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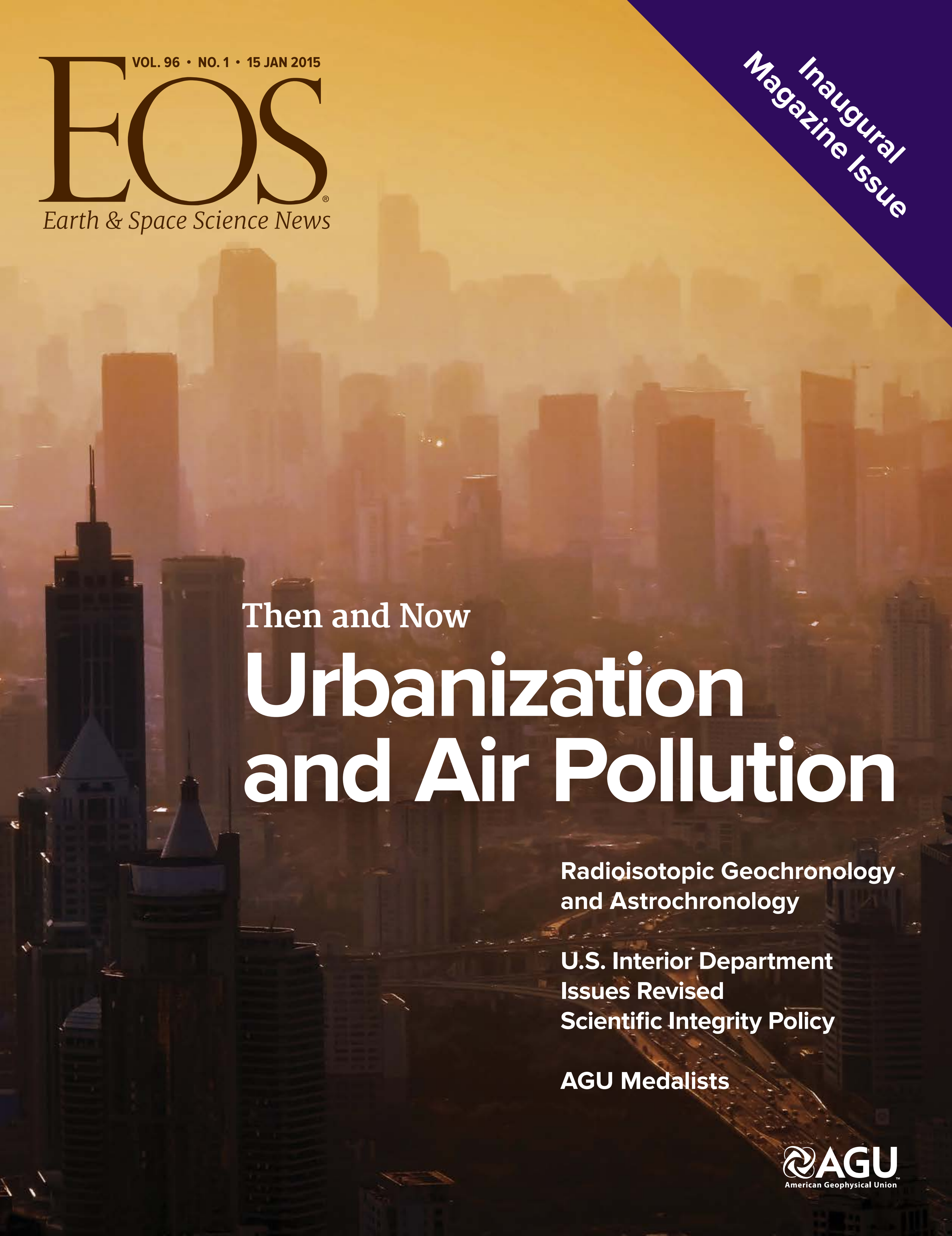

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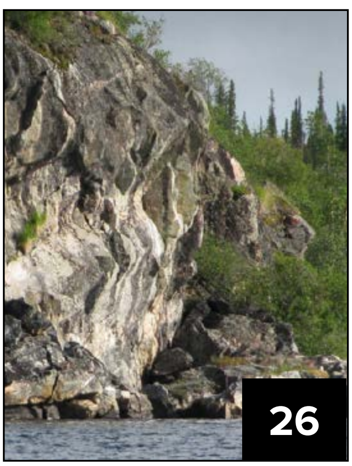

On the Cover

Smog over a densely populated city. Photo: Thinkstock; Michal_Staniewski

Eos

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Christine W. McEntee, Executive Director/CEO

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Satellites Show True Extent of California Drought

California Department of Water Resources

(left) California's Lake Oroville reservoir was at 30% capacity in September 2014, approaching the 26% record low of 1977. (right) California's Lake Oroville in 2011. New data from NASA say that California needs 10 Lake Orovilles' worth of water to recover from the current drought.

Images of docks stranded above lake shorelines and of desiccated earth cracking and turning into dust (e.g., http://bit.ly/1JUhQeF) have become commonplace after three years of crippling drought in California. Now a view from space offers a new perspective on the severity of the water shortage.

A new analysis of satellite data reveals that California needs 11 trillion gallons of water (42 cubic kilometers) to get out of its ongoing drought, NASA scientists reported in a 16 December press conference at the 2014 AGU Fall Meeting in San Francisco, Calif.

Where Has All the Water Gone?

Since their launch in 2002, the twin satellites of NASA's Gravity Recovery and Climate Experiment (GRACE) mission have acted like a space-based water meter, measuring month-to-month changes in the volume of water in California by detecting subtle variations in Earth's gravity.

These data have allowed NASA scientists to calculate, for the first time, exactly how far California's water supply has fallen behind its seasonal norms.

"We can begin to answer the question: How much water will it take to end the drought?" said GRACE team leader Jay Famiglietti of the University of California, Irvine, and NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif. "And, no, the recent rains have not put an end to it, but they are certainly welcome."

> California needs 11 trillion gallons of water to get out of its ongoing drought.

The data show that two-thirds of the 11-trillion-gallon loss represents groundwater depletion in California's Central Valley. The loss reflects unsustainable use of water resources by state policymakers, Famiglietti said.

In the past 5 decades, groundwater levels in the Central Valley have declined sharply during dry years and recovered only slightly during wet years as water was diverted for agriculture and municipal use, he explained. "It's the definition of unsustainable," he said. "Like a tennis ball bouncing down a flight of stairs, the ball always ends up at the bottom."

Mapping Snow from the Air

Another major contributor to California's water shortage is the declining snowpack in California's Sierra Nevada range. This problem is twice as severe as previously thought, according to new data from NASA's Airborne Snow Observatory (ASO), also presented at the press conference.

Thomas Painter of JPL, who leads the ASO project, explained that early data from the airplane-based science lab revealed that 2014 snow levels had reached a near-record low, the lowest since 1977. Now California's population is twice as large, putting significantly more strain on the state's limited water, Painter said.

The trend may be hard to recover from, Painter said, because the loss of snow exposes darker mountain terrain, which absorbs more heat from the Sun and makes it harder for future snows to stick.

The loss of snowpack is particularly worrisome because it deprives California of the natural reservoir that usually helps the state make it through its regular dry spells, Painter told *Eos*. The mountain snows store up water from the heavy winter storms of California's wet years and release it gradually as summer melt-water in dry years. California's manmade reservoirs aren't big enough to take on this role. Even when full, they can only hold a season and a half of storm runoff, Painter said. "They're not a great buffer against drought."

This means that even if winter storms return in force this year or the next, California will be in trouble if the clouds drop their moisture as rain rather than snow, which Painter said is increasingly likely as the climate warms. Much of the runoff will simply flow down to the sea and be lost. "We've seen some of that, but nothing like where we're going with warming," he said.

GRACE in the Future

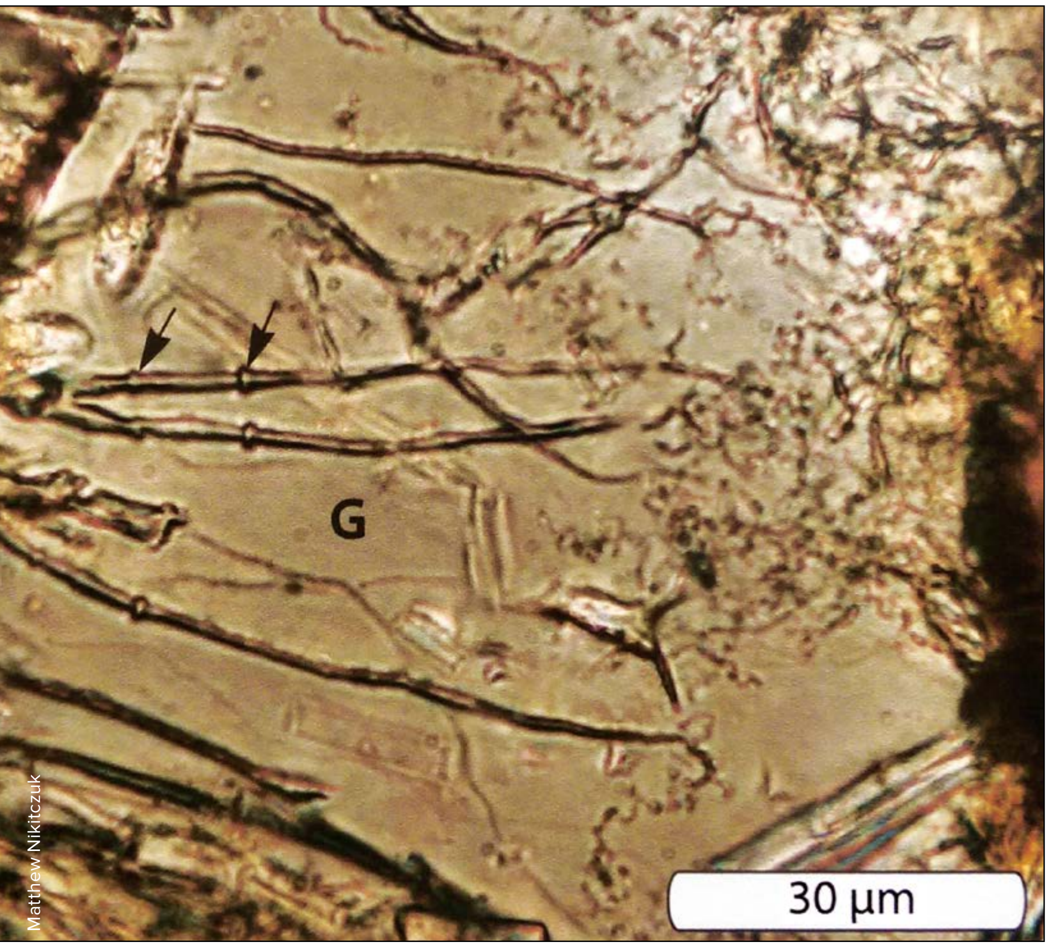
Scientists at the press conference expressed hope that the new detailed data about available water resources from their space-based and airborne observatories will aid policymakers who need to make hard decisions about how to allocate water for current and future droughts.

NASA leadership has extended the original 5-year GRACE mission and plans to launch a new pair of satellites with enhanced technology in 2017, said Matt Rodell, chief of the Hydrological Sciences Laboratory at NASA's Goddard Space Flight Center. However, "We don't know if GRACE is going to last that long," Rodell told *Eos*.

He explained that several of the satellites' solar-charged batteries have already failed, forcing the team to power the sensors down whenever the satellites fly through Earth's shadow to save power. "We're trying to keep it going as long as possible," Rodell said.

By **Nicholas Weiler,** Freelance Writer

Traces of Glass-Eating Microbes Found in Ancient Lake Bed



Microscope image showing tiny tunnels (G) in volcanic glass likely created by microbes.

In December 2014, scientists reported that the Curiosity rover has detected belches of methane, which could have been produced by microbes, wafting periodically from the planet's surface. However, whether this methane is a definitive signature of life remains unclear. What would provide more concrete proof?

Matthew Nikitczuk may have stumbled on one possibility. While conducting fieldwork in ancient lake beds in Oregon, Nikitczuk, a graduate student at Brock University in Ontario, discovered tiny tunnels burrowed into volcanic glass—tunnels that looked biological.

"This is something I've never seen before in real life," Nikitczuk told *Eos.* "I thought: 'microbes.'"

Could similar microsopic tunnels be discovered on the red planet?

Tunneling Through Glass

Nikitczuk, who was looking for Earth analogues for environments on Mars, presented the work in a 16 December 2014 poster session at the AGU Fall Meeting in San Francisco, Calif. (see http://bit.ly/144Zp6O). He explained that meandering, microscopic tubes within the volcanic glass—some hollow, some filled with minerals—show very characteristic features of trace fossils.

Additional research revealed that these traces exist all around the Fort Rock volcanic formation in southern Oregon.

As far back as 2 million years ago, lava spilling into a shallow lake cooled and solidified violently in hundreds of continuous explosions as it encountered the water, producing fractured volcanic glass. Over time, water seeped into the lava, flooding the tiny fractures within the glass and bringing heat-loving microbes along with it. The microbes then burrowed farther into the glass, carving the characteristic tubes.

Nikitczuk added that similar-looking traces have been attributed to processes not related to life—such as tiny crystals being pushed through the glass by gas—but his research turned up none of the characteristic nonorganic signs.

Similar structures created by tunneling microbes have been found only in marine environments, Nikitczuk explained. Researchers taking samples of the pillow basalts at mid-ocean ridges have identified similar tube structures (see http://1.usa.gov/1wP6DGX); however, Nikitczuk believes that the traces of organisms that he found are from a freshwater lake.

