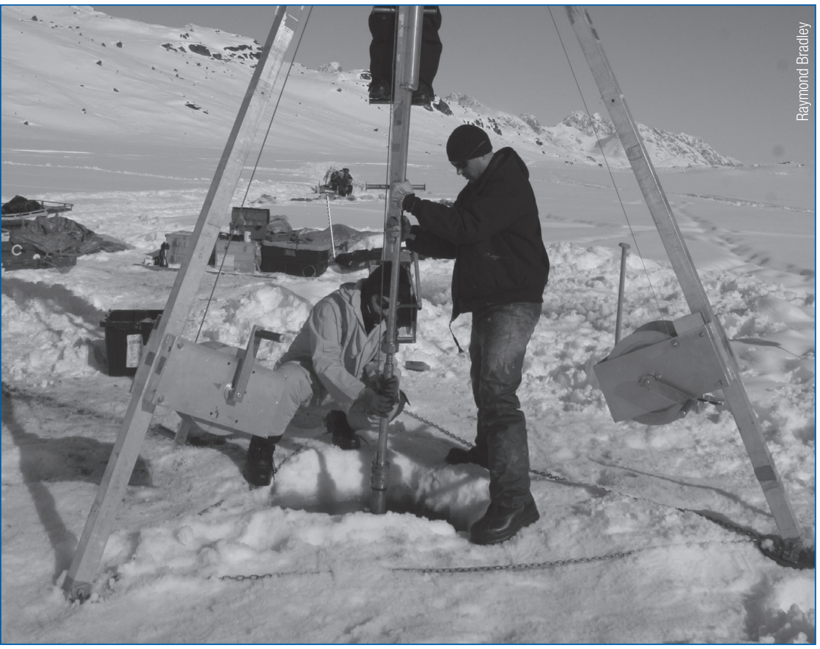
ELUSIVE RECORDS OF PAST RAINFALL

Rainfall patterns are a fundamental aspect of a region's climate, but retrieving information about past rainfall has long eluded scientists. "It's extremely hard to infer how rainfall patterns have changed," says deMenocal. But by leveraging new advances in biogeochemistry, scientists are developing methods to reconstruct alterations in precipitation levels.

Within a given body of water, each H_2O molecule can contain different variants of hydrogen and oxygen. These variants, or "isotopes," don't affect function, but they do affect the weight of the water molecule. The first raindrops that fall from a cloud tend to have heavier water molecules, and researchers can use this fact to determine past precipitation levels in a given region. Scientists such as Pratigya Polissar, a research professor who recently joined Lamont-Doherty, analyze the isotopic composition of organic molecular fossils to uncover the behavior of historic water cycles.

"Plants take rainwater from soils and synthesize organic molecules to make their leaves and stems," explains Polissar. These organic molecules incorporate the isotopic variants of hydrogen or oxygen that exist in the water.

Polissar harvests organic molecules from numerous locations to explore water cycles from



After drilling through lake ice, D'Andrea's team lowers a coring system through the water to collect sediments from the lake bottom.

Peter deMenocal in the Observatory's Deep-Sea Sample Repository—an extensive archive of sediment cores from every major world ocean and sea

many different eras, ranging from 15,000 years ago in Venezuela and Bolivia to 10 million years ago in California. Changes in precipitation can greatly affect the conditions of a region. In the Venezuelan Andes, for example, a shift in isotopic composition over the last 10,000 years suggests that a changing tropical climate led to drier conditions in the mountain range as well as in the low Amazon basin.

Tierney has adopted isotopic analysis to explore past precipitation conditions as well, applying the technique to better understand the monsoon and El Niño weather systems in the tropics. By studying lipids that derive from plant leaves, she has explored how monsoon intensity over the last few millennia has vacillated between East Asia and Indonesia.

