The Record
SPECIAL

COLUMBIA
Leadership in Climate Change

By Ken Kostel

Sometimes, science develops in grand leaps of eureka moments, but often builds through the gradual accumulation of incremental advances and subtle refinements. Nowhere is this more evident than in the body of investigation known as "climate science." And that's where the dogged commitment of researchers across Columbia are making large and small advances every day in efforts to unlock the secrets of how the climate functions, how human action affects the planet, how our changing environment affects societies around the globe, and what to do about it.

The study of Earth's climate is a vast collection of disciplines that draws upon the expertise of scientists from across the academic spectrum. At Columbia the notion of what is a climate scientist changes almost daily. A quick glance at the CVs of some of the major researchers, as well as the up-and-coming stars, bears this out.

James Hansen, director of the Goddard Institute for Space Studies, which is affilliated with Columbia's Earth Institute, received his PhD from The University of Iowa in astrophysics and for several years published widely on the atmosphere of Venus. Only later did he turn his singular focus and careful study to the question of energy balances and greenhouse gases in our own atmosphere.

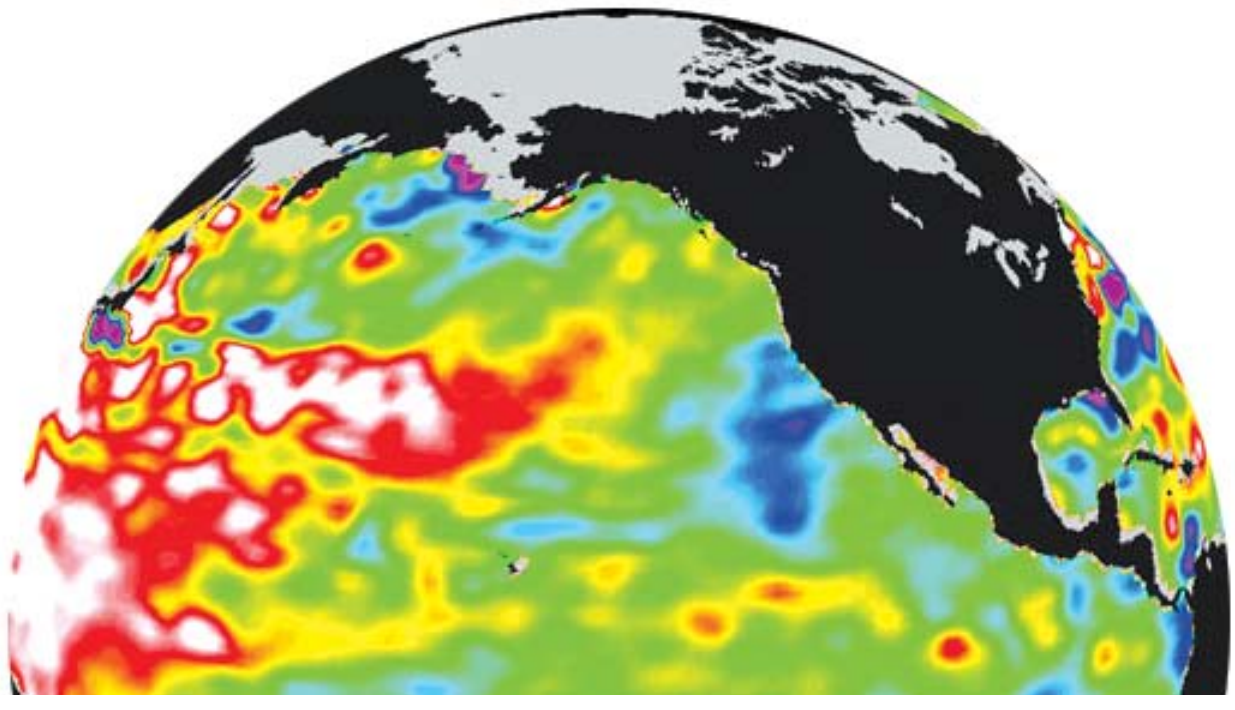
Mark Cane of Lamont-Doherty Earth Observatory and Stephen Zebiak, director-general of the International Research Institute for Climate and Society, well-known climatologists for their work in forecasting short-term climate variations in the tropics, did much of their graduate work in applied math. In 1985, they devised a simple numerical model relating wind speed and sea surface temperature that proved to be a remarkably good predictor of the El Niño phenomenon that periodically brings life-threatening weather changes to large parts of the developing world.

Even Columbia's legendary seismologists—a group known more for their work studying earthquakes, volcanoes and thermonuclear detonations—are bringing their expertise to bear on the issues of climate change. Meredith Nettles and Göran Ekström of Lamont-Doherty recently discovered a connection between some curious seismic events along the coast of Greenland and the movement of glaciers that link the island's vast ice sheet to areas of the North Atlantic, which are critical to Earth's global ocean circulation.

Having led the way in studies to unlock how Earth's climate works, how human action can affect it, and what the future of our climate might be, Columbia is beginning to play another, crucial role in the climate sciences. The next great step is to devise ways for humanity to mitigate our increasingly unavoidable impact on global systems such as the climate, the biosphere, and ocean circulation and to help societies learn to adapt to the changes. In this effort, the insight of social scientists and public health experts are also crucial to build on the foundation laid by those such as Doc Ewing and Wally Broecker, two of Lamont's legendary founding scientists.