Evidence for a freshwater setting comes from chunks of diatomite—a sedimentary rock built entirely from the silicic skeletons of shelled planktonic organisms called diatoms—found in the dry lake bed. Nikitczuk analyzed the skeletons and determined that they come from a freshwater species.

What Does This Mean for the Search for Life on Mars?

Because Earth-like basaltic rocks and glass are found on Mars, it is possible that similar microscopic tunnels could be discovered as rovers probe the red planet's surface, said Mariek Schmidt, Nikitczuk's adviser at Brock University and an active scientist on NASA's Mars Science Laboratory Mission.

In particular, Gale Crater—where Curiosity is busily roving—is thought to have hosted a lake environment, Schmidt said. A shallower, freshwater lake like the one Nikitczuk analyzed in Fort Rock provides a better analogue for what kinds of environments scientists think existed on Mars, she explained. Thus, a main goal at the moment is to pinpoint the biogenic origins of the tubular structures on Earth, Schmidt said.

"We've seen hydrovolcanic rocks on Mars in a number of different locations," including in Gusev Crater, which was explored by the Spirit rover several years ago, Schmidt added. "I think that this is a really good possible place to find life on Mars, in these kinds of deposits."

By **JoAnna Wendel,** Staff Writer

Robot Explores Under-Ice Habitats in the Arctic

A new underwater vehicle has successfully demonstrated that it can explore physical and biological phenomena in undisturbed areas beneath sea ice. It has also shown that a thriving biological realm of algae and other creatures exists on and beneath at least some of the ice, according to scientists at a 16 December news briefing held during the AGU Fall Meeting in San Francisco, Calif. The *Nereid Under Ice* (NUI) vehicle, which completed its first series of trial under-ice dives during a July 2014 scientific expedition, is part of a series of technological advances that allows scientists to better understand the world's oceans.

During those summer dives in the Arctic Ocean about 200 kilometers northeast of Greenland, NUI found unexpectedly high amounts of algae and other biological productivity under the ice that appear to support a diverse food web in the region, according to the scientists. "What might look on the surface like a barren wasteland may actually be a thriving biological community," said Christopher German at the Woods Hole Oceanographic Institute (WHOI). He is co-principal investigator for the design and construction of NUI and science lead for the NUI Arctic dives. The approximately $3 million vehicle was designed and built at WHOI, and it was tested during a scientific expedition aboard the Alfred Wegener Institute's *Polarstern* research vessel.

"Whereas there are lot of autonomous vehicles that have been used to fly underneath a variety of ice-covered environments, including the glacial cavities, what NUI provides as a complementary capability is to use the real-time video and other sensor feedback that are coming back all the time to enable scientists to effectively explore in real time, to react to the unexpected," German explained. During the series of dives, the vehicle operated at a distance away from *Polarstern*—and away from the influence of an ice-breaking research ship that by nature disrupts the ice—on both a thin fiber-optic tether and as a free-swimming autonomous vehicle.

"Why are we so fascinated with these under-ice situations?" asked Antje Boetius, Arctic expedition chief scientist with the Alfred Wegener Institute Helmholtz Center for Polar and Marine Research. "One [reason] is it's really a habitat for life and has always been a habitat for life."

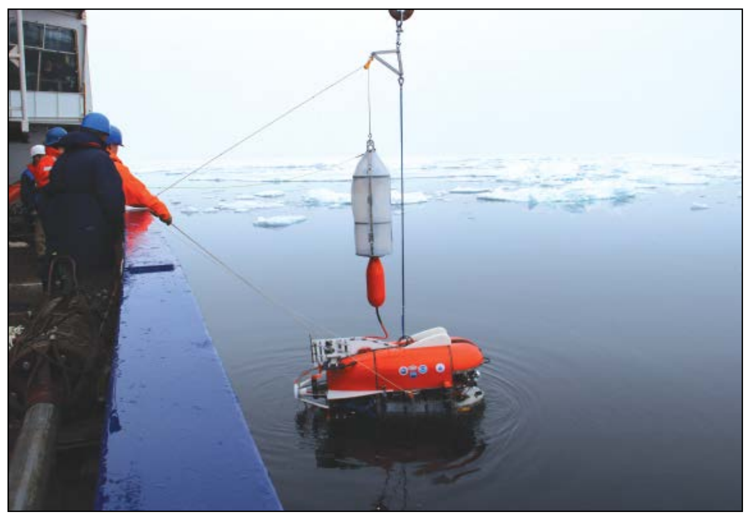
Boetius said that with climate change and the thinning and melting of sea ice, "the hardest answer of them all is what will it mean to us, what will it mean to life on Earth."

Science and Engineering Working Together

"The greatest fun in science is, of course, when people tell you 'you can't do that' or 'you won't manage' or 'this is not possible,' and then you go and do it anyway," she said. Boetius said that in 2009 when she was planning the expedition to explore the deep-sea floor and how climate changes under-ice habitat, the NUI did not yet exist. "I had big hopes, and I wrote it into the cruise proposal anyway that this robot would exist years later," she said, noting that she was optimistic that the vehicle could be developed.

Michael Jakuba, lead project engineer for NUI at WHOI, said there was "a continual push-pull" in the interaction between engineers and scientists in developing the vehicle. "On the engineering side, we are trying to push the technology and trying to anticipate to some degree what the scientific needs might be and at the same time communicating what our capabilities are to the scientific community," he said. "But in no way can we possibly imagine what people might want to do with such systems ahead of time entirely. So we build them to be flexible."

German chimed in, "Historically, over my 20 years at this interface between science and engineering, the really coolest thing is as soon as you build something new, designed for one purpose, the first time you go out and use it, you find that you generate an entirely new scientific vocabulary and you develop a whole new range of programs you can now pursue scientifically where you could not have proposed that hypothesis previously because you weren't even aware of a certain situation or a process."



Chris German, WHOI

Nereid Under Ice *vehicle being deployed from* Polarstern *during summer 2014.*

Part of a Series of Technological Advances

In an interview with *Eos*, WHOI president and director Susan Avery said, "The ability to have [NUI] look at the very complicated ecosystem and physical interactions with that ecosystem in a part of the world that is changing so rapidly is critically important. What happens in the Arctic is going to impact all of us, either whether you are thinking about it from an atmosphere point of view or from an ocean point of view."

Avery also placed NUI within the larger context of ocean exploration. "I think of the ocean as the last frontier, and the need to explore our own planet is much more urgent in my mind than other planets, even though I know that the space program has been wonderful for the United States and for the world. But this is our planet. The ocean is a frontier, and there are major parts of the ocean that our technology is just now getting to the point where we can actually explore these frontiers, and one of the frontiers is that part under ice."

She said that other ocean exploration frontiers include the deep trenches, mid-water column, and microbial world. "All of these frontier zones are reached right now because of technology advances," Avery said.

By **Randy Showstack,** Staff Writer

Interior Department Issues Revised Scientific Integrity Policy

The Department of Interior's (DOI) newly revised scientific integrity policy broadens, clarifies, and underscores the agency's "commitment to sound science," said U.S. Secretary of the Interior Sally Jewell. She said that the policy—which applies to DOI employees and has provisions for contractors, partners, volunteers, and others—reflects enhancements based on 3 years of experience with the current policy.

"Science is at the heart of Interior's mission, so it's important that we continue to lead federal efforts to ensure robust scientific integrity," Jewell said in releasing the policy on 17 December.

Updates include specifying that adherence to DOI's Code of Scientific and Scholarly Conduct is a standard for maintaining scientific integrity, adding an ombudsman role, forming a DOI Scientific and Scholarly Integrity Council, and streamlining and clarifying the intent and procedures for reporting and resolving allegations. Along with the revised policy, DOI also issued the *Scientific Integrity Procedures Handbook* and announced online training for maintaining scientific integrity.

"This Departmental policy assures the integrity of scientific and scholarly activities it conducts and the science and scholarship it uses to inform management and public policy decision," the handbook states. It continues, "Scientific and scholarly information considered in Departmental decision making must be robust, of the highest quality, and the result of rigorous scientific and scholarly processes as can be achieved. Most importantly, it must be trustworthy. It is essential that the Department establish and maintain integrity in its scientific and scholarly activities because information from such activities is a critical factor that informs decision making on public policies. Other factors that inform decision making may include economic, budget, institutional, social, cultural, legal and environmental considerations."

The policy revises the department's scientific integrity guidelines that were originally issued on 1 February 2011 (see http://bit.ly/1xVHMTm). DOI was the first federal agency to issue guidelines following a July 2009 White House memorandum on scientific integrity (see http://1.usa.gov/1wrIouW) and the December 2010 White House guidelines for federal agencies (see http://1.usa.gov/1vy8rjk).

Critique of the Policy

The Union of Concerned Scientists (UCS) praised the revised policy as simplified, streamlined, and clear and said that it sets "a strong standard" for the Obama administration. "Outside pressure on the Department of Interior to politicize science is strong, so it's critical that the department respond with strong policies to protect science and scientists from political interference in their work," Michael Halpern, program manager for UCS's Center for Science and Democracy, said in a 17 December statement. "While the different bureaus within the Department of Interior have been uneven in terms of embracing reform, headquarters has devoted significant resources to implementing and improving its scientific integrity policies, and this new policy is no exception."

Halpern specifically noted that the new policy and handbook provide more specifics on the policy and how it will be carried out. He also applauded the new online training program and the intradepartmental scientific integrity council. However, he cautioned that the department "should make clear that completed investigations will continue to be reported publicly." In an 18 December blog post (see http://bit.ly/1HN5mBN), Halpern stated that the "most glaring flaw" in the revised policy is that "while the department has been reporting out scientific integrity cases on its website, there is nothing in the policy that requires it to do so."

He said other concerns DOI should address in future policy updates or that should be monitored include whistleblower protection. Halpern noted, "While the policy refers to established whistleblower laws, the language used could be considerably more aggressive to state that there will be zero tolerance for any retaliation against anyone who files a scientific integrity complaint." He added that questions remain concerning the definition of conflict of interest, and that there is no explicit statement that experts do not need to seek permission before they speak publicly about their work.

Public Employees for Environmental Responsibility (PEER) blasted the revisions, claiming that they narrow the scope of the rules and make it more difficult to bring and pursue charges of scientific misconduct (see http://bit.ly/1zYUqzk). The revisions "threaten to make a sham out of an already tattered scientific integrity process," PEER Executive Director Jeff Ruch said in a 22 December statement. He noted that most of the 27 complaints processed since 2011 were summarily dismissed without an investigation. "Success of scientific integrity complaints will be less likely under these revisions which read as if they were written to accommodate every bureaucratic grievance from agency managers and lawyers."

Scientific Integrity Is Called Interior's "North Star"

U.S. Geological Survey Acting Director Suzette Kimball told *Eos* in an interview that the policy update "reaffirms that scientific integrity is our absolute North Star for where we are going." Kimball, who also serves as DOI's chief scientific integrity officer, said, "Scientific integrity is our foundation. That is what our reputation is built on. So being able to have this document really makes a statement that it is one of our foundational policies and it is one of our foundational tenets for how we operate."

Kimball added that the policy is "a living document" and that the department already is considering how to strengthen it, including providing more clarity about requirements for posting the results of DOI scientific integrity cases, as UCS recommended, "so that people can see how the process works. We do that, it's part of our standard procedures, but it's not clearly articulated," she said.

DOI also will look into clarifying and making a stronger statement about retaliation against whistleblowers, Kimball said. She added that DOI also may look into "having stronger statements about the responsibility that we have to ensure that scientists have the opportunity to engage in professional activities, that scientists have the opportunity to participate in a number of activities, to talk to the press, and so forth."

Kimball told *Eos* that another element that still needs clarification concerns communications and the public outreach aspects of scientific publications. She said the concerns relate to "how we present in press releases or outreach documents our science and how that relates to making sure that the scientists have a role in those kinds of documents so that press releases absolutely accurately portray the science in that publication that we are releasing."

By **Randy Showstack,** Staff Writer

Does War Influence Forest Growth?

The border city of Abyei burns as a result of recent armed conflict in Sudan and South Sudan. Wars in the region have killed and displaced millions. Do they also impact ecology?

Over the past half century, wars in Sudan and what is now South Sudan killed more than 2 million people and displaced more than 4 million more (see http://bit.ly/13KqyLJ). Although the human cost is the most tragic outcome of armed conflict, a 17 December presentation at the AGU 2014 Fall Meeting in San Francisco, Calif. (see http://bit.ly/1CYEfD3) explored another facet of war: its effects on the environment.

The ecological aftereffects of war are far from straightforward. On the one hand, less governance can lead to an increase in banned practices like poaching and harvesting of protected natural resources. On the other hand, a lack of oversight can reduce destructive government-sponsored practices like mining and deforestation. In the demilitarized zone between North and South Korea, for instance, biodiversity has skyrocketed ever since human activity was banned there in 1953 (see http://bit.ly/1ErKgwy). Because a huge number of conflicts occur in biodiversity hot spots—80% of all conflicts from 1950 to 2000, according to one study (see http://bit.ly/1znkjGh)—it is vital to understand how ongoing strife will affect the surrounding environment.

A Close Look at South Sudan from Space

For a case study, geographer Virginia Gorsevski from the nonprofit Global Environment Facility turned to South Sudan, where satellites have imaged terrain during and after war. Her objectives were twofold: to determine the effects of conflict on the country's forests and to evaluate the utility of data gathering using satellites. "I was really interested in looking at how remote sensing could be used in these areas which are otherwise inaccessible," she said. "It makes remote sensing an ideal technology to use to access this information."