THE WIDE WORLD OF BIOGEOCHEMISTRY

The intersection of biology and geochemistry (an emergent field referred to as biogeochemistry) covers many topics within the Earth sciences—from the amount of stress generated during earthquakes to the age of certain mountain ranges. Polissar, for example, compared the isotopic composition of water in the Himalayas over the last 50 million years to study the origin of the Tibetan Plateau. He discovered that the Tibetan Plateau reached its high elevation much earlier than some popular theories describe and therefore possibly played a significant role in the development of the Asian monsoon system during that time.

Biochemists address the acidification of our oceans, a phenomenon that is threatening the marine food chain. Scientists know our oceans are growing more acidic (lower pH) due to greater amounts of CO_2 in our atmosphere. Researchers at Lamont-Doherty are investigating how increased carbon emissions and associated warming affects the productivity and genomic structure of marine organisms. Scientists can put current changes in context by studying ancient fossils of shell-producing microorganisms.

The field can also reveal the landscapes inhabited by our ancestors. Molecular fossils from grasses carry different chemical signatures from those from trees, allowing scientists to determine whether a particular region once looked like a savannah or a forest. Researchers are using these tools to understand the evolution of species—including our own. Peter deMenocal's climate reconstructions of Northeast Africa document a drying trend that began roughly three million years ago, turning the region into the savannah grasslands we see today. DeMenocal uncovered new evidence that shifts to more open grassland vegetation coincided with important junctures in the evolution of early man. These findings have brought into focus climate's role in shaping human evolution.

And when environmental data are coupled with the study of ancient societies, we can see how climate changes affected the human species in the past. For example, at different times, groups of Eskimos and Norse Vikings settled western Greenland, only to later abandon the region. D'Andrea's work showed that their departures coincided with abrupt decreases in temperature. As the winters there grew more severe, perhaps those early peoples decided to seek a warmer home and an easier life.

As researchers at Lamont-Doherty and beyond continue to integrate biology into their study of Earth, they will see more clearly how climate change will influence life on this planet in the future.

"This new focus on biogeochemistry is a natural extension of existing strengths in geochemistry and climate research at Lamont-Doherty, and it provides us with innovative tools to explore biological responses to climate," explains deMenocal.

"In my opinion, this convergence of disciplines is one of the most promising ways to advance the study of climate."

Letter from Steven Cande Alumni Board President

Dear Alumni and Friends of Lamont,

This year members of our alumni board participated in the first ever Lamont alumni thank-a-thon. Alumni board members Dee Breger, Rudi Markl, Greg Mountain, Michael Rawson, and Joyce O'Dowd Wallace took the lead, reaching out to alumni across the country in gratitude for their loyal support of the annual fund. The calls sparked lively exchanges and led to some good old-fashioned storytelling. We're fortunate to have alumni who make meaningful contributions—both in their field and to the Observatory.

On the topic of contributions, I am continuously impressed by the Lamont alumni that pop up in the media offering insight to the public after a significant natural disaster. The large earthquake in Virginia was no exception; within a matter of hours I heard Art Lerner-Lam on national radio speaking about the efficacy of seismic energy transmission, and over on NBC television I saw the news anchor interviewing former Lamonter Lucy Jones at the USGS in Pasadena. Earlier this year when a volcano in Iceland again disrupted air traffic between North America and Europe, I was pleasantly surprised to hear the voice of Icelander Pall Einarsson, another former Lamonter, explaining the difference in the grain size between this and last year's ash clouds.

Lamont alumni constitute an amazing web of scientific knowledge, and I salute their willingness to share their expertise with others on the fly.

Warm regards,

Steven C. Cande

Steven C. Cande, PhD '77

AGU FALL MEETING 2011
San Francisco, California, USA | 5-9 December

SAVE THE DATE!
Tuesday, December 6, 2011
San Francisco Marriott Union Square
480 Sutter Street, San Francisco, CA

GENERAL LAMONT-DOHERTY ALUMNI MEETING
5:30 to 6:30 p.m.
Russian Hill Room, 30th Floor

ANNUAL LAMONT-DOHERTY ALUMNI RECEPTION AND SALUTE TO MIA LEO
6:30 to 8:30 p.m.
Savoy Room, 30th Floor