Today, in the cafeteria at Lamont and the hallways of Schemerhorn, Pupin and even the law or business schools, more scholars are coming together formally and informally to trade ideas, often surprising one another with the similarity of the problems they address or the techniques they employ. The results can have lasting and far-reaching effects in how we look at our planet and in how quickly we address the complex and thorny questions that face us. Indeed, more than a dozen Columbia scientists have worked with the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize with former Vice President Al Gore.

From the science of decision making to low-cost energy sources for Africa's rural poor, to the demographics of those hardest hit by Hurricane Katrina, Columbia is focusing its extraordinary breadth of intellectual resources on expanding human understanding of our relationship to the planet. In the process, the University is also redefining what it means to be a climate scientist in an increasingly uncertain climate future.



Latest Findings: 2007 Was Second Hottest Year on Record

By Record *Staff*

Climatologists at the NASA Goddard Institute for Space Studies (GISS) at Columbia recently named 2007 the second warmest year in a century, tying with 1998 for that dubious distinction.

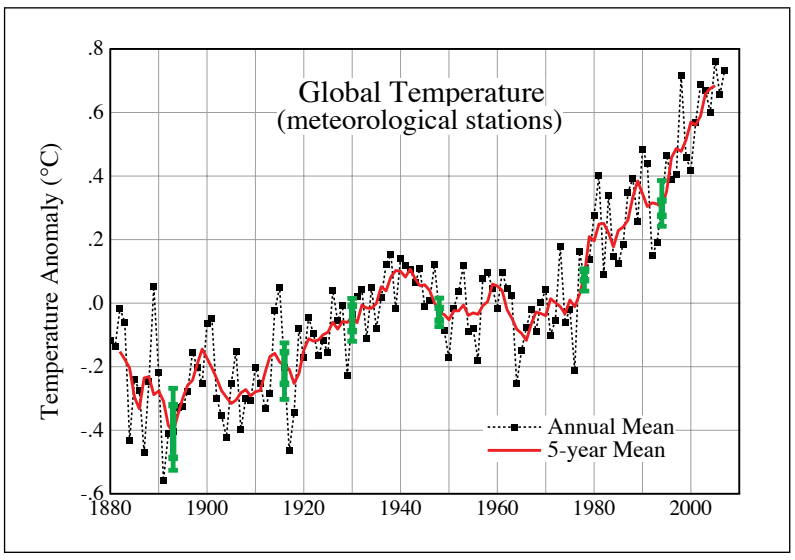
To measure average temperatures, Goddard Institute researchers used temperature data from weather stations on land, satellite measurements of sea ice temperature since 1982, and data from ships for earlier years.

The greatest warming in 2007 occurred in the Arctic and neighboring high-latitude regions. Global warming has a larger effect in polar areas, as the loss of snow and ice leads to more open water, which absorbs more sunlight and warmth. Snow and ice reflect sunlight; when they disappear, so too does their ability to deflect warming rays. The large Arctic warming anomaly of 2007 is consistent with observations of record-low levels of arctic sea ice in September 2007.

"As we predicted last year, 2007 was warmer than 2006, continuing the strong warming trend of the past 30 years that has been confidently attributed to the effect of increasing human-made greenhouse gases," said James Hansen, director of GISS.

The warmest year on record was 2005, according to GISS data. The eight warmest years in the GISS record have all occurred since 1998, and the 14 warmest years have occurred since 1990. Looking ahead, Hansen said that he doubts 2008 "will be a year with truly exceptional global mean temperature." But within a few years, he added, he expects to see a global temperature exceeding that of 2005 because of the overall global trend of warming temperatures.

The NASA Goddard Institute for Space Studies at Columbia is a laboratory of the Earth Sciences Division of NASA's Goddard Space Flight Center and a unit of the Columbia University Earth Institute.



Global temperature changes, in Centigrade. Mean temperature changes are about 0.57 degrees Celsius warmer than the mean for 1951 to 1980, continuing the strong warming trend of the past 30 years. GISS has attributed the change to the effect of more human-made greenhouse gases.

Five Groups, One Goal: Columbia Center Links NYC's Environmental Research Institutions

By Donna Cornachio

If you go to the Web site for Columbia's Center for Environmental Research and Conservation (CERC), you'll find a photograph of Shahid Naeem, with a scarlet-and-blue bird known as a Crimson Rosella resting on his outstretched palm.

It was taken in Lamington National Park in Queensland, Australia, where the bird has no natural predators, so the Crimson Rosella knows no fear and will approach anyone, naturalist or not. But it seems understandable that wildlife would be drawn to the soft-spoken Naeem, who studies how changes in the distribution of plants, animals and microbes affect how ecosystems function. Naeem chairs Columbia's department of ecology, evolution and environmental biology, and he is also the science director of CERC, a consortium of five world-renowned scientific institutions.