> Conflict study is decades old, but environmental scientists are poised to offer new perspectives on the field.

Gorsevski and her colleagues hypothesized that ongoing conflict led to increased tree growth in South Sudan. By their estimation, most residents would have fled to refugee camps, allowing vegetation to grow unhindered in villages and on agricultural land.

The team estimated forest cover in the county using algorithms designed to identify vegetation in satellite imagery. They calculated the changes in forest cover during wartime (1980s to 2001) and in the period at the end of the war leading up to South Sudan's independence (2003–2010).

Trends in the extent of forests during the 30-year study period were subtle, resulting in a small net gain in the country's forests, as the researchers had expected. However, some places still surprised the researchers—such as a forested area damaged both during and after the war because, as Gorsevski noted, the Sudan People's Liberation Army permitted its unrestricted deforestation.

Surveying People Affected by War

To figure out why the effects were so slight, the researchers supplemented their data with surveys of people in South Sudan. Gorsevski interviewed locals using a strategy called participatory mapping. "I took some of the satellite imagery with me and I handed it out to a focus group," she said. "I asked them to point out where did they go during the war, what did they do?"

Villagers, guides, and local lawmakers revealed hidden trends in how people relocated. For instance, after the war ended, many refugees remained in camps for their schools and hospitals, preventing rapid postwar redevelopment in village areas. Although the information gathered on the ground was predominantly qualitative, it helped to illuminate patterns the researchers could not have gleaned from satellite data alone.

Toward New Perspectives on Armed Conflict

This union of data and personal interaction was one reason NASA researcher Jamon Van Den Hoek invited Gorsevski to present her team's research at a session on armed conflict and environmental change (see http://bit.ly/1CNgO2b). Conflict study is decades old, he says, but environmental scientists are poised to offer new perspectives on the field.

"I think there's a great opportunity to really fuse the kinds of data we have...with broader theoretical frameworks that are very mature and very developed," Van Den Hoek said.

By **Kerry Klein,** Freelance Writer

MEETING REPORT

Climate, Land Use, and Conflict in Northern Africa

Workshop on Climate, Land Use, and Conflict in Northern Africa
Lübeck, Germany, 22–25 September 2014


Thinkstock; fiondavi

A field lies ready for planting in the Sahel region of West Africa.

The near-surface atmosphere over the Sahara has warmed at 3 times the rate of the global mean in the past 30 years, most likely triggered by increasing fossil fuel emissions.

Northern Africa, and the Sahel region in particular, are highly vulnerable to climate change, due to strong exposure to increasing temperature, precipitation variability, and population growth. A major link between climate and humans in this region is land use and associated land cover change, mainly where subsistence farming prevails. But how strongly do climate change and land use change affect each other? To what extent are climate-induced water, food, and wood shortages associated with land degradation, migration, and conflict?

Some 60 natural scientists, sociologists, economists, and peace researchers from various institutes, as well as participants from governmental and nongovernmental organizations from a dozen countries, met to address these questions. Twenty brief impulse presentations and seventeen poster contributions, together with in-depth discussions in focused sessions and a concluding panel, covered the nexus of climate change, land use, and conflict in Northern Africa.

Talks on climate change highlighted that the near-surface atmosphere over the Sahara has warmed at 3 times the rate of the global mean in the past 30 years, most likely triggered by increasing fossil fuel emissions. Climate models that predict the dynamics of vegetation change reveal some greening that extends into the Sahara in the coming decades. The underlying processes and the time horizon differ, however, among models.

New evidence was presented for the strong connection of the large-scale Sahel greening or the recent decline in burnt area with precipitation variability. However, besides climate, local land use decisions as well as global drivers such as land grabbing were shown to affect land use and, thus, vegetation change.

In the discussion, it was pointed out that the sensitivity of climate to land use change was found to be highly scale dependent. Two presentations explicitly showed that the response of climate to land use change appears to be weak in comparison with the overall effects global warming imposes on the Sahel. Hence, one important conclusion of the workshop is that any effort in modeling the interaction between climate, land use, and conflict can treat climate change as external forcing.

Several speakers presented cases where the interplay of land use and climate change tends to aggravate existing conflicts between resource users, in particular between farmers and herders in eastern parts of the region. Clear messages are complicated by the diverse consequences of temperature and precipitation changes, which affect multiple pathways in the nexus of water, food, energy, and migration in climate hot spots of Northern Africa. Other conflict factors, including political instability, economic crisis, marginalization, and land use policies, are likely more essential drivers of conflict but are not independent of climate change.

Participants in the panel discussion highlighted the role of vulnerability and adaptive capacity, as well as governance and institutional mechanisms, to contain security risks and strengthen cooperation. They emphasized the benefits of this interdisciplinary exchange, which needs to be continued.

The workshop was funded by the Max Planck Institute for Meteorology and by the Cluster of Excellence CliSAP (integrated Climate System Analysis and Prediction, DFG EXC 177/2). For more information, see http://bit.ly/1viPLDf.

By **Martin Claussen,** Universität Hamburg, and Max Planck Institute for Meteorology, Hamburg, Germany; email: martin.claussen@mpimet.mpg.de; **Jürgen Scheffran**, Institute of Geography, Universität Hamburg, Germany; and **Tim Brücher**, Max Planck Institute for Meteorology, Hamburg, Germany

Exploring Radioisotopic Geochronology and Astrochronology

IsoAstro Geochronology Workshop: The Integration and Intercalibration of Radioisotopic and Astrochronologic Time Scales
Madison, Wisconsin, 18–23 August 2014

Numerical dating of the geologic record provides an essential framework for interpreting the rich history of our planet. Common applications include the determination of dates for extinction events and climate reorganizations, the assessment of rates of paleoenvironmental and paleobiologic change, and the correlation of rocks across vast expanses. Such investigations have yielded crucial insight into the mechanisms that shape Earth's surface environments over geologic time. However, as geoscientists increasingly pursue high (spatial) resolution stratigraphic analyses in "deep time," the short temporal scales (<100,000 years) of the processes investigated push the limits of high-precision geochronology.

Concerted efforts over the past decade have yielded transformative advances in the accuracy and precision of uranium-lead (U-Pb) and argon-argon ($^{40}Ar/^{39}Ar$) radioisotope geochronology, which provide the backbone of the latest Phanerozoic time scale. Major achievements have included, among others, the reduction of interlaboratory bias with new U-Pb tracer solutions, the development of chemical abrasion methods to address the problem of lead loss (U-Pb), improvements in the calibration of $^{40}Ar/^{39}Ar$ monitor minerals, and instrumental advances that greatly reduce analytical uncertainties.

In tandem, astrochronology has emerged as an important tool for enhancing the accuracy and precision of high-resolution time scales, especially through ash-poor intervals that cannot be directly dated with radioisotopic methods. Astrochronology uses the geologic record of climate oscillations—those ascribed to periodic changes in the Earth's orbit and rotation—to measure the passage of time from rhythmic layers in strata.

Major advancements in astrochronology derive from improvement of the theoretical astronomical models, the acquisition of high-quality paleoclimate records and their integration with bio-chemo-magneto-litho-stratigraphy and radioisotopic data, and the development of statistical methodologies to assemble and evaluate cyclostratigraphic records. Astrochronology is now even used to calibrate and evaluate radioisotopic geochronology.

Although these three techniques are broadly employed, many conceptual barriers exist between the historically disparate fields. To address this issue, the National Science Foundation sponsored a summer workshop and short course in August focusing on the integration and intercalibration of radioisotopic and astrochronologic time scales. Undergraduate and graduate students, postdocs, and faculty from 28 institutions located in eight countries attended the workshop, held at the University of Wisconsin–Madison.

The workshop reviewed the basic theory underlying each geochronologic method (U-Pb, $^{40}Ar/^{39}Ar$, and astrochronology), with an emphasis on understanding the challenges inherent in the interpretation of radioisotopic and astrochronologic data, the sources of uncertainty in developing high-precision time scales, and the power of combining multiple chronometers. Investigation of each technique was aided by interactive lab practicals to provide hands-on experience with data analysis. This included astrochronology tutorials with the software Astrochron: An R Package for Astrochronology, a new Web-based interactive U-Pb practical, and analysis of $^{40}Ar/^{39}Ar$ data with the software Isoplot.

Participants also delivered 22 research talks that explored a wide range of questions for which an understanding of geologic time is essential and toured geochemistry labs used for geochronologic research.

The IsoAstro workshop content illustrates how the development of state-of-the-art "high-resolution" time scales is a truly interdisciplinary pursuit and that research in this field provides tremendous new opportunities for integration across disciplines.

By **Stephen R. Meyers**, Department of Geoscience, University of Wisconsin–Madison; email: smeyers@geology.wisc.edu; **Bradley S. Singer**, Department of Geoscience, University of Wisconsin–Madison; and **Mark D. Schmitz**, Department of Geosciences, Boise State University, Boise, Idaho

Urbanization and Air Pollution

Then and Now

By David D. Parrish and William R. Stockwell

Analysis of decades of mitigation efforts in Los Angeles demonstrates that air quality in megacities can be greatly improved.


Thinkstock; Hung_Chung_Chih

Air pollution in China is now so bad that it resembles a nuclear winter, slowing photosynthesis in plants—and potentially wreaking havoc on the country's food supply.

Since the beginning of the industrial revolution, people have increasingly congregated in urban areas so that as of 2005, more than half of us lived in cities [*Cohen*, 2006], There are about 28 megacities, defined by populations greater than 10 million. Most projected future growth in the world's population will occur in urban areas [*United Nations*, 2014].

Air pollution often plagues industrialized cities, particularly during their early development. Episodes of high levels of sulfurous smog killed or sickened thousands in Donora, Penn., in 1948, as well as in London in 1952 [*Bell and Davis,* 2001; Helfand et al., 2001]. Other cities—primarily in the industrialized regions of the United States and Europe—also suffered from notoriously bad air quality. These events were the result of very high emissions of sulfur dioxide, smoke, and other particles during stagnant, foggy weather conditions.

Fig. 1. *Degraded air quality in two megacities: (a) Los Angeles in 1948 (from the* Los Angeles Times *Photographic Archive, UCLA; http://bit.ly/LA1948) and (b) Beijing 65 years later (© JasonLee/Reuters/Corbis).*

As governments controlled more traditional pollution sources and urban vehicle fleets grew, a different type of air pollution also arose. Photochemical air pollution—a new phenomenon, distinct from sulfurous smog—clouded the skies over Los Angeles, first recognized in the 1950s. This type of air pollution results from photochemical reactions involving nitrogen oxides (NO_x) and volatile organic compounds (VOCs; e.g., ethylene and benzene) that produce ozone (O_3) and particulate matter. Both cause lung problems, among other deleterious effects, and particulate matter reduces visibility.

In North America and Europe, the coupling of industrialization and air pollution required the creation of air quality standards and regulations for emission sources such as vehicles, electrical power generation, and industrial facilities. The success of these efforts has caused the most severe air pollution episodes to be distant memories in those regions. However, as industrialization spread, air quality concerns also spread to other areas of the globe. For example, recent news headlines warn of extreme air pollution episodes in many Chinese cities, including Beijing, Shanghai, and Guangzhou (Figure 1), showing that urban air pollution remains a major world health issue [*Chen et al*., 2013; *Grahame et al.*, 2014].

Cleaning up the world's air is a daunting task. However, a broad review of about 6 decades of efforts in Los Angeles, including how scientists overcame societal and technical challenges, demonstrates that air quality in megacities can, in fact, be greatly improved. Several questions remain: Looking forward, what new challenges will megacities now developing throughout the world face? Are there limits to further improvement of air quality in more developed countries? Looking back, has the improved air quality in our cities been worth the large expense required?

Steps Taken to Recover Air Quality over Los Angeles

At its height in the 1950s and 1960s, air pollution got so bad in Los Angeles that reportedly "parents kept their kids out of school; athletes trained indoors; citrus growers and sugar-beet producers watched in dismay as their crops withered; the elderly and young crowded into doctors' offices and hospital ERs with throbbing heads and shortness of breath" [*Masters*, 2011]. Motorcycle couriers even donned gas masks during particularly severe episodes [*Harrison*, 2014]. On rare occasions, ozone concentrations exceeded 600 parts per billion by volume (ppbv, representing nanomoles per mole ambient air), and 8-hour averages sometimes exceeded 300 ppbv (Figure 2a).