LDEO.columbia.edu/about-ldeo/alumni/alumni-news

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New York NY

Alumni Presence at Open House 2011

Lamont-Doherty alumni returned to campus during October's Open House weekend to mingle with former classmates and mentors. Some brought family members to experience the science presentations firsthand, while others participated in the day's events. Heidi Cullen (PhD '00) skillfully moderated a panel discussion on the topic of climate change and extreme weather. Kerry Hegarty (PhD '85), Supria Ranade (MS '07), Kyla Simons (PhD '09), and Kevin Wheeler (PhD '07) took part in an alumni career panel, moderated by Philip Orton (PhD '10), which highlighted the numerous career options available to students with science degrees.

Brian Kahn

Alumna Heidi Cullen moderates extreme weather panel.

Climate Scientist, Alumna to Head Lamont-Doherty's Core Repository

By Kim Martineau

Kalman Zabarsky

The seas are rising, as they have during past periods of warming in Earth's history. Estimates of how high they will go in the next few thousand years range from 5 meters, putting greater Miami underwater, to 40 meters, wiping most of Florida off the map. "The range of estimates is huge to the point of meaninglessness," says Maureen Raymo, a climate scientist who joined Lamont-Doherty this summer from Boston University.

On a desolate coast in Australia, Raymo aims to close the gap. By analyzing ancient fossils, sand dunes, and coral reefs, she wants to pinpoint where the seas stood three million years ago, when warming temperatures and collapsing ice sheets pushed the seas much higher than today. This information could help scientists narrow their estimates for how ice sheets today will respond to hotter temperatures and rising greenhouse gas levels, she says.

Captivated by Jacques Cousteau's stories at sea, Raymo knew from an early age she would become a scientist. Her father, a physics professor and science journalist, encouraged her by casting her in the starring role of her own comic book, "Maureen's Adventures Under the Sea."

Raymo first came to Lamont-Doherty in the 1980s to earn her PhD. With adviser Bill Ruddiman, she proposed the controversial "uplift weathering hypothesis" that rising mountain ranges could cool Earth's climate. Over time, the exposed rock of new mountain ranges, such as the Himalayas, undergoes a chemical weathering process that removes carbon dioxide from the air to cool the planet globally, she says.

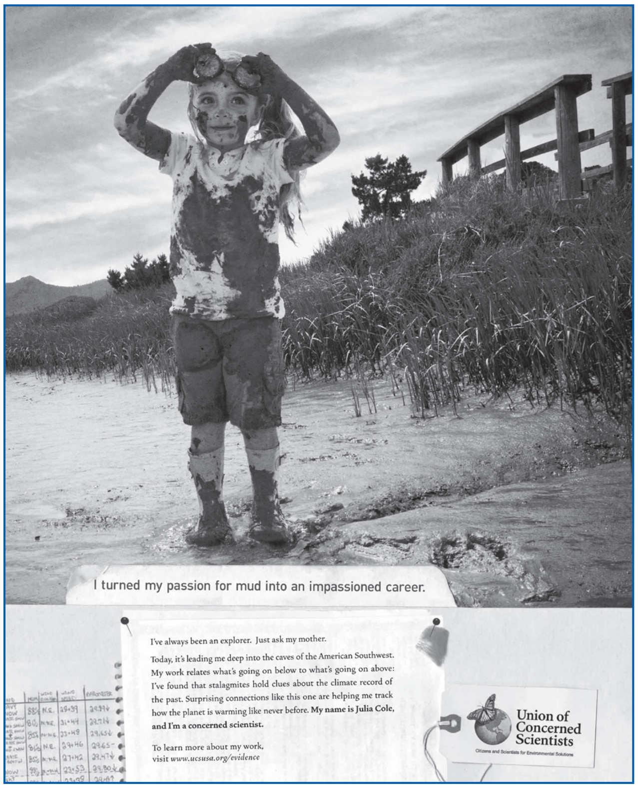
More recently, Raymo came up with another big idea to explain why ice ages came and went more frequently between 3 million and 1 million years ago—arriving every 41,000 years instead of every 100,000 years. After watching the documentary *March of the Penguins,* Raymo started to think about Earth's orbital cycles and how shrinking ice cover in Antarctica coupled with cyclical changes in the direction of Earth's rotating axis might alter the timing of ice ages. In a 2006 paper in *Science,* she proposed that the Antarctic ice sheet was far more dynamic in the past than generally accepted.