In addition to Columbia, CERC comprises the American Museum of Natural History, the New York Botanical Garden, the Wildlife Conservation Society and the Wildlife Trust. (CERC, headquartered at Columbia, also is part of the Earth Institute.) The five institutions work together to teach and train students in ecology, evolution and the environment about the natural world, and they work collectively (and sometimes competitively) on research projects. CERC's research programs are currently running in over 60 countries.

"I can't think of a more intellectually stimulating question: Are we ready to be the Earth's stewards?"

Climate change tops the list of CERC's priorities. "We need to take a global view of climate change, not by trying to save one species or one area, but by thinking of the problem on a global scale," Naeem explains. "The more poorly conserved our habitats are, the worse off we all are."

Naeem cites as an example the erosion of wetlands in Louisiana. Scientists estimate the state has lost more than one million acres of wetlands at the mouth of the Mississippi River, a crucial buffer zone that once protected the Louisiana coast and environs from hurricanes. Since the devastation caused by Katrina, "suddenly," Naeem says, "the conservation of wetlands takes on a new meaning."

Some methods of offsetting the effects of global warming on climate change focus on mitigation: using alternative energy; offering credits for carbon management, such as carbon capture and storage, which captures carbon dioxide from fossil fuel power plants and stores it instead of releasing it into the atmosphere; and buying hybrid cars.

What CERC is exploring involves adaptation rather than mitigation. "Maybe that means not building our houses so close to the shore," Naeem says. "Perhaps it involves planting trees differently—different species of trees, at different ages, at different intervals, to prevent the domino effect of trees being downed during big storms. Maybe it means preparing for some species like the Africanized honey bee and the fire ant to move north because of warming temperatures."

The goal of the CERC consortium is to build environmental leadership through its collective resources and to become a world leader in conservation education, training and research. It is a goal that keeps Naeem ever hopeful.

"I can't think of a more intellectually stimulating question: Are we ready to be the Earth's stewards? There's no repair manual to guide us. But I'm very excited by this new age. I do believe we have the capacity to retool and repair and manage the biosphere."

S. F. TJOSSEM

Shahid Naeem studies the importance of biodiversity and travels extensively for his research. Naeem holds a Crimson Rosella in Lamington National Park, Australia, where wild parrots fearlessly approach visitors who offer them parrot food.

JAMES HANSEN

POSITION:

Director, NASA Goddard Institute for Space Studies (GISS)

Adjunct Professor, Earth and Environmental Sciences at Columbia University

LENGTH OF SERVICE:

Director of NASA Goddard Institute for Space Studies since 1981;
Adjunct Professor since 1985

HISTORY:

Space Scientist, Goddard Institute for Space Studies

Manager, Planetary and Climate Programs at GISS

Interviewed by Bridget O'Brian

ARNOLD ADLER

PHOTO COURTESY OF THE EARTH INSTITUTE

James Hansen testifying before the U.S. Senate, issuing his warning about global warming in 1988.

Long before Al Gore's Nobel Peace Prize, before the Kyoto Protocol, compact fluorescent light bulbs or hybrid cars, James Hansen was sounding the alarm on greenhouse gas emissions and bringing the world's attention to the issue of climate change.

It was August 1981 when the journal *Science* published Hansen's galvanizing paper, which concluded that carbon dioxide in the atmosphere would lead to global warming faster than prior predictions. Those 10 pages, riddled with equations, graphs and charts and bearing the bland title "Climate Impact of Increasing Atmospheric Carbon Dioxide," became the shot heard 'round the world in scientific circles. Its message has been reverberating ever since, ricocheting through the political landscape and becoming a clarion call for environmental activists and average citizens alike.

Hansen has taken more than his share of heat for his climate warnings. He has complained of being muzzled by presidential administrations, Democrat and Republican alike, who didn't appreciate his conclusions, as they contradicted the nation's energy policy. His 2006 battle on that score is the subject of a book published last month called *Censoring Science: Inside the Political Attack on Dr. James Hansen and the Truth of Global Warming*, by Mark Bowen.

Born and educated in the Midwest, Hansen lives and works on the Upper West Side, heading the NASA Goddard Space Institute for Space Studies, which is affiliated with Columbia. He also teaches earth and environmental sciences at the University.

Q. *The 1981 analysis in the journal* Science *was one of the first public discussions about an increase in global temperature. Did you have any inkling how important your findings would be?*

A. The broad long-term implications were pretty obvious. I worked on it more than a year to get it into a shape that *Science* would accept, submitting it at least three times, each time cutting the length about 15%, finally getting it to a length they would accept, even though it was twice what the editor kept saying was their size limit. I also sent it to Walter Sullivan, *The New York Times* reporter, who wrote an article on the front page, which got me in trouble with some colleagues and [the Department of Energy.]

Q. *It seems that you were among the few scientists talking about climate change for a long time. What was it like to be out there alone?*

A. That's not true. There were a lot of scientists working on climate. There were different threads, different approaches. For example, global modeling along the lines that GFDL [Geophysical Fluid Dynamics Laboratory], NCAR [National Center for Atmospheric Research] and GISS pursued. There were paleo-climate studies of the history of the Earth's climate, and there were observations of on-going climate changes via satellites and other methods. But not as much interactions among these [researchers] as you would like. Now we have reached the point where you need to have your fingers into all of these if you want to develop insight quickly into how climate works and what the consequences of human forcings will be.