In Los Angeles, scientific and engineering advances combined with political and societal commitment sustained over decades resulted in remarkable air quality improvement. The city took a comprehensive approach that

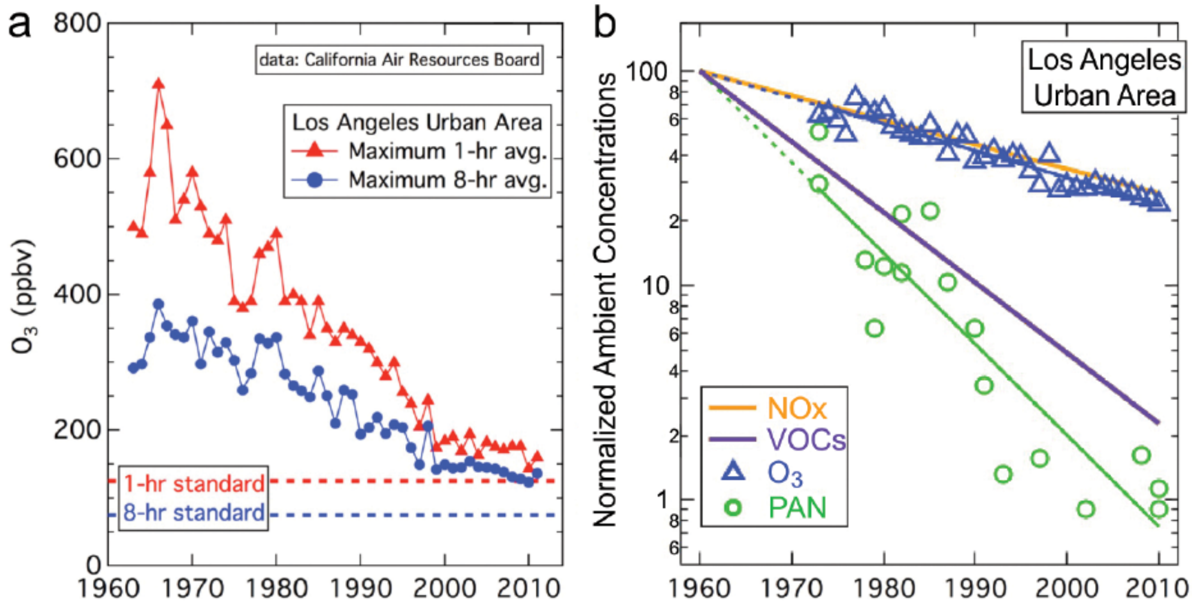


Fig. 2. (a) Fifty-year history of reduction of ambient ozone concentrations (in parts per billion by volume (ppbv)) in Los Angeles and (b) a logarithmic plot of ambient concentrations of several air pollutants, normalized to 100 in 1960 [after Warneke et al., *2012;* Pollack et al., *2013].*

addressed all emission sources. Officials banned open burning and passed laws that curbed industrial pollution. They regulated emissions from electrical power generation; plants emitting in excess of certain thresholds closed. Companies built new power plants elsewhere and transmitted electricity into the city.

However, the most critical and effective efforts addressed motor vehicle emissions. Initial efforts controlled emissions of VOCs and included notably catalytic convertors, engine redesign, and fuel reformulation to minimize evaporation and optimize performance of emission controls.

Documenting Recovery

In Los Angeles, ambient concentrations of VOCs have decreased by a factor of 50 from 1960 to 2010 (solid purple line in Figure 2b), despite a threefold increase in fuel used [*Warneke et al*., 2012]. Compared with their counterparts in 1960, modern automobiles emit less than 1% as many VOCs per distance traveled. Motor vehicle emissions of NO_x have decreased more slowly: Ambient concentrations of NO_x have decreased by a factor of 4 from 1960 to 2010 (solid orange line in Figure 2b) [*Pollack et al*., 2013].

Photochemical modeling of the historical changes in pollutant concentrations in Los Angeles has not been accomplished in detail, mainly because of difficulties in reconstructing the emissions inventory. Modeling particulate matter, especially secondary organic aerosols, is particularly challenging. Measurements and modeling do show that the photochemistry of VOCs and NO_x is nonlinear, and ambient concentrations of ozone, peroxyacetyl nitrate (PAN), and particulate matter have responded in a complex manner to emission changes. Ozone has decreased at about the same rate as NO_x (Figure 2b), but detailed chemical modeling shows that this is not a simple causal relationship. The ratio of ambient VOCs to NO_x, which controls many aspects of the photochemistry, has decreased by a factor of about 12 over the period from 1960 to 2010 because of different reduction rates of VOCs and NO_x emissions. Interestingly, PAN (which was responsible for severe eye irritation in Los Angeles several decades ago) has decreased by a factor of about 130, a decrease greater than that of either VOCs or NO_x.

Challenges to Curbing Air Pollution

Why did the improvements shown in Figure 2 take so long to accomplish? Not only was development of the scientific understanding and engineering advances challenging, but protracted legal, social, and political processes also slowed implementation of the required emission controls.

Effective air pollution control efforts require concerted action over the entire airshed. This proved difficult—the Los Angeles region contains 3 counties and more than 50 separate cities. Progress proceeded slowly until officials formed the South Coast Air Quality Management District in 1976, which then regulated all stationary emission sources within the region in a consistent and comprehensive manner.

Government officials, industry managers, and the public have maintained these concerted pollution control efforts for more than 50 years in Los Angeles. Progress there and across the United States occurred over such a long period that many have forgotten how bad air pollution once was and have failed to notice the gains made. In fact, most people alive in the United States today never experienced the very poor air quality of Los Angeles that occurred in past decades. This fading societal memory poses another challenge: how to ensure that improved air quality is not compromised as communities focus on efforts to spur depressed economies and deal with other urgent societal problems.

Los Angeles: A Pollution Analogue for China?

Residents of Beijing now face problems from degraded air quality similar to those the residents of Los Angeles once faced. As the *Guardian* reports, "Chinese scientists have warned that the country's toxic air pollution is now so bad that it resembles a nuclear winter, slowing photosynthesis in plants—and potentially wreaking havoc on the country's food supply" [*Kaiman*, 2014].

The comparison between cities in Figure 1 suggests that present urban visibility degradation in Beijing is similar to that in Los Angeles 65 years ago. Although measurement methods and data reporting procedures have changed, in situ atmospheric measurements of particulate matter suggest that the maximum concentrations in Beijing now may be higher than those ever experienced in Los Angeles, but on an annual average basis, Los Angeles may have had worse particulate matter air quality.

In contrast, reported O_3 concentrations in Beijing seldom exceed 200 ppbv [e.g., *Zhang et al.*, 2004], so O_3 in Los Angeles had been worse than what Beijing has experienced so far. Air pollution in cities such as Beijing is in transition from sulfurous smog to photochemical air pollution. The rapid increase in motor vehicles in Beijing and other developing cities may lead to greater photochemical O_3 production and higher future O_3 concentrations.

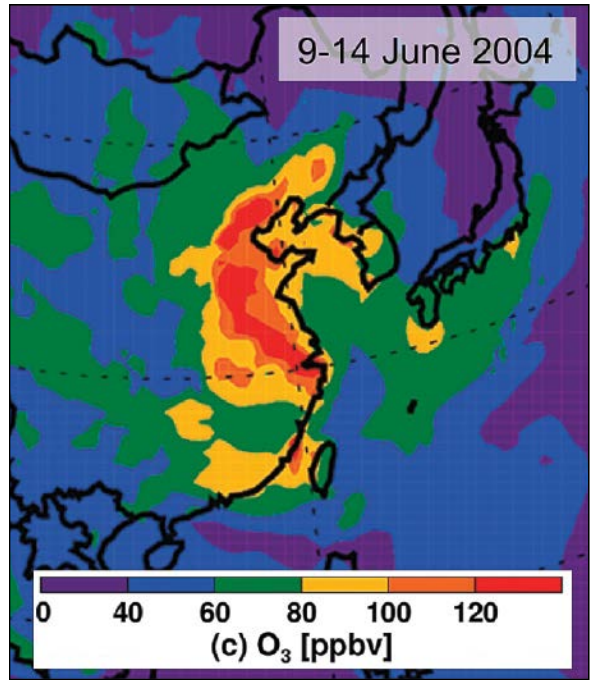


Fig. 3. Results of a modeling study of ozone during a pollution episode that encompassed nearly all of eastern China. Adapted with permission from Zhao et al., *[2009]. ©American Chemical Society.*

A Regional, If Not Global, Approach

As urbanization, global population, and economic development increase, long-range transport of pollution becomes an increasingly important factor for cities looking to improve air quality. Regardless of where we live, air flow brings pollution from our upwind neighbors to us, whether those neighbors are nearby urban areas, adjacent states or countries, or relatively distant continents. Similarly, transport of our own pollution affects our downwind neighbors.

The importance of regional transport of pollutants originally emerged in Europe (e.g., acid precipitation [*Nordo*, 1976]) and later in North America (e.g., Ozone Transport Assessment Group research in the eastern United States [*Parker and Blodgett*, 1999]). In Houston—a city that recently rivaled Los Angeles for the worst U.S. air quality largely because it is home to a large fraction of the U.S. petrochemical industry—the contribution of O_3 transported into the city has been, on average, larger than the contribution of local photochemical production, even on days when O_3 exceeded the National Ambient Air Quality Standards (NAAQS) [*Berlin et al.*, 2013].

Long-range transport of O_3 and particulate matter is an important issue to consider in all urban areas, not only in the more developed countries where local emissions have already been stringently controlled but also in densely populated developing countries, where large cities lie in close proximity to one another. In Asia, high population densities over a very broad region mean that the regional transport of pollution amplifies risks from poor Asian air quality in ways that have no analogue in the United States. For example, more than 800 million people live in eastern China, which includes Beijing and four other megacities. The air flowing into each of these cities will often carry a concentrated mix of aged pollution from an upwind city. The addition of fresh emissions from local sources to the transported pollution will likely present new challenges to scientific understanding of photochemical smog—challenges that must be surmounted in the effort to improve Chinese air quality.

In Asia, regional transport of pollution amplifies risks in ways that have no analogue in the United States.

Just as the establishment of the South Coast Air Quality Management District was required to effectively improve the air quality in Los Angeles, it is likely that the entire eastern China region, or at least the North China Plain, will need to be treated as a single air basin before improvement in air quality can be seen in Beijing, Shanghai, and the surrounding areas.

The modeling results shown in Figure 3 emphasize that, in effect, the entire eastern China region should be considered to be one very large super megacity. Other areas in Asia (e.g., the Indo-Gangetic Plain) may face similar problems and may need similar concerted mitigation efforts.

Limits to Air Quality Improvement

Despite the documented successes in the United States following implementation of the Clean Air Act, the United States's ability to improve air quality has limits. Figure 2a shows that O_3 mixing ratios have now dropped much below those observed before 1970; however, this decrease cannot continue indefinitely. Air flowing into the United States contains background O_3 concentrations, and similar considerations exist for particulate matter.

An emerging challenge for American policies involves determining at what point air quality has been improved to an optimum extent. Even the background O_3 and particulate concentrations transported into the country may have adverse health effects; however, these concentrations cannot be reduced solely by local and regional emission control efforts. Setting the U.S. NAAQS while considering only health impacts without regard to feasibility—as currently is required of the U.S. Environmental Protection Agency (EPA)—will likely lead to standards that cannot be met in some areas.

Are Pollution Control Efforts Worth It?

Has the improvement of air quality in U.S. urban areas been worth the cost? EPA conducted a series of studies (http://www.epa.gov/cleanairactbenefits/) to specifically determine how the overall health, welfare, ecological, and economic benefits of Clean Air Act (CAA) programs compare to the costs of these programs.

The first report released in 1997 presented a retrospective analysis of costs and benefits for the period spanning 1970 to 1990 (see http://www.epa.gov/cleanairactbenefits/retro.html), and the later reports provided a prospective analysis for 1990 to 2020. These reports underwent extensive review by panels of outside experts and by the Department of Labor and Department of Commerce.

EPA found that improving air quality has been costly: Control efforts from 1970 to 1990 cost an estimated $0.52 trillion (inflation adjusted to 1990 dollars), whereas the central estimate of total monetized benefits of the CAA from 1970 to 1990 was $22 trillion. Thus, the air quality improvement that resulted from the CAA from 1970 to 1990 was quite cost-effective, with benefits exceeding costs by a ratio of approximately 42:1 (best estimate). Subsequent EPA reports found continuing large benefit-to-cost ratios.

In addition, as noted in the first report, "there are social and personal values furthered by the Clean Air Act, which have not been effectively captured by the dollar-based measures" used in the studies. Reductions in adverse health and environmental effects enhance quality of life well beyond factors that can be monetized. How can one fairly value a morning walk while breathing fresh air and enjoying a view of the surroundings? Such an activity was seldom available to Los Angeles residents during the mid-20th century.

The EPA reports can assure developing megacities that investments in air quality improvement are rewarded by improved health and general well-being of the urban populations. Although the experience in the United States may not directly apply to other megacities, it is a guide to some of the scientific, technical, and policy approaches required elsewhere.

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Medalists Honored at 2014 AGU Fall Meeting

Hiroo Kanamori Receives 2014 William Bowie Medal

Hiroo Kanamori was awarded the 2014 William Bowie Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding contributions to fundamental geophysics and for unselfish cooperation in research."

Hiro Kanamori

Citation

Hiroo Kanamori has made outstanding contributions to fundamental geophysics, earthquake physics, and hazard mitigation, but equally important is his contribution to the global geoscience community through his unselfish cooperation with a myriad of colleagues and students over the years.

Hiroo started research work at the University of Tokyo in the 1960s by designing and building a shipboard gravity meter, which was followed by his study of the crust–mantle structure of Japan. Being so versatile, he soon was engaged in experimental and theoretical research with younger colleagues on the physical properties of rocks and minerals, the shock wave equation of state, elastic waves, thermal diffusivity, and electrical conductivity, to name just a few subjects. All these areas were highly pioneering at that time. These experiences were instrumental in providing Hiroo with an unusually broad scope in his later research. After a few years, around 1970, he decided to concentrate his efforts on seismology and was apparently fascinated by the power of the wave equation.

His monumental works in the early 1970s verified the newly born plate tectonics idea by analyzing great island arc earthquakes and presenting the notion of tsunami earthquakes. After moving to the California Institute of Technology in 1972, his activity bloomed in diverse fields. The introduction of moment magnitude, quantification of great earthquakes, and the diversity of subduction zones are some examples. After around 1980, volcanic eruptions at Saint Helens and Pinatubo were apt targets for his long-period techniques. His discovery of the W phase, establishment of real-time seismology, and its application to the Caltech-USGS Broadcast of Earthquakes (CUBE) system for the mitigation of seismic hazard have followed one after another, with each one being truly epoch making.