Now that she's returned to the Observatory, Raymo will oversee the Lamont-Doherty Core Repository, the world's largest collection of seafloor sediments. She is also helping to direct the current renovation of the New Core Laboratory. One of her goals is to broaden access to the collection by training more scientists to tap into its data.

"We have more cores, from more places on Earth, than any other institution," she says. "They are a treasure trove for understanding how Earth's climate and life have evolved in the past."

Alumni Profile: Julia Cole, PhD ’92

By Mary Beth Griggs



Julia Cole is, quite literally, a poster child for climate scientists everywhere. Not only does she spend her days solving enigmas in Earth’s history, she does so in incredible places. A typical year will see her diving down to coral reefs in the Galapagos or venturing deep inside Arizona’s limestone caves, living proof that climate science is anything but mundane.

“I have always thought of science as a creative endeavor; one of my biggest challenges is to maintain and nurture that part of my work,” Cole says.

Cole, a professor of geosciences at the University of Arizona, has spent much of her career gleaning information about past climates from fossilized records preserved in the natural environment. Lately, she has also started to communicate her climate research (and that of her colleagues) to individuals outside the field.

Cole’s paleoclimate work began here at Lamont-Doherty in 1986, when her adviser, Richard Fairbanks, encouraged her to make use of his vast coral collection to study the history of El Niño. Known more formally as the El Niño Southern Oscillation (ENSO), this system is one of the most influential climate phenomena on Earth. It occurs irregularly every few years, bringing warm ocean temperatures to the tropical Pacific and disrupting rainfall patterns throughout the tropics and the Americas. Researchers have sought clues about how ENSO might respond to a changing climate by examining coral reefs in the tropical Pacific as a means to decipher ENSO’s past variability.

Cole’s graduate years coincided with an important chapter in the study of El Niño at Lamont-Doherty. In the mid-80s, scientists Mark Cane and Steve Zebiak built the first computer model to simulate and successfully predict El Niño’s occurrence. The two publicized their prediction in 1987 for the first time.

Cole is particularly interested in the history of climate that occurs on human time scales. “We are looking closely at the last century to get a better understanding of 20th-century temperature trends across the tropical Pacific,” she explains. Her research in the tropical oceans has expanded over the years to include reef ecosystems, monsoon variability, and anthropogenic climate change.

When she moved to Arizona, Cole adapted her research to fit her new home. “I became interested in the Southwest when I moved west and realized the fascinating climate history of the region,” Cole says. While the southwestern United States has detailed tree ring records that stretch back millennia, Cole hoped to complement existing tree-ring data with data from the stalagmites that grew in nearby limestone caves.

She developed a paleoclimate project that would include fieldwork and appeal to her students. Using her experience analyzing the geochemical makeup of coral reefs, Cole and her students collected samples from the cave formations and took them back to the lab. Stalagmites form over time, built by the steady dripping of water laden with minerals. Changes in climate indicators, like the amount of water in the area, are recorded in the stalagmites as they grow. With radiometric dating and isotope geochemistry, Cole and her students were able to build an accurate picture of what the climate of the Southwest was like tens of thousands of years ago. They found that previous warm periods were coupled with long spells of drought in the Southwest, and the likely mechanism was the same as that proposed for a future warmer world—the northward shift of the Pacific storm track.

Climate has become a charged political issue in the public realm, and many scientists are unwilling to wade into the morass. Cole is not one of them. “The degree of misinformation and misunderstanding about climate change can be astounding, and I believe we have an obligation to make our science connect with public concerns. The public funds most of our work. More importantly, public awareness of climate change might just help us avoid its most costly and damaging impacts,” Cole says.