Q. *A forcing is described as a disruption created by outside action. What kind of forcing are you referring to here?*

A. A natural forcing is a change in the sun's brightness. The largest human-made forcing is change of the amount of greenhouse gases in the air, gases that absorb heat radiation and make the planet warmer.

Q. *Usually the media seizes on stories with doomsday scenarios. Why do you think it took so long for people to appreciate the danger of climate change.*

A. Well, business-as-usual is doomsday. But the things that need to be done to avoid business as usual have many other benefits… Unfortunately, if special interests prevent us from taking an energy path that does not put all the fossil fuel carbon dioxide into the air, we will get at least part of doomsday. I think that we still have time to avoid that, but just barely.

Q. *Were you surprised at the government's reaction to your findings?*

A. Well, not after my experience with DOE in 1981. They made it very clear that the government did not want to hear results that it did not want to hear.

Q. *There is so much talk about climate change these days. Is the conversation where it should be?*

A. No, far from it. The special interests, with financial interests that they feel would be threatened, have succeeded in muddying the waters so much that the sensible actions, which would solve the problem and have many other benefits, are not being taken. Unfortunately, this is because special interests in Washington have undue sway over politicians. We should have statesmen in Washington—instead we have politicians.

Q. *Did you ever consider leaving NASA to do research somewhere that would be more accepting of your conclusions?*

A. No, NASA is the perfect place, because it has the capability to get much of the most critical data—and a can-do attitude.

Q. *You've estimated that temperatures on Earth will be two to three degrees Celsius warmer at the end of the 21st century than they are now. That may not sound like a serious change to the layman. Can you explain why it is important?*

A. I do not think that global temperature will be two to three degrees Celsius warmer, because if it is, that is doomsday. I believe that it is still possible to wake people up, and we can move on to the world beyond fossil fuels. A warming that large would set us on a path toward sea level tens of meters higher, at least a few meters higher this century, with a continually changing coastline. That would be catastrophic. It would also spell the end for a substantial fraction of species on the planet.

Q. *Do you have specific solutions to reduce greenhouse gas emissions?*

A. The phase-out of coal use over the next 25 years, except where carbon dioxide is captured, by itself would keep carbon dioxide below 425 parts per million, and warming less than one degree Celsius. That's not enough, but it's a large fraction of the solution.

Q. *Can individual actions can make a difference, or is climate change the kind of problem that can be solved only through government action?*

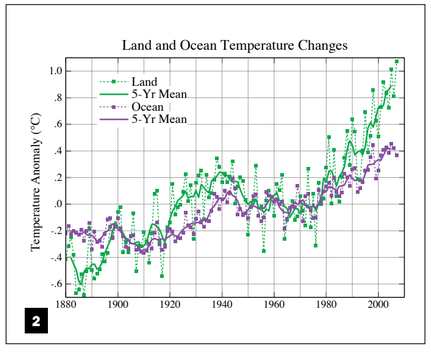
A. By far, the most important requirement is government leadership. What the individual can do is demand that. As long as we let people who are under the heavy thumb of special interests run the country, individual actions are meritorious, but they cannot solve the problem.

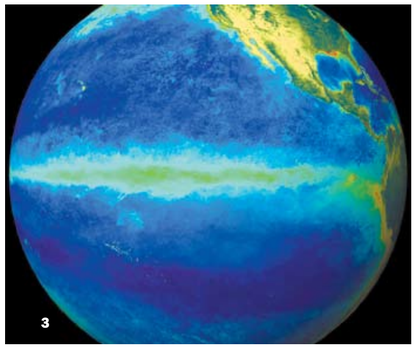
BREAKTHROUGHS IN CLIMATE SCIENCE

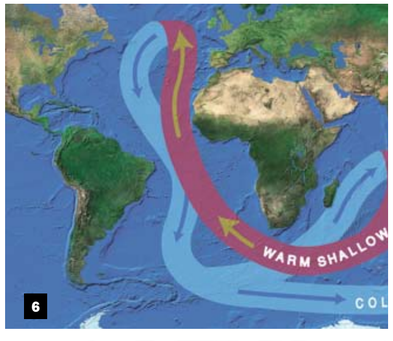
By Ken Kostel

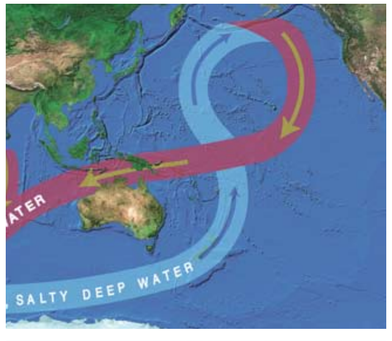
When they think of climate, many people turn their eyes to the clouds or conjure up images of torrential rain and parched earth, of smokestacks and polar bears. A handful of scientists, especially those who led the way with early breakthroughs in our modern understanding of Earth's climate, turn their thoughts to the bottom of the ocean.