Hiroo's contributions to the field of seismology are clear to anyone familiar with modern seismology and geophysics. His long exemplary track record of unselfish cooperation is also exceptional. Hiroo is a private, self-effacing individual who has always remained focused on scientific research. But he has mentored and inspired generations of students and colleagues. They can all attest to how freely he offered his guidance to anyone and how keenly interested he was in colleagues' work. It is impossible to count how many publications were critically shaped or even sparked by insights that Hiroo offered.

Hiroo Kanamori is a true gentleman and always most friendly to people regardless of their gender, ethnicity, or race. Not only a great number of students but also the whole geophysical community have profoundly benefitted from him. Together with the late Kei Aki, Hiroo Kanamori is really the "made in Japan and perfected in America" giant star who will remain shining brightly in the history of seismology.

—**S. Uyeda,** *The Japan Academy, Tokyo, Japan*

Response

Thank you very much for the kind words from Professor Uyeda. I am extremely honored to be awarded the 2014 AGU Bowie Medal.

I have been fortunate to be at the right place at the right time as a geophysicist and seismologist. Hewitt Dix introduced me to the California Institute of Technology (Caltech), and Bob Sharp, Don Anderson, and Clarence Allen, among others, encouraged me to come to Caltech. Fortunately, my move coincided with a time of spectacular development in seismic instrumentation, theories, and communication technology, which all contributed to making seismology a truly quantitative and exciting field.

I had been fascinated by the exciting geophysical processes I learned at the University of Tokyo working with Hitoshi Takeuchi and Seiya Uyeda, and I wished to strengthen the evidence for various models. Because of the limited quality and quantity of data available then, the progress had been slow; however, the situation has changed drastically. The quality and resolution of the interpretation of data have improved to the extent that we can almost believe the results. This is quite satisfying for observational scientists, and I believe that the situation can only improve, but we should all strive to further advance this science with creative and innovative approaches and hard work.

Although I was happy with my academic work, I had a strong interest in making good use of scientific knowledge for hazard mitigation by using modern technology. Inevitably, natural processes are complex, and no matter how much progress we made in science, it would be difficult to make precise short-term forecasts of natural processes in a way the public would perceive them as useful predictions.

Fortunately, the advancements in instrumental, computational, and communication technology have provided a means to use real-time information effectively for the benefit of society. Working in this area is not always easy in academic environments, but I was again fortunate in getting moral and practical support from the Caltech administration to start initial investigations in this direction. In this endeavor collaboration with government agencies like the U.S. Geological Survey played a key role. It is satisfying to see seismology working for the benefit of people.

I thank my colleagues, my students, and the staff who contributed to all the excitement we have had together in advancing science and in using it to save lives and property. I also thank my family for their wonderful support of my academic life.

—**Hiro Kanamori,** *California Institute of Technology, Pasadena, Calif.*

Dasgupta, Frankenberg, Perron, Shuster, and Tierney Receive 2014 James B. Macelwane Medals

Rajdeep Dasgupta, Christian Frankenberg, J. Taylor Perron, David Lawrence Shuster, and Jessica Erin Tierney were awarded the 2014 James B. Macelwane Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "significant contributions to the geophysical sciences by an outstanding early career scientist."

Rajdeep Dasgupta

Citation for Rajdeep Dasgupta

It is fitting that one of this year's Macelwane awards is being given to Rajdeep Dasgupta. There are but a handful of people who have accomplished so much and have had such an impact on the scientific community at such a young age.

Together with his students, he has published a series of papers that have defined him and his laboratory at Rice University as one of the world leaders in understanding the role of volatiles in phase equilibria. His work is now the gold standard for the melting of rocks in carbon dioxide–rich systems, and he has provided new models and data for carbon dioxide solubility in melts. He has also provided new constraints on carbon solubility in the core and has given us a deeper understanding of how melting happens in the mantle, with implications for the physical properties of the asthenosphere.

On top of all the experimental work, he has still managed to find time to synthesize observations with experiments, providing the community with comprehensive and, at times, provocative views of how the whole Earth carbon cycle operated, from magma oceans in the Hadean to the plate tectonics at present. These are clearly hot topics in the Earth science community right now, but it is clear that Raj has played a dominant role in defining these research directions, rather than being someone who follows fads. Thus, it is no surprise that he is continuing to push new frontiers as we speak. He is currently working on sulfur solubility in a variety of petrologic systems in order to understand sulfur transport in subduction zones and even during Martian magmatism.

On top of his research accomplishments, Raj has also carved a niche for himself as a great mentor and educator, inspiring and working with numerous graduate students and undergraduates. His ability to pay attention to important details and, at the same time, maintain the big picture is a skill that all desire but few have. Raj is the quintessential role model for a new generation of petrologists.

—**Cin-Ty Lee,** *Rice University, Houston, Texas*

Response

Thank you, Cin-Ty, for the kind and generous citation and thanks to the Macelwane committee and those who contributed toward my nomination for their time and consideration. I am deeply honored to receive this recognition from AGU. Especially, looking at the list of illustrious scientists who received this award in the past, I feel humbled.

It is usual for the honorees to thank some key people and recall a few defining moments in occasions like this, and my response, in many ways, is not going to be different. Without the tutelage and encouragement of Somnath Dasgupta, Pulak Sengupta, Sudipta Sengupta, Pradip Bose, the late Prasanta Bhattacharya, Subir Ghosh, and many others at Jadavpur University during my B.Sc. and M.Sc. days; the guidance of Marc Hirschmann at University of Minnesota during my Ph.D. work; and the supervision of Dave Walker during my postdoc research at Lamont, I would not be standing here. In particular, getting a taste of the full course of geological sciences at Jadavpur, learning how to ask important questions and connect small-scale experiments to big-scale processes from Marc, and the out-of-the-box and free thinking under the support of Dave were all essential for me.

When I wrote similar responses even 2–3 years ago, I could have stopped with more or less what I have written thus far. But for this particular recognition, I feel it is really my time at Rice University since 2008 that made this happen. I am grateful to the Department of Earth Science for providing me with the much-needed support to build my experimental lab and group plus supportive colleagues. Not too many young investigators can say with confidence that it is the work of their current and past advisees that brought them the recognition. But it is certainly the hard work, dedication, and accomplishments of Ananya Mallik, Kyusei Tsuno, Justin Filiberto, Veronique Le Roux, Han Chi, Megan Duncan, Echo Ding, Sébastien Jégo, Laura Carter, Yuan Li, James Eguchi, Sriparna Saha, and several undergraduate researchers that made my scientific career flourish in recent years. So I am standing here simply on behalf of all of them, and they should feel as proud as I do today.

Finally, the adventure with geology and life would have been impossible without Sushmita and so much less fun to look forward to without Pritthij, Aurno, and Odri. So this is to all of you as well.

—**Rajdeep Dasgupta,** *Rice University, Houston, Texas*

Christian Frankenberg

Citation for Christian Frankenberg

Christian Frankenberg is pioneering the development and use of satellite remote sensing for new and original scientific research coupling ecology with the larger-scale physical processes of the Earth system carbon and water cycles. He is one of the discoverers of the new remote sensing technique for solar-induced fluorescence that is providing new global data on the terrestrial biosphere. This is one of the most important discoveries in remote sensing in recent years.

He began his early research as an undergraduate and graduate student in Germany, moving from geoecology to remote sensing. He provided algorithms to derive atmospheric carbon monoxide and methane from Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY) spectral observations and analyzed these data to estimate global emissions. When he moved to the Institute of Environmental Physics in Heidelberg and then the Netherlands Institute for Space Research in Utrecht, he continued developing new satellite data products, extending them to water vapor and the important isotopologue, HDO. His research on the fractionation of HDO provided new insights into the dynamical processes regulating water vapor in the lower troposphere and thus the global water cycle.

Currently at the Jet Propulsion Laboratory at the California Institute of Technology, Christian has been an integral part of the Orbiting Carbon Observatory 2 (OCO-2) team involved in the challenge of measuring atmospheric carbon dioxide concentrations from space with the sensitivity to infer patterns of the underlying exchange of carbon dioxide with the surface. In analyzing the Japanese Greenhouse Gases Observing Satellite (GOSAT) high spectral resolution data intended for greenhouse gas measurements, he and others discovered that the fluorescence photons emitted by chlorophyll during photosynthesis, even though small in number, could be detected as the filling in of the solar Fraunhofer lines. This unexpected by-product offers new information about global plant primary productivity, complementing existing light interception observations.

An impressive characteristic of Christian's research is his ability to bring together an understanding of fundamental atmospheric radiative transfer, spectroscopy, and nuances of the performance characteristics of the instruments to first tease out these new data sets and then later to analyze them for new understanding of global biophysical processes. He has more than 64 peer-reviewed multidisciplinary publications to his credit since 2004, an impressive body of work that will no doubt continue to expand. These publications have already had both high impact factors as measured by their frequent citation and the more telling impact of stimulating new directions for satellite observations of the Earth system.

—**Michael Gunson,** *California Institute of Technology, Pasadena, Calif.*

Response

Thank you, Mike, for your kind words, and thank you, AGU, the Macelwane committee, and my nominators, for this unexpected and overwhelming honor. Going through the list of previous recipients is stimulating and intimidating at the same time. I feel very lucky and honored.

Like life itself and the Earth system, careers are often nonlinear, and I am indebted to many scientists and friends who shaped mine. I was fortunate to start my Ph.D. work at the University of Heidelberg at a time when the ENVISAT satellite was just launched and the SCIAMACHY instrument started shaping my research path. After working with the inspirational Ulrich Platt at Heidelberg, I continued my research in Utrecht with a Veni postdoc fellowship and enjoyed working with a great group of scientists under Ilse Aben.

For various reasons, I may not have made the big jump across the pond to the Jet Propulsion Laboratory (JPL) but for my childhood friend Kai Buchholz. Working for the United Nations, he died tragically during the earthquake in Haiti, just when I started working for JPL in the United States. In many ways, he was the most extraordinary person I knew and has always been an inspiration and moral compass for me. I would not be standing here without him.

I came to JPL about half a year after the OCO launch failure, but we were lucky to be able to work with the Japanese GOSAT satellite and the National Institute for Environmental Studies and Japan Aerospace Exploration Agency teams. Kuze-san, Yokota-san, Dave Crisp, and Mike, thank you for all your support. Again, I was somewhat lucky and at the right place at the right time. Over the last few years, I drifted back to the roots by studying chlorophyll fluorescence from space. This not only was an exciting topic but also gave me the chance to meet and collaborate with great scientists, such as Joe Berry, who probably is one of the most original and knowledgeable yet humble scientists I know. Over the last few years I had the pleasure of working work with and being influenced by many others, including Chris O'Dell, Luis Guanter, Andre Butz, Joanna Joiner, and many others. I learned a lot from many more people than I could possibly mention here.

Last but not least, I want to thank my parents for providing me all the freedom I could wish for; my wife, Suniti, for all her support; and my son, Neal, for teaching me again how powerful curiosity is.

—**Christian Frankenberg,** *Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.*

J. Taylor Perron

Citation for J. Taylor Perron

Pioneering research in geomorphology requires breadth and deep physical insight. The puzzles to be solved extend over vast ranges of spatial and temporal scales and include a wide spectrum of surface features on Earth and other planets. Finding solutions requires mathematical analysis, numerical modeling, field observations, laboratory experiments, and high-resolution remote sensing. This complexity is motivating a new generation of remarkably talented planetary scientists, and J. Taylor Perron's elegant and transformative research has placed him at the forefront of that group.

Innovation builds on fundamentals. After receiving undergraduate degrees in Earth and planetary sciences and in archeology at Harvard, Taylor moved to University of California, Berkeley, to join Dietrich's and Kirchner's legendary geomorphology groups. Working in this thriving intellectual community—with fellow graduate student Mike Lamb and Professors Manga, Fung, Richards, De Pater (astronomy), and others—he developed the extraordinary breadth of interest and skill that remains a defining character of his research. As a graduate student, Taylor worked on problems as varied as hillslope erosion, valley formation by methane rain and rivers on Titan, polar wander on Mars, and topographic signatures of life. These interests broadened while he was a Daly Postdoctoral Fellow at Harvard, where he explored (with Professor Huybers) the possibility that polar deposits on Mars record Milankovitch cyclicity and continued his seminal study of the regular spacing of ridges and valleys.

Taylor returned to the latter problem after joining the faculty of the Massachusetts Institute of Technology (MIT). In a remarkable study published in 2012, he demonstrated how competition between soil transport and river incision controls the spatial scale of river networks, one of the most striking and pervasive features on Earth's surface. His work elucidated how these networks record the influences of rock strength, rainfall, and even life and provided a universal framework for understanding drainage networks on other terrestrial bodies. Many other important contributions could be mentioned, but we end by looking back a century, to Darwin's classic model of the progression from coral reef to atoll. Many islands do not follow this sequence, and providing an alternative has long been a goal in geomorphology. Taylor and his group resolved this enigma by using a model that links reef accretion with island vertical motion and by establishing that coral reefs bear the imprint of ice age sea level cycles—a perturbation to the Earth system of which Darwin was unaware.

This medal recognizes Taylor's landmark achievements and the promise of discoveries yet to come.