In order to meet that obligation, Cole has gone out of her way to engage new audiences. In February 2011 she was selected to be a fellow in the fledgling Google Science Communication Fellows program. As part of the initiative, Google will fund work by the fellows that makes use of technology and new media in communicating the science of climate change.

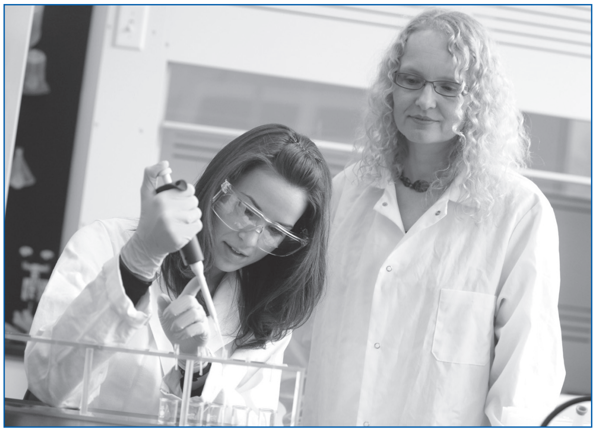
Cole is no stranger to science communication. Last year, she took part in a PR campaign run by the Union of Concerned Scientists (see inset). And as an Aldo Leopold Fellow in 2008, Cole traveled to Washington, D.C., and met with elected representatives to discuss scientific topics and gain insight into the perspectives held by our elected leaders. The Stanford-based Aldo Leopold Leadership Program works to provide scientists with communication skills that can help them interact with both politicians and the press.

Cole encourages her students to seek similar training, and she is working to start something like the Leopold Program for students and young environmental scientists at the University of Arizona.

While these pursuits do take time, Cole finds that the rewards are plentiful. “One of the best things about the workshops is that they attract fascinating, smart, and energetic scientists. I’ve learned a lot of science through communication activities!”

“I like the process of distilling complex information to something you can explain to your family,” Cole says. “And I can’t help but think that better information will lead to smarter policies, someday.”

Friends and Alumni Support Campaign in Record Numbers

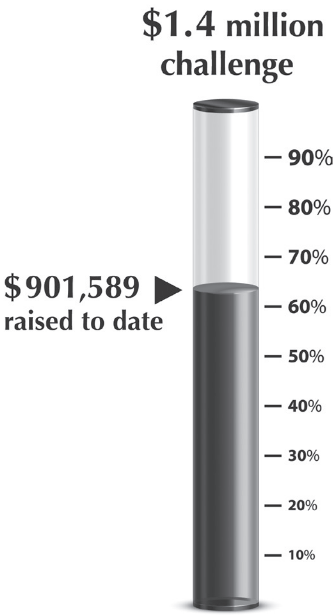


Eileen Barroso

In January 2010, Lamont-Doherty secured a highly competitive $1.4 million matching grant from the National Institute of Standards and Technology to complete the final laboratory in the Gary C. Comer Geochemistry Building. The new facility will be the most sophisticated of its kind in academia and will accelerate our research into a wide range of environmental processes affecting the planet.

We've been greatly heartened during this campaign by the donor participation rate. To date, the Observatory has raised more than $900,000, with 128 separate gifts made by 122 friends, staff, and alumni (many thanks to those who gave twice!).

Our sincerest thanks to those of you who've made gifts to expedite breakthroughs in the Earth sciences. If you are still considering a contribution, there is no better time than the present to help us meet the $1.4 million match!



For information about how to support the Ultra Clean Lab, please contact Director for Development Barbara Charbonnet at 845-365-8585.

IN MEMORIAM

Dr. Oswald A. Roels (b. 1921), whose research at the Observatory focused on artificial upwelling in St. Croix, passed away in May 2011.

Lamont-Doherty Earth Observatory
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P.O. Box 1000, 61 Route 9W
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FROM THE ARCHIVE

Courtesy of Charles Gallegher

Wally Broecker and colleagues return from Tahiti aboard the R/V *Melville,* 1974.

INSIDE