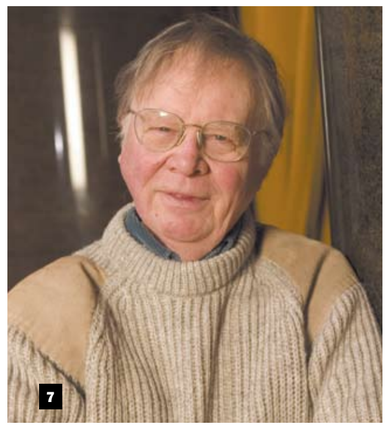
ERIC CONDLIFFE, EARTH SCIENCES, LEEDS UNIVERSITY, UK











1 Foraminifera skeletons found in sediment cores provide scientists a means to date cores. Photo: Eric Condliffe, Earth Sciences, Leeds University, UK

2 Annual and five-year running mean temperature changes for the land (green) and ocean (purple). Graph: Courtesy of GISS

3 The path of El Niño. Photo: Courtesy of The Earth Institute

4, 5 Arctic work being done via aircraft surveys by Lamont scientists.

6 Broecker's conveyor belt. Photo: Courtesy of The Earth Institute

7 Wally Broecker. Photo: Courtesy of The Earth Institute .

THE CORE OF THE ISSUE

In 1947, two years before founding what would later become the Lamont-Doherty Earth Observatory, Columbia geophysicist Maurice "Doc" Ewing set sail for the mid-Atlantic Ridge out in the Atlantic Ocean. Along the way, he and his crew found a flat-topped seamount beneath 1,450 meters of water north of Bermuda and "decided to work it." Using a device known as a Stetson corer, Ewing and the crew brought up a narrow cylinder of muddy ocean sediment. (This first core was an inch and a half in diameter; most samples in the repository now measure two and a half to five inches.) It was the first deep ocean core Ewing ever collected and he immediately recognized the usefulness of sediment cores to his work studying the formation and evolution of the ocean floor. For years afterward scientists on Columbia research vessels had standing orders to collect at least one core a day, wherever they were or whatever they were doing. "A core a day keeps Doc happy," was their mantra. Since Columbia-run vessels stayed at sea virtually year-round (and because just about everyone feared an unhappy Ewing), the University gradually amassed one of the world's most comprehensive archives of rock and sediment samples. The samples, taken from every major world ocean and sea, totalling nearly 45 miles of core.

THE CLIMATIC SEESAW

The cores proved to be a storehouse of data that still provide a window on the Earth's past—and future. The idea that Earth periodically plunged into lengthy ice ages was little more than 100 years old when Ewing gathered his first core. Theories describing these sudden changes were based on terrestrial rock records, which were often incomplete or difficult to interpret. In the hands of Lamont's growing geochemistry group, particularly a young graduate student named Wally Broecker, the ocean sediment cores began to tell their own story.

Using new techniques such as radio-carbon dating, developed and refined partly at Lamont-Doherty, Broecker and other Lamont geochemists were able to date the remains of microscopic shelled animals known as foraminifera found in layers of mud back to nearly 50,000 years and determined that the last ice age abruptly ended some 11,000 years ago. The ratio of oxygen isotopes in the shells also pointed to the same conclusion: the earth's temperature seesawed between cold glacial and temperate interglacial periods for hundreds of thousands of years. But the real surprise was that the climate seemed to hover in one state for long periods before shifting precipitously. It was, as Broecker wrote in his 1957 doctoral thesis, as if Earth was capable of just two stable climate states. What mechanism drove such a complete switchover?

IN SEARCH OF A PACEMAKER

Part of the answer came from earlier work by a Serbian mathematician named Milutin Milankovich, who in 1938 published one of the first numerical climate models. It was based on the theory that regular variations in Earth's orbit can affect how much sunlight reaches the planet's surface during the summer, which could explain why polar ice caps advanced and retreated periodically.

Milankovich made his calculation of summertime sunlight using 65 degrees north, a latitude at which Lamont scientists later collected cores in the North Atlantic, and they very quickly saw a link between the Milankovich Cycles, as they became known, and ocean temperature. From fossilized coral in Bermuda, Broeker also found evidence of fluctuations in the Earth's sea level that linked closely to the Milankovich Cycles. Later, in 1976, Lamont's John Hays and John Imbrie, together with Nicholas Shackleton of Cambridge University, examined cores from the opposite end of the Atlantic, that reflected 500,000 years of geologic history. They found such a close fit to the Milankovitch Cycles that they described orbital variations as the "pacemaker" of Earth's climate.

THE CONVEYOR BELT

Today, it is understood that a host of planetary systems play a role in stabilizing the climate and contributing to its abrupt changes. Interactions between the oceans and the atmosphere suck carbon dioxide from air near the water's surface, while ocean currents carry dissolved greenhouse gases deep below the surface, where they remain for centuries, and distribute heat around the globe, a system first identified by Broecker as the great "ocean conveyor belt." It also became apparent that transitions between glacial and interglacial periods were anything but smooth.