—**Jerry X. Mitrovica,** *Harvard University, Cambridge, Mass.*

—**Robert D. van der Hilst,** *Massachusetts Institute of Technology, Cambridge, Mass.*

Response

Thank you, Rob and Jerry, for the kind words. I am grateful to AGU for this honor and also for shining a light on the field of geomorphology. It is remarkable that landscapes, which are so eminently observable, can be so full of mystery. And there is no shortage of mysteries: from the ancient Appalachians to the spidery networks of methane rivers on Titan, there are many landscapes we have yet to fully explore.

But I didn't realize at first how many stories the geological landscape has to tell. As an undergraduate, I spent a lot of time wondering how and when humans migrated to the Americas. Through a stroke of luck, I migrated from the east side of North America to the west side. There, in Berkeley, Jim Kirchner, master analyst, and Bill Dietrich, insightful questioner, found a kid with an archaeology degree on their doorstep and taught him to think quantitatively about Earth's surface. Around the same time, Alan Howard, Jerry Mitrovica, and Michael Manga sparked my interest in planetary landscapes, which never fail to surprise.

In the years since, new institutions have brought new friends. Colleagues at MIT and Woods Hole have drawn my attention to new problems, introduced me to stellar students, and made time to learn about my work. I especially thank Dan Rothman, Rob van der Hilst, Maria Zuber, Leigh Royden, Sam Bowring, Andrew Ashton, John Southard, Paul O'Gorman, Tanja Bosak, and Ben Weiss. Many others have helped me as collaborators, kindred spirits, or both. I am particularly indebted to Mike Lamb, Kelin Whipple, Paul Myrow, Peter Huybers, Ken Ferrier, Sean Willett, Steve Martel, Sujoy Mukhopadhyay, Devon Burr, Josh Roering, Noah Snyder, Sergio Fagherazzi, John Grotzinger, Mike Church, and Tom Dunne.

I will end by mentioning three groups who deserve their own medals. First, to the students and postdocs who have fueled our work, I look forward to counting you as colleagues for many years to come. Second, I thank my parents, who fostered my curiosity, invested in my education, and kept open minds about what they would get in return. Finally, and most importantly, I thank my wife, Lisa, who makes all my work possible, and our daughters, Mia and Ada, who have inspired me in ways I never anticipated.

—**J. Taylor Perron,** *Massachusetts Institute of Technology, Cambridge, Mass.*

David L. Shuster

Citation for David L. Shuster

It is with great delight and surprise that I introduce David Shuster as a recipient of the Macelwane Medal—it is a great delight to recognize a young scientist who has brought unique gifts to the emerging field of thermochronology but also a great surprise to be David's citationist after having contributed essentially nothing to his intellectual growth. My role instead appears to have been that of his number one fan. I became aware of David's work while reviewing his early manuscripts, but we didn't meet until years later when I approached him at a meeting to say how profoundly impressed I was with his thoughtful approach and extraordinary experimental skills. I mention this here to underscore my deep admiration of David as, to the best of my recollection, I have never done that before or since.

The development of (U+Th)/He dating of accessory minerals provided new thermochronometers for investigations of tectonic and landscape evolution but was notably limited by near-surface recoil effects and the need for bulk analysis. The former interferes with recognition of high-frequency diffusion information, and the latter precludes obtaining continuous thermal histories. David's pioneering development of $^{4}He/^{3}He$ profiling transcended both limitations, opening up entirely new avenues of research. His investigations of time-varying erosion rates in orogenic terranes have provided the clearest views of how tectonics and climate may be linked. His discovery of proton-induced neon during sample irradiation led to a novel method to determine Ne diffusion in silicates—data essential to understanding the thermal behavior of cosmogenic chronometers. He made significant contributions to developing dating methods to assess the timing of pedogenic processes with a view to better understanding past changes in environmental conditions at the Earth's surface. In particular, his pioneering application to iron oxides opened up the possibility of directly dating soil formation and thus the calibration of paleosol records with which to examine evidence of past climate change. Although it would have been tempting to simply reproduce the tools he had already developed when commissioning his Berkeley laboratory, David adopted the complimentary capabilities of $^{40}Ar/^{39}Ar$ dating for revealing intragrain thermochronological variations. His clever application of this method to reveal thermal histories of lunar and Martian samples resulted in standout papers documenting impact events, the effects of solar heating, and timing constraints on the lunar dynamo that are revitalizing the field.

David's career is characterized by a unique style: an idea for a novel or refined dating method is realized through an equally inspired laboratory development that yields data understood by sophisticated application of physical modeling, ultimately leading to a new view of how a planetary body works. Thus, I believe that this award both recognizes David Shuster's outstanding early career achievements and presages his emergence as the leading international figure in his field. Congratulations, Professor Shuster!

—**Mark Harrison,** *University of California, Los Angeles, Calif.*

Response

Thank you, Mark, for your generous citation. I am grateful to those who nominated me and to the members of AGU for this honor. I am humbled to be in the company of four outstanding scientists who are also receiving the Macelwane Medal this year and many of my academic heroes who are past recipients.

The science I pursue is an interdisciplinary and collaborative endeavor, which benefits from colleagues and mentors too numerous to fully acknowledge here. My friend and colleague Don DePaolo first introduced me to isotope geochemistry and the joys of scientific inquiry as an undergraduate at the University of California (UC), Berkeley. Don taught me how to simplify a problem's complexity to gain an intuitive understanding of it and the importance of the words "I don't understand." Don then enabled me to freely pursue my curiosity as a 21-year-old, with a research position at Lawrence Berkeley National Laboratory, where I learned noble gas geochemistry and mass spectrometry from Mack Kennedy while studying geothermal fluids and volcanic gases. Those early experiences with noble gases defined the trajectory of my career.

As a graduate student at the California Institute of Technology (Caltech), I received mentorship of outstanding geochemists, including John Eiler, Don Burnett, Ed Stolper, Jerry Wasserburg, Jess Adkins, and, of course, my Ph.D. advisor, Ken Farley. I will always appreciate their influence, and I especially thank Ken for teaching me to be rigorous, fearless, and persistent with my science. To this day, Ken is my close colleague, my friend, and always my advisor. And since we began studying meteorites and lunar rocks together as graduate students, I've learned much about thermochronology in trying to answer Ben Weiss's seemingly limitless questions beginning with the word *why*.

Since my return to UC Berkeley, my work has benefited from the creativity of outstanding graduate students and postdocs in my research group, the penetrating questions of undergraduates in my classes, the creativity and generosity of Greg Balco, and my exceptional colleagues in the Department of Earth and Planetary Science, most especially Kurt Cuffey and Bill Dietrich. I am grateful to the Berkeley Geochronology Center and the Ann and Gordon Getty Foundation for continuing to support my laboratory at a level that is essential but increasingly uncommon and to Tim Becker for world-class laboratory support.

Finally, the love of my wife, Erin, and our beautiful daughter, Nora, provide the most gratifying balance to my life that anyone could hope for. However, when we first met in middle school, Erin could not have predicted that she would later in life become so inadvertently knowledgeable in geochemistry.

—David L. Shuster, *University of California, Berkeley, Calif.*

Jessica Tierney

Citation for Jessica Tierney

Jess Tierney has made lasting contributions to paleoclimate research through the development, testing, and application of organic biomarkers in key regions of the tropics. Her records provide valuable estimates of past hydrological variability in areas where traditional paleoclimate records are sparse, best illustrated by her extensive work in tropical Africa. Such reconstructions serve to constrain the bounds of natural climate variability while characterizing the sensitivity of the climate system to past climate forcings—information of vital interest to society under continued climate change.

During her graduate work at Brown, she generated several important tropical paleoclimate records and began to work through the complexities of multiproxy records in earnest. Seeking to increase the utility of organic biomarker records like those she generated during her dissertation research, she completed an ambitious effort to refine the community's understanding of such records. It was during her postdoctoral tenure that she began to work with climate model output, collaborating with a range of top climate modelers on questions at the interface of paleoclimate and climate dynamics.

Early investments in expanding her conceptual and analytical tool kits has equipped Jess to tackle the most pressing questions in paleoclimate, which often require collaborations with climate modelers. Her latest achievements include a sophisticated comparison of paleoclimate data with output from models, demonstrating the potential for paleoclimate data to provide much-needed tests of model accuracy. Increasingly, climate scientists are turning to paleoclimate data sets to test the accuracy of the complex numerical climate models that are used to simulate future climate trends. Jess is a true pioneer in such data-model comparisons and has already made seminal contributions in this rapidly evolving field. In this regard, the quantification and representation of uncertainty in paleoclimate data lie at the core of her research endeavors, and her contributions in this area are helping to define best practices across the field. The fact that much of her published work has appeared in high-profile journals is a testament to the excellence and relevance of her research.

Jess combines a strong vision for paleoclimate science with the skills and leadership qualities necessary to move the field to its next level of evolution—one focused on delivering rigorous constraints on climate variability and change in sensitive areas of the Earth's climate system.

—Kim Cobb, *Georgia Institute of Technology, Atlanta, Ga.*

Response

Thank you, Kim, and my thanks to the Macelwane committee and to AGU. It is truly an honor to receive this award and to join the company of the many prestigious colleagues who are past recipients of this medal.

My love of studying past climate change began with a deep appreciation for history. Historical precedence and legacy can explain the present state of world affairs and can shed light on the future evolution of society. Similarly, Earth history reveals much about the present behavior and future state of the climate system. Through my research, I strive to understand past climates, with an eye toward placing the fate of our Earth in a greater context. I believe that new and evolving techniques, geochemical and statistical, can move us forward in this respect.

I would not be receiving this award without the encouragement and support of many wonderful mentors and collaborators. During my time as a postdoctoral scholar at the Lamont-Doherty Earth Observatory, I was fortunate to be mentored by Peter deMenocal, who went above and beyond to support me, to help me meet top researchers in the field, and to engage me in interesting questions in paleoclimatology. While at Lamont, I also had the privilege to collaborate with Ben Cook, Allegra LeGrande, Gavin Schmidt, Richard Seager, and Jason Smerdon, who expanded my knowledge of climate dynamics and climate modeling. I continue to learn new things from my research with my talented collaborators and friends Pedro DiNezio and Martin Tingley.

I owe a huge debt to the organic geochemistry field, a discipline that has been so welcoming to young researchers. In particular, I want to thank Kate Freeman and Ann Pearson—two visionary scientists who, as leaders in the field, are role models for me. I also want to thank Rich Pancost, Jaap Sinninghe Damsté, and Mark Pagani, who have always generously provided analytical resources, their unique insights, and invaluable advice.

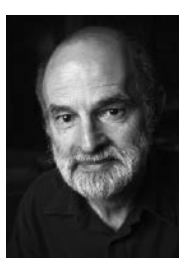
I also want to thank my family, in particular my wonderful husband and fellow paleoclimatologist, Kevin Anchukaitis, with whom I am truly blessed to share my life and science.

Finally, I would like to thank all of the women in science who have made it possible, through their perseverance, strength, and example, for me to receive this award. I hope that AGU will continue to recognize, support, and honor the extraordinary achievements of women in the geosciences.

—Jessica Erin Tierney, *Woods Hole Oceanographic Institution, Woods Hole, Mass.*

Gary A. Glatzmaier Receives 2014 John Adam Fleming Medal

Gary A. Glatzmaier was awarded the 2014 John Adam Fleming Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "original research and technical leadership in geomagnetism, atmospheric electricity, aeronomy, space physics, and related sciences."



Gary A. Glatzmaier

Citation

Gary Glatzmaier is known worldwide for his pioneering use of massive three-dimensional numerical models that simulate convection in the interiors of planets and stars. His most significant scientific accomplishment is developing a mechanically and thermodynamically consistent numerical model of the geodynamo that produces occasional, spontaneous polarity reversals of the magnetic field that closely resemble the polarity reversals in the paleomagnetic record.

In a series of papers beginning in 1995, Gary and his collaborator Paul Roberts made first-principles numerical simulations of the magnetohydrodynamic dynamo process in the Earth's electrically conducting fluid outer core, thereby providing a convincing demonstration that the main geomagnetic field is generated by a self-sustaining fluid dynamo.

In addition to being an important scientific achievement—the origin of Earth's magnetic field had long been cited as one of the major unsolved problems in physics—this was also a game-changing technological advance. Thanks to Gary's vision, physical insight, and skill at numerical modeling, along with his generosity in sharing his numerical models with the community, we can now make direct comparisons between numerical dynamo predictions and magnetic data from the Earth and other planets.

Following his work on the geodynamo, Gary also made seminal contributions to the dynamics in Earth's mantle and the interiors of planets and satellites throughout the solar system, particularly the gas giants Jupiter and Saturn and their moons.

Gary has served with distinction as an officer in the U.S. Navy; as a member of numerous national and international science panels and advisory boards; as a fellow of AGU, the Los Alamos National Laboratory, and the American Academy of Arts and Sciences; and also as a member of the University of California, Santa Cruz, faculty and the U.S. National Academy of Sciences.

Gary's unselfish approach to research has spawned a new subfield of our science that aims to reveal the origin of planetary magnetic fields, starting from basic physics and chemistry. His work has inspired a generation of young scientists eager to use numerical dynamos as a tool for understanding how magnetic fields are produced in objects as large as Jupiter, as small as planetary embryos, and as distant as the exoplanets.

The purpose for which the John Adam Fleming Medal was envisioned—to recognize original and highly significant research in geomagnetism and related sciences—is a most fitting description of Gary Glatzmaier's fundamental and groundbreaking contributions.

—**Peter Olson,** *Johns Hopkins University, Baltimore, Md.*

Response

Thank you, Peter, for those kind words. I am delighted and certainly honored to receive this year's John Adam Fleming Medal.

I have been very fortunate to have had great opportunities and wonderful colleagues over the years.

Nearly all my research has been based on computer simulations. I wrote the first version of my convective dynamo code 3 decades ago while a postdoctoral researcher at the University of Newcastle in the United Kingdom, learning dynamo theory from Paul Roberts and Chris Jones.

I then spent 16 years at the Los Alamos National Laboratory doing computational studies of magnetic field generation in the Sun, Jupiter, and the Earth. I also simulated global circulation in the Earth's atmosphere and mantle. I'm thankful for all the support I received during those years from NASA and from the University of California's Institute of Geophysics and Planetary Physics (IGPP). I want to mention Bob Malone, who got me interested in global climate modeling, and Chick Keller, the director of the Los Alamos branch of IGPP at that time. IGPP also sponsored the annual Los Alamos Mantle Convection Workshop, where I first met and collaborated with many now longtime friends and colleagues like Jerry Schubert, Peter Olson, Uli Christensen, and many others.

In 1998 I joined the faculty of the Department of Earth and Planetary Sciences at the University of California, Santa Cruz (UCSC). My teaching there over the past 16 years has been a great experience. I made sure that each of my graduate students learned how to write a two-dimensional nonlinear magnetoconvection code. I have also had many productive research collaborations with my colleagues at UCSC. In particular, my good friend and UCSC colleague Rob Coe collaborated with Paul Roberts and me on geodynamo studies.

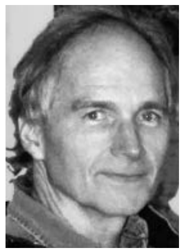
When I got the first version of my dynamo code running 30 some years ago, I never imagined I would still be using it today or that others would be using some version of it for their research. I have been improving this code over the years, and now, with the latest massively parallel supercomputers, which allow us to run much higher resolution and more realistic cases, it is again time for me to make some major improvements to the anelastic equations and numerical methods used in the code.

In closing I want to thank my wife, Tracy, who has been my best friend.

—**Gary A. Glatzmaier,** *University of California, Santa Cruz, Calif.*

Bryan L. Isacks Receives 2014 Walter H. Bucher Medal

Bryan L. Isacks was awarded the 2014 Walter H. Bucher Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "original contributions to the basic knowledge of the crust and lithosphere."



Bryan L. Isacks

Citation

Many would agree that the recognition of plate tectonics has been the most significant development in the geosciences since Darwin and Wallace proposed evolution by natural selection. Reduced to its essence, plate tectonics includes seafloor spreading, transform faulting, subduction of oceanic lithosphere, and rigid-body motion of lithospheric plates. No one has made a greater contribution to our understanding of the subduction of oceanic lithosphere than Bryan Isacks.

With Jack Oliver, Isacks reintroduced the concept of the lithosphere and showed how its subduction explained a plethora of peculiarities of island arc structures. Isacks, Oliver, and Lynn Sykes wrote definitive papers showing how many key aspects of plate tectonics are defined by earthquake seismology. In these papers Bryan demonstrated that fault plane solutions of intermediate and deep-focus earthquakes require that those earthquakes occur within the downgoing slab of lithosphere, and he used those solutions to place constraints on the forces that drive plate motion. With Muawia Barazangi and others, he showed that the deep structure of back-arc basins implied seafloor spreading there.

Like most major contributors to plate tectonics, Bryan moved away from it in the 1970s, and he turned to subduction beneath a continental margin, the Andes, where the idealized rules of plate tectonics fail. With Barazangi and in a later elaboration with Teresa Jordan and others, he pointed out the geologic similarity between portions of the Andes where subduction occurs at a gentle angle and what geologists had inferred for the tectonic development of the western United States from 80 to 50 million years ago. His leadership in this area of research made Cornell a major center of Andean research.

Then 25 years ago, Isacks was one of the first to exploit digital topography to understand both geodynamics and erosion. He combined the fact that glaciers form at high altitudes with the widely accepted notion that glaciers erode more rapidly than rivers, and he coined the term "glacial buzz saw" to explain the hypsometry with seemingly flat high terrain despite many deep glacial valleys.

An unusually humble man, Isacks has received only one important accolade, the respect and appreciation of many students; ~35 of the ~45 graduate students whom he had advised attended a celebration of his 70th birthday. Until now, Bryan Isacks may have been AGU's most outstanding scientist who had never received a medal or formal recognition of his contributions. We are delighted that this oversight has now been set right.

—**Peter Molnar,** *University of Colorado Boulder, Boulder, Colo.*

—**Frank Richter,** *University of Chicago, Chicago, Ill.*

Response

I thank Peter Molnar and Frank Richter for their very kind and generous citation.

In the 1960s I was lucky to have been immersed in the exciting and enabling culture of collaborative research at Lamont when the ideas of plate tectonics emerged, seemingly, by a process of "self-organized criticality" involving the interactions of numerous scientists in England, Canada, and the United States. In that network of interactions at Lamont I particularly linked with my thesis advisor Jack Oliver and colleagues Lynn Sykes, Peter Molnar, Muawia Barazangi, and Walter Mitronovas.

In the 1970s, after moving to Cornell, Muawia Barazangi and I came upon the segments of alternating steep and flat dipping plates that are subducting beneath the Andes. We were taken by the remarkable correlation between plate dip and Andean volcanism and topography. In the early 1980s, Rick Allmendinger and Terry Jordan came to Cornell with ideas about the role of flat subduction in the Laramide tectonics of the western United States. We were amazed at the analogy between the Laramide western United States and the late Cenozoic tectonics of the central Andes. Sharing this amazement were Suzanne and Bob Kay, who were working on subduction-related volcanism in the Aleutians, and Art Bloom, who was involved in NASA's Landsat and Shuttle Imaging Radar programs. The six of us started the Cornell Andes Project in the early 1980s, and it continues to this day.

The close relationship between the dip of the subducted plate and upper plate tectonics led me to the outstanding signal of Andean tectonics, the Central Andean Plateau. As revealed by digital topography, a picture emerged involving plateau uplift by lower crustal shortening, a crustal-scale monocline defining the seaward edges of both the plateau and the volcanogenic asthenospheric wedge, and the enhanced bending of the Bolivian Orocline. In NASA's Earth Observing System (EOS) and spaceborne imaging radar-C (SIR-C) programs I worked on satellite remote sensing of glaciers past and present and the coupling between mountain building and climate. I was fortunate to have very talented and enthusiastic graduate students, who worked as colleagues and often led the way, as in the old days at Lamont. They deserve a significant piece of the medal.

Recently, I've used digital topography to show how ice sheets have so beautifully sculpted the Finger Lakes' landscape. The resulting video is narrated by my wife, Marjorie Olds, who, as my life coach, also owns a piece of the Walter Bucher Medal.

—**Bryan L. Isacks,** *Cornell University, Ithaca, N. Y.*

John A. Whitehead Receives 2014 Maurice Ewing Medal

John A. Whitehead was awarded the 2014 Maurice Ewing Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "significant original contributions to the scientific understanding of the processes in the ocean; for the advancement of oceanographic engineering, technology, and instrumentation; and for outstanding service to the marine sciences."

John A. Whitehead

Citation

First, full disclosure: I am an isotope geochemist penning a citation for a fluid dynamicist. This is the first big hint that Jack Whitehead is unusual and special. Many will not think it complimentary if I say that all the fluid dynamics I know, I learned from Jack! But this speaks directly to the enormous and collegial generosity Jack brings to his science, students, and life. For me, it started when Jack suggested we "make some mantle plumes." Thus began a journey of novelty and reward and sticky encounters with Karo syrup (likely warping my intuition about mantle plumes!). And what a scientific journey! Or, quoting T. S. Eliot, "We shall not cease from exploration / And the end of all our exploring / Will be to arrive where we started / And know the place for the first time."

More grandly, Jack's collegiality is reflected in his CV, a veritable Who's Who of oceanography and fluid dynamics, to which we add the Woods Hole Oceanographic Institution summer Geophysical Fluid Dynamics Program, which has influenced generations of bright students. They will remember Jack's palpable love of science and his enthusiasm for arresting them into summer projects! Jack will be indelibly recollected as the resident spirit of the unique program known informally as the Walsh Cottage Summer School or, by some, as "the porch people."

In the "real world" of oceanography, Jack pioneered the application of classical hydraulic theory to rotating flows and overflows. This started in 1974 with his seminal paper "Rotating Hydraulics of Strait and Sill Flows." Over the next 30 years, Jack continued expanding the theory, also applying it to observational oceanography. This culminated in a 2007 book with Larry Pratt, Rotating Hydraulics: Nonlinear Topographic Effects in the Ocean and Atmosphere. This book is exceptionally thorough and useful and also relevant to the global climate system and the parameterizations used in climate models. Jack's experimental demonstration of flows with multiple steady states is also directly relevant to the global climate system.

In 1975, Whitehead and Luther published "Dynamics of Laboratory Diapir and Plume Models," which explored many basic dynamical issues underlying the behavior of buoyant plumes. This incredibly important paper migrated geoscientists toward support of Jason Morgan's 1971 hypothesis concerning mantle plumes sourced at Earth's core-mantle boundary. Jack's trailblazing work nucleated a cascade of ever more complex experimental and theoretical studies. Today, Morgan's plume theory rests comfortably on this amassed construction built on Whitehead and Luther's research.

Jack Whitehead's contributions to science and the community are extraordinary; he is an exemplary recipient of the Maurice Ewing Medal.

—Stan Hart, *Woods Hole Oceanographic Institution, Woods Hole, Mass.*

Response

Thank you all! It has been my good fortune to collaborate with almost 100 coauthors (so far), so mentioning each by name would be excessive. Their expertise includes physical oceanography, geochemistry, petrology, geophysics, volcanology, atmospheric dynamics, planetary dynamics, climate studies, applied mathematics, and physics. Their vocabulary exhausts me! I gratefully thank them for the success of our mutual results both as scientists and as educators. In addition, the complexity and mysteries of the oceans and Earth have surrounded me for 44 years at Woods Hole Oceanographic Institution. Thanks to all my fellow scientists, staff, and students there. And, finally, in spite of all the observations, I require simple explanations to help me with the mathematics, dynamics, and interpretations of ocean and Earth data. Participation, since 1972, in the Geophysical Fluid Dynamics Summer School has been essential and a joy! Finally, thanks to the National Science Foundation, the Office of Naval Research, and the joint program with the Massachusetts Institute of Technology for supporting the Geophysical Fluid Dynamics program and my research.

Most of my work has used fluid mechanics laboratory experiments. Laboratory results differ from numerical modeling results, and the data differ from actual observations. Experimental runs can often be viewed in three dimensions evolving in time. Through the miracle of scaling and dimensionless numbers, a minute in the laboratory can transform to hundreds, thousands, or even millions of years in the oceans or on Earth. A centimeter can transform to meters or even kilometers. Finally, you can often *see* and sometimes even *stir* experiments. Incomparable! Thanks especially to technicians Paul Cox and Bob Frazel (both no longer with us), followed by John Salzig, Keith Bradley, and Anders Jensen. Also thanks to my fellow scientists Claudia Cenedese and Karl Helfrich. Showing results to visitors and to my wife, Lin, and children, Glen, Wendi, and Amie, has always been a pleasure and inspiration. We all have received numerous insights while watching experiments and have even had a few eureka moments. It has been wonderful!

Speaking of eureka, I want to encourage everyone out there to try a new idea, the one you always wanted to do. When he was younger, my son, Glen, once asked why the ocean water is blue. I hemmed, hawed, and mentioned the blue sky and nitrogen and so forth, but clearly, my explanations were going nowhere. He simply scowled and said, "well you're a scientist, discover it!" So to everyone here, let's discover something new! Thank you.

—John A. Whitehead, *Department of Physical Oceanography, Woods Hole Oceanographic Institution, Woods Hole, Mass.*

W. James "Jim" Shuttleworth Receives 2014 Robert E. Horton Medal

W. James "Jim" Shuttleworth was awarded the 2014 Robert E. Horton Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding contributions to hydrology."

W. James "Jim" Shuttleworth

Citation

Professor W. James Shuttleworth has brought innovative research, novel scientific thinking, and outstanding leadership to the interface between hydrology and other Earth science disciplines. He has motivated young hydrologists to move beyond established boundaries and brought the hydrologic and atmospheric sciences together to foster the growing field of terrestrial hydrometeorology.

A cornerstone of Jim's career has been the development of theoretical and experimental methods that underlie the prediction of natural evaporation and are now the foundation for the land-atmosphere models used in numerical weather and climate prediction. He is regarded as *the* leading international expert on evapotranspiration, and his work led a transformation to physics-based formulations based on the laws of conservation of mass and energy. It is, therefore, no surprise that he was asked to write the chapter on evaporation in the *Handbook of Hydrology*.

Jim pioneered the modern era of environmental investigations in the Amazon River Basin, where his team developed the capability to measure surface-atmosphere exchanges, ultimately revealing that theories about seasonal variations of evapotranspiration there were wrong. His precedent of combining research with training young scientists is a key aspect of the Large Scale Biosphere-Atmosphere Experiment (LBA).

Jim was arguably the first hydrologist to understand the importance of the hydrology-ecology interface to climate and weather prediction. His papers established a subfield of hydrology devoted to large-scale modeling and prediction. He helped organize and lead large international multidisciplinary research initiatives to improve the representation of surface exchanges in meteorological models and to acquire the data required to test and improve them.