In the early 1990s, a Lamont geologist who spent most of his career on projects in the Rocky Mountains looked at a North Atlantic core and saw something surprisingly familiar—grains of rock stained red by iron oxides. Gerard Bond concluded that grains originating on land must have been carried to sea by armadas of icebergs sweeping into the North Atlantic, as often as every 1,500 years as the climate emerged from the last ice age. These could have pumped enough fresh water into the North Atlantic to disrupt ocean circulation and reverse the planet's warming trend. Such temperamental actions have prompted Broecker to describe the climate system as "an angry beast." Human action, he added, such as increasing carbon dioxide emissions, is tantamount to poking the beast with sticks.

THE ULTIMATE WILDCARD

Even as research sheds light on Earth's past, it also helps predict our climate future. In the mid-1980s, Lamont's Mark Cane and his student Steve Zebiak used a simple mathematical model to predict that the El Niño warming trend in the waters of the eastern tropical Pacific Ocean would occur a year later than originally forecast. El Niño, and its opposite phenomenon La Niña, were known to cause widespread, often violent changes in global weather patterns. Even a few months' warning can help farmers in developing nations decide what and when to plant, or help public health specialists predict when diseases such as malaria might break out.

Others at Columbia specialize in looking even further ahead and factoring the ultimate wild card—human activity—into the climate equation. The Goddard Institute for Space Studies in 1992 successfully predicted the magnitude of cooling that gas and ash from the Philippines' Mt. Pinatubo had on the global climate. Modelers there also have shown that the warming potential of increasing carbon dioxide and other greenhouse gases in the atmosphere currently far outweigh the cooling effects of smog and other human emissions.

The continued pace of the human factor has caused many scientists to warn of an approaching "tipping point" in Earth's climate—when we may push the system out of equilibrium. If so, future scientists may look at early 21st century sediment cores and wonder why such a severe reversal of climate fortune had to happen at all.

RESEARCH

Rainforest Nations

By Melanie A. Farmer

Geoffrey Heal

What began as a student thesis project is now well on its way to amending the Kyoto Protocol.

When Kevin Conrad was a student in the global Executive MBA program at Columbia Business School, together with three fellow group members, he wrote a thesis on how developing countries could make money from their tropical forests—without cutting them down. Raised in Papua New Guinea, Conrad knew the government there had turned down a $70 million offer from the World Bank to end logging. The Pacific island nation reaps millions every year from logging its rainforests, and giving that revenue up wouldn't make economic sense, he said.

But Conrad also knew that under the Kyoto Protocol, member countries that exceed their emission quotas are able to buy extra credits from other countries. In his proposal, developing countries could sell carbon credits to larger nations, and use that money to offset money lost if they gave up such activities as logging. The Kyoto Protocol currently does not allow this, but that's what Conrad hopes to change.

"We can't talk seriously about climate change if we ignore the role of deforestation in climate change," says Conrad, citing a widely used statistic that deforestation accounts for 20 percent of all global carbon emissions annually.

Conrad turned to several faculty members for help, particularly his academic advisor, Geoffrey Heal. Heal is the Paul Garrett Professor on Public Policy and Business Responsibility, and his specialty is the costs and benefits of environmental conservation. He is currently looking into the dwindling bee population and the detrimental effect it is having on agriculture. His book *Nature and the Marketplace* discusses the need to modify the Kyoto Protocol and give local carbon credits in order to keep forests intact.

After Conrad's graduation in 2005, he and Heal cofounded the Coalition for Rainforest Nations, an organization composed of developing countries that support and promote their goal of eliminating deforestation. Conrad, who didn't set out to be an environmentalist, used to be an investment banker with Putnam Investments and Salomon Brothers (now known as Smith Barney). He calls his shift to climate change "quite serendipitous."

Conrad, who knows Prime Minister Sir Michael Somare, said he presented his solution to Papua New Guinea's leader and gained the nation's support. A few months later, he gained Columbia's, too. Based within the business school, the coalition's advisory boards consist of several influential Columbia professors, including Nobel Laureate Joseph Stiglitz, Jeffrey Sachs, director of the Earth Institute, and Don Melnick, professor of ecology, evolution and environmental biology.

At the 2007 United Nations Climate Change Conference held in Bali in December, the coalition received unanimous support for its proposal. The idea is expected to be implemented in 2012 in conjunction with a revised version of the Kyoto Protocol. Papua New Guinea and Costa Rica are considered the founding participant nations but have since been joined by over 30 tropical countries, including Chile, Bolivia, Peru and others.

The concept has been approved, but now comes the hard part: finding alternate revenue to offset deforestation for these developing nations. Heal and Conrad will be working on this part of the proposal. "We need to figure out a way to pay developing countries for the global ecological services of these rainforests," says Conrad. "The international community needs to prove to these developing countries that these new revenue streams will not only sustain them in the short-term but for decades to come."

Do We Have Your Attention Now?

By Stacy Parker Aab

Elke Weber

Global warming has been described as one of the greatest threats to humanity. So why isn't it a high priority for most people?

Elke Weber and her coinvestigators at Columbia University's Center for Research on Environmental Decisions (CRED) are studying this very question as they examine human perceptions of climate change. Weber, the Jerome A. Chazen Professor of International Business and a professor of psychology, researches decision making under risk and uncertainty, exploring what it takes to set off our internal crisis alarm and spur us into action.

The major problem, she says, is that human brains are not wired to immediately react to threats that seem far off. "One of the largest challenges we face with global warming, or saving for our pensions in old age, is the time distance, and the discount rate that we use," says Weber. She defines discount rate as how much less delayed risks or benefits are worth to us compared to immediate ones. Delayed risks fail to set off any alarms, she says, because "our decision-making systems evolved in a time when most risks were immediate."

In her 2006 paper "Why Global Warming Doesn't Scare Us (Yet)," published in *Climatic Change*, Weber suggests that the way global warming risk is typically presented—in an abstract and statistical way—fails to elicit feelings of concern. "Emotional reactions really guide our actions," she says. "Engineers, climatologists and technocrats in this world can do all the calculations they want, but when it comes to public reaction, [people] are guided by older brain structures—our reptilian brain."

Weber suggests that leaders who want to shape public opinion should consider ways to make environmental risk appear more immediate and specific, an approach that is not without risk. "There's something called the 'finite pool of worry,' the notion that we can only deal with so much bad news at a time," says Weber. "Engaging emotional appeals work in the short term because they capture our attention, but then our attention will shift to something else. Using such appeals in a cautious and controlled way is what CRED is trying to contribute to."

CRED was started in 2004, but Weber conducted her first global warming study in the late 1980s in east central Illinois on farmers' reactions to climate change. She was then asked to serve on the advisory committee on Human Dimensions in Global Change for the National Academy of Sciences. From these experiences, Weber realized that her research could illuminate decision-making processes regarding what many consider to be the critical crisis of our time.

Weber is not holding her breath that humanity will band together and tackle global warming any time soon, but she does see positive developments, such as churches in the United States getting involved. "They're reframing the question from an economic one with cost/benefit calculations into a moral and ethical one," she said. "An ethical rule gives the impetus to change one's behavior initially, and then after awhile, the new behavior becomes automatic. What would Jesus drive? Probably not an SUV."

Watching Ice Melt

By Melanie A. Farmer

Stephanie Pfirman

In fall 2002, Stephanie Pfirman, chair of Barnard's department of environmental science, introduced Exploring the Poles, a course for first-year students in which they read and discuss literature from early 20th-century polar explorations. It was a new way of teaching environmental science, she said, an effort to draw in students who might not otherwise realize their interest in the subject. To boost such interest, Pfirman added an interactive incentive—she sent students on their own simulated expeditions.

The class divides into three teams, each of which must navigate a ship through actual ice conditions for a different year. "Students get competitive," Pfirman said. "It has a game aspect to it, but at the same time, they're learning about decision making and uncertainty."

Dealing with uncertainty, of course, is a big component in any research or teaching having to do with climate change, and it is something Pfirman—who is also an adjunct research scientist at Lamont-Doherty—contends with in her own work.

Pfirman tracks sea ice, following it from where it forms at the edge of the Arctic and studying what happens to it over the years it takes to drift thousands of miles away, typically east of Greenland. Pollution from Russia and the northern hemisphere, for example, can deposit contaminants such as PCBs (polychlorinated biphenyls) and lead in the ice. When it melts, says Pfirman, the contaminants are released into productive fishing grounds.

Pfirman's concern is the vulnerability of the Arctic marginal ice zone, where as much as half the growth of algae in the region can occur within two weeks in spring. "It's just completely loaded with organic matter," she says, "and that forms the base of the food chain that organisms live on for much of the year." A simple shift, from either contamination or climate change, can have a dramatic impact on the entire ecosystem.

"What is going to happen when you have potentially more industrialization in the north, and more tourism and more ships and traffic?" Pfirman asks.

Pfirman began working in the Arctic in the 1980s as a doctoral student at the Massachusetts Institute of Technology. Given the choice of several locations where she could work on sediment transport in the ocean, she chose the Arctic. While on an expedition there in 1987 she saw sea ice covered in mud. It turned out that the mud was traveling down from Siberia, getting trapped and frozen in the ice and releasing sediments once it melted.

In addition to running Barnard's environmental science department, Pfirman served as the first chair of the National Science Foundation's Advisory Committee for Environmental Research and Education, and oversaw an NSF 10-year outlook for environmental research and education, released in 2003.

Now that there's so much more knowledge about climate change and its effects, Pfirman says it is more important than ever to get local communities involved. "For the first time we actually have a pretty good prediction of how things may play out," she says. "What that means is that people now have the knowledge but also have the responsibility to do something about it."

Sustainable City: Studying New York's Climate Future

By Candace Taylor

Columbia scientists have studied thousands of ecosystems worldwide as they assess the effects of global warming, but some of their most comprehensive work takes place far from polar ice caps or tropical rain forests.

New York City, it turns out, is an ideal place to examine the challenges cities face as temperatures climb across the globe. Part of a comprehensive 2001 national study on climate change—the first of its kind—the Metropolitan East Coast Regional Assessment (MEC) reported that the average temperature in the New York region had risen 2 degrees Fahrenheit since 1900 due to greenhouse gases, and may climb by as much as 10 degrees by 2080, while the number of 90-degree-plus days a year increases from 14 to as many as 89. Sea levels will rise between two and three feet in the next century, the report predicted, while floods, droughts and intense hurricanes and Nor'Easters become more frequent.

JASON LAMBERT

Skyline of Lower Manhattan, as seen from the top of the Brooklyn Bridge.

Much of the city's infrastructure—already vulnerable to storm surges—will be threatened by rising seas and the accompanying climate variability, said MEC contributor Vivien Gornitz, a geologist and special research scientist with the NASA Goddard Institute for Space Studies and Columbia's Center for Climate Systems Research. Flood levels occurring every 100 years could come as often as every four years by 2080, the MEC report predicted, and Gornitz said she wishes developers in Coney Island, Brighton Beach and Lower Manhattan would pay heed. "There's a tremendous amount of development in a high-risk zone," she said.

Recently, researchers from Columbia have shared their expertise to help develop PlanNYC 2030, the city's blueprint for sustainability over the next two decades, including a stated goal of reducing global warming emissions 30 percent by 2017. In 2006, Mayor Bloomberg announced the creation of a partnership with the Earth Institute, in which Columbia's experts provide the city with research and advice on environmental and climate change-related issues and ensure that the city's policies are based on up-to-date research.

Columbia faculty Cynthia Rosenzweig, Vivien Gornitz and others have made valuable contributions and "continue to be an asset to our office as we implement the plan," said Rohit T. Aggarwala, the city's director of long-term planning and sustainability, who himself holds four Columbia degrees—B.A., M.A., MBA, and a doctorate in history.

PlaNYC "puts New York City in the leadership of American cities," on this issue said Earth Institute Executive Director Steve Cohen.

Since many scientists believe global warming can be mitigated but not stopped, much of Columbia's post-MEC research is focused on adaptations to climate change. Klaus Jacob, a special research scientist at Columbia's Lamont-Doherty Earth Observatory, for example, is creating a 3-D map of the New York City subway system showing areas that are vulnerable to flooding, starting with Lower Manhattan below Canal Street—one of the city's lowest-lying neighborhoods.

In even the mildest type of hurricane, he said, "segments of all subway lines in the area below Canal Street will be flooded." As sea levels rise, flood risks will increase, said Jacob, who is currently writing grant proposals to expand the subway study and begin to determine ways to fix the system.

Green roofs are another climate change adaptation Columbia is helping to pioneer. In November, the University installed seedlings of the hardy plant sedum spurium on the roofs of buildings on 118th Street and 115th Street, and researchers will soon begin collecting data to measure their effect on local temperature and air quality, said Stuart Gaffin, a research scientist at the Center for Climate Systems Research.

Replacing heat-absorbing roofs with plants may decrease what is known as the "urban heat island" effect—the tendency for cities to be warmer than the surrounding suburbs.

The green roofs also are expected to reduce runoff, said Gaffin. That's good news for Gregory O'Mullan, an environmental microbiologist at Lamont-Doherty who studies the Hudson River. Runoff caused by even a small amount of rainfall—just over 1/10 of an inch—currently exceeds the capacity of the city's storm water drains, O'Mullan said, bringing untreated sewage into the city's waterways. The corresponding oxygen depletion—which will grow worse as water temperatures rise—kills wildlife, creates a fertile environment for pathogens and releases methane, a greenhouse gas.

"PlaNYC puts New York City in the leadership of American cities."

Increasing the city's sewer capacity, O'Mullan said, is an expensive but necessary proposition.

"We can't be satisfied that the average condition looks OK," O'Mullan said. "We have to manage so we can respond to those extreme events."

COLUMBIA PEOPLE

Margaret Turrin

WHO SHE IS: Education Coordinator, Marine Geology and Geophysics Division at Lamont-Doherty Earth Observatory

YEARS AT COLUMBIA: 10 years

WHAT SHE DOES: Turrin works with faculty members connecting active science research to high school and middle school groups, community groups and the general public. Topics vary from polar science to Hudson River education to the environmental impacts of land use decisions. She also coordinates the activities such as the upcoming New York City International Polar Weekend (co-hosted by Lamont-Doherty) and works with teachers on science workshops and classroom visits.

A GOOD DAY ON THE JOB: Spending a day in field education or conducting training programs. Turrin's work with River Summer, a field course that explores the Hudson Watershed, is a highlight because "it uses a research vessel as a platform so we live and work from the boat … and it can't get any better than that."

WHAT BROUGHT YOU TO COLUMBIA: Turrin moved from northern California 10 years ago, and has worked at Lamont-Doherty ever since. She attributes her love for field work to her husband, a geologist, who introduced her to it in the early days of his own career.

BEST PART OF THE JOB: Working with teachers and students. "Teacher training is always fun. They are a great audience because they are already invested in learning about the subject … and they always have something from their own experiences to add to the day so we all come away with something new to share."

MOST MEMORABLE MOMENT: Turrin can't narrow it to just one. "What I do have is memories of many amazing people I have met through organizing international and national workshops."

IN HER SPARE TIME: Turrin enjoys combining her volunteer work with fun outdoor activities such as taking hiking trips while mapping invasive plants or kayaking while also mapping submerged vegetation in the Hudson. Her growing interest in native plants has led her to cultivating a garden of her own, which she loves to tend to in her spare time.

— By Melanie A. Farmer