Perhaps most noteworthy, however, is Jim's leadership in developing terrestrial hydrometeorology as a major discipline of Earth system science, resulting in the world's first graduate degree program in this subject at the University of Arizona. Characteristic of this leadership, he published the first textbook on the subject, and it is destined to become a classic and basic text for similar academic programs elsewhere.

In summary, Professor Shuttleworth has been an intellectual leader in the field of hydrology for over 40 years and has contributed to broad philosophical perspectives in hydrology, as well as hydrologic understanding and prediction based on careful integration of observations and theory. He has been a prime motivator in vigorous discussions that have been illuminating but never divisive. He is a true gentleman, recognized for his honest commitment to advancing science for the benefit of society, and a consummate example of AGU's motto "unselfish cooperation in science."

—**Hoshin V. Gupta,** *University of Arizona, Tucson, Ariz.*
—**Dennis P. Lettenmaier,** *University of Washington, Seattle, Washington*

Response

I am humbled and honored to receive this year's AGU Horton Medal and sincerely grateful to my nominators, Hoshin Gupta and Dennis Lettenmaier, and to those who wrote in support.

I am lucky to have worked in hydrological science research during 40 years in which it grew hugely in the range of other environmental sciences with which it interacts and in acknowledgment of its importance to humanity. My career was carried forward by this growth.

I am lucky to have worked in two centers of excellence during periods when each experienced the zenith of their success. First, I worked at the UK Institute of Hydrology (IH) when that institution, under Jim McCulloch, was the flag bearer of officer innovation in process studies of surface hydrology. At IH I discovered my passion for understanding natural evaporation and worked with colleagues, including John Gash, Colin Lloyd, Dave McNeil, Chris Moore, Han Dolman, and Howard Oliver, to establish routine application of the *eddy correlation* method to measure surface exchanges. It is also where, working with Luis Molion, Carlos Nobre, and many, many Brazilian colleagues, we ventured into the then novel hydrometeorological quantification of Amazonian rainforest and where we joined the battle for large-scale quantification of surface-atmosphere exchanges, working with international colleagues, including Jean-Claude Andre, Hans Bolle, Piers Sellers, and Pavel Kabat.

I am lucky because I was next recruited by Soroosh Sorooshian to join the Department of Hydrology and Water Resources (HWR) at the University of Arizona, a unique and massively productive center for hydrological science research. There I work in a stimulating environment with colleagues, including Hoshin Gupta, Tom Maddock, Juan Valdes, Paul Brooks, Shlomo Neuman, and Marek Zreda, to extend studies of surface exchanges with greater emphasis on using remote sensing and on research implemented through talented graduate students, including Paul Houser, Altaf Arain, Russ Scott, Dave Gochis, Omar Sen, Ismail Yucel, and Chawn Harlow, to name just a few. It is where I have been most active in science management, working in National Research Council committees and the International Geosphere-Biosphere Programme, Global Energy and Water Cycle Experiment, and Climate Variability and Predictability programs, and where my interest in using hydrological research to aid policy arose, fostered via the International Association of Hydrological Sciences' Hydrology for the Environment, Life and Policy (HELP) program and as director of the Semi-Arid Hydrology and Riparian Areas Science and Technology Center.

But I am lucky most because I married my wife, Hazel, who, throughout 50 years of marriage, has been my consistent supporter and who has given me my children, Craig, Matthew, Nicholas, Jonathan, and Amy, and 11 grandchildren and three great-grandchildren!

—**W. James "Jim" Shuttleworth,** *University of Arizona, Tucson, Ariz.*

Donald J. DePaolo Receives 2014 Harry H. Hess Medal

Donald J. DePaolo was awarded the 2014 Harry H. Hess Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding achievements in research on the constitution and evolution of Earth and other planets."

Donald J. DePaolo

Citation

To convey how richly Don DePaolo deserves the Hess Medal as recognition of his many significant contributions to the Earth sciences, I will use a recent, possibly apocryphal, story.

An officer of a distinguished scientific society enters a bar in North Tonawanda, New York, and asks the bartender, who is regarded as infallible by all patrons, how to recognize a great geochemist. The bartender replies, "You give him or her a prestigious award." The officer of the society says, "No, no—I meant how does one know who is a truly great geochemist?" The reply to this was "it just takes four things. First, you need to find someone who has played a major role in developing new geochemical tools as Don DePaolo did with the neodymium-samarium system. Second, the new approach needs to have been effective at solving important geological problems. For examples of this you should read DePaolo's classic monograph *Neodymium Isotope Geochemistry*. Third, a great geochemist will have developed powerful conceptual models such as those in DePaolo's paper "Trace Element and Isotopic Effects of Combined Wallrock Assimilation and Fractional Crystallization," which are now so widely used that one forgets where they came from."

The high-ranking officer, thinking the issue resolved, runs out of the bar without waiting to hear the fourth key attribute. But a nagging thought creeps in—might there not be some bias in the bartender's testimony given that the bar is in North Tonawanda and Don DePaolo is originally from North Tonawanda? At this point further testimonials from a number of leading Earth scientists are solicited, and the remarkable outcome is that although they were unanimous in their affection and admiration for DePaolo, each used different topics as examples of his impact across the full range of the Earth sciences. He was praised for his contributions to igneous, metamorphic, and sedimentary petrology; for developing the method for determining crustal mantle separation age; and for work on the chemical evolution of seawater and low-temperature processes during calcite precipitation.

Had the high-ranking officer stayed in the bar a bit longer, the fourth key attribute would have become clear: you need to be a great field geologist to bind the whole package together, and Don DePaolo is a perfect illustration of the importance of this trait. I'm sure I don't have to tell you that the "an officer goes into a bar" story has a happy ending.

—**Frank Richter,** *University of Chicago, Chicago, Ill.*

Response

My thanks to the Hess Medal committee, friends, and colleagues who thought of me for this award and to AGU for continuing to provide this outstanding scientific venue. At my first AGU meeting in spring 1976 in Washington, D. C., I gave a presentation on a few neodymium isotopic analyses we had done at the California Institute of Technology (Caltech). I have not missed many meetings since. That work, with a few twists and turns and a few other isotopes, led ultimately to my presence at this event.

It is gratifying to receive an award named for Harry H. Hess. Judging from his publications, he had many characteristics as a scientist that I admire. Although strongly attached to making measurements, he apparently was also unafraid to develop models from limited data and creatively follow the implications into uncharted territory! I discovered with a little digging that Hess and I have a few things in common. Hess started as an engineering major at an Ivy League school and switched to geology, he wrote papers on the Stillwater igneous complex, and he was a leader of the Mohole project. The last connection refers to the fact that the original proposal Ed Stolper, Don Thomas, and I submitted to the National Science Foundation (NSF) in 1986 for the Hawaii Scientific Drilling Project was for a deep core hole to penetrate the Moho under Hilo.

Not unusually, my career trajectory has involved a series of unlikely events. I am immensely pleased with where they led. The initial research direction and subsequent tendency toward directional variance were influenced by the mentorship and example of Jerry Wasserburg. Many years of friendship and collaboration with Frank Richter helped keep the fires lit. Not much would have been done without consistent and substantial research support from NSF and the U.S. Department of Energy and institutional support from the University of California (UC), Los Angeles; UC Berkeley; and the Lawrence Berkeley National Laboratory. My wife and partner for the last 30 years, Lynn Ingram, kept me balanced and almost centered while pursuing her own research.

Probably the best thing I did for science and myself over the years was recognize when colleagues were describing to me exceptionally good research ideas that deserved my attention. In this regard I will mention in particular Karl Turekian, John Rosenfeld, Joe Skulan, Ken Sims, Peter Zeitler, Mark Jellinek, Matt Fantle, and Kate Maher.

And one other thing...the bartender must have known me in another context.

—**Donald J. DePaolo,** *University of California, Berkeley, Calif.*

Christopher B. Field Receives 2014 Roger Revelle Medal

Christopher B. Field was awarded the 2014 Roger Revelle Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding contributions in atmospheric sciences, atmosphere-ocean coupling, atmosphere-land coupling, biogeochemical cycles, climate, or related aspects of the Earth system."

Christopher B. Field

Citation

Chris Field always seems a step ahead. Like a premier athlete, he uses talent and vision to make success look easy, and his 30+ years of insights into the climate system have helped improve both monitoring and prediction. These contributions, and his integrity, have earned him a reputation as scientist, mentor, and public liaison that is worthy of the great Roger Revelle.

It began with Chris's Ph.D. thesis in 1981 showing how evolution shapes the physiology and ecology of terrestrial ecosystems. He then built on these concepts to develop global models of plant growth and carbon cycling. These models, combined with satellite data, spawned decades of insights into land carbon dynamics, many of which came from the Carnegie Institution's Department of Global Ecology, of which he is the founding director.

Chris is also the faculty director of the Jasper Ridge Biological Preserve at Stanford, where experiments using combinations of carbon dioxide, temperature, moisture, and nitrogen have led to many important results on the ecological impacts of global change and grassland feedbacks to the climate system. His extensive use of both experimental and modeling approaches, spanning many spatial and temporal scales, is extremely rare.

On top of his scientific activities, Chris has been a remarkably, perhaps uniquely, effective and influential communicator of climate science to policy makers and the public. His current role as cochair of the Intergovernmental Panel on Climate Change exemplifies his long-standing commitment to and excellence in representing science in the policy arena.

In any one of these areas, Chris' achievements would represent an impressive career. That he has managed all three at once is a testament to his tremendous intellectual and leadership abilities. And he continues to lead the way into new areas, such as understanding impacts of large-scale solar and bioenergy systems.

For all of these laurels, many are surprised upon meeting Chris to find such a humble person. He is generous with his time to all comers and listens more than he speaks. On a scatterplot of intellectual horsepower versus genuine humility, Chris is an outlier in the top right corner. At first I viewed this as a happy coincidence, but over the years I have come to recognize his humility as a source of his greatness. He never stops learning or thinking about the next opportunity to contribute to science and society. I am one of many colleagues who are inspired by the example he has set, who admire him as a scientist and person, and who are overjoyed to see him recognized by AGU with the Revelle Medal.

—**David Lobell,** *Stanford University, Stanford, Calif.*

Response

I'm deeply grateful to David Lobell and AGU. It is both humbling and energizing to share recognition as a recipient of the Roger Revelle Medal with the distinguished past recipients. It is also inspiring to reflect on the ways Revelle thought about science and society.

In the sweep of history, there are a few points when trajectories change and the shape of the future is determined. The late 20th and early 21st centuries are surely a global inflection point, as increasingly numerous and capable humans and human societies confront intrinsic limits in the Earth and its ability to absorb the consequences of our activities. Roger Revelle played a key role in documenting and understanding the fundamental importance not only of the characteristics of the Earth system but also of the necessary responses.

Understanding the controls on Earth's climate is one of the scientific triumphs of our era. The basics are well established, but the system is complex. The aspects that fascinate me are similar to those that fascinated Revelle, the processes that can amplify or suppress the initial changes. A system this complex demands a highly integrated approach—that is why I have invested so much in the discipline of global ecology, in careful scientific assessments, particularly those of the Intergovernmental Panel on Climate Change (IPCC), and, like Revelle, in institutions as well as experiments.

Personally, I have had the great good fortune of working in a community that is wise, supportive, and generous. Colleagues at Carnegie, especially Joe Berry, Olle Björkman, and Winslow Briggs, always proved with their own lives that science should be fun as well as important. They and many Stanford colleagues, notably Hal Mooney, Paul Ehrlich, and Steve Schneider, inspired me to think about science as a human as well as a technical endeavor. Alexander von Humboldt wrote that the key to his success was tackling an overly broad set of scientific interests, capitalizing on a gift for identifying and nurturing new talent. Whether or not that was really the secret for Humboldt, it has definitely worked for me. I have been inspired by many students, postdocs, and young colleagues, as well as hundreds of collaborators in the IPCC. Their brilliance transforms half-baked ideas into important results. Most important, my family, especially my wife, Nona, has shared and shaped my entire scientific adventure. This Roger Revelle Medal should recognize them all.

—**Christopher Field,** *Carnegie Institute of Science, Stanford, Calif.*

Thorne Lay Receives 2014 Inge Lehmann Medal

Thorne Lay was awarded the 2014 Inge Lehmann Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding contributions to the understanding of the structure, composition, and dynamics of the Earth's mantle and core."

Thorne Lay

Citation

Thorne Lay has made contributions to our knowledge and understanding of deep Earth structure that have had an exceptional multidisciplinary impact, as have his contributions to the study of earthquakes.

As a graduate student with Don Helmberger in the early 1980s, his discovery of the discontinuity at the top of the *D″* region in the lowermost mantle, now sometimes called the "Lay" discontinuity, attracted the attention of the community to a region of the mantle that previously had been somewhat neglected. At the time, this was quite an achievement, using for the most part analog, noisy data from a not-so-large global seismic network. These observations have since been confirmed by many independent studies. Perhaps most importantly, they have inspired the mineral physics community, culminating in the discovery, 10 years ago, of the postperovskite (pPv) transition in magnesium at pressures and temperatures corresponding to those in the vicinity of Earth's core-mantle boundary.

Since then, Thorne has been at the forefront of intellectual efforts to characterize the consequences of these findings for the interpretation of complexities in the seismic structure at the base of the mantle, such as the possible double occurrence of the pPv, folded slabs, and partial melting at the base of the mantle.

Even before the pPv transition "explosion," Thorne and his students, postdocs, and collaborators continued over the years to document lateral variations in the *D″* discontinuity as well as other complexities, such as seismic anisotropy and velocity gradients. He largely contributed to the development of the broad picture that we now have of the fine-scale structure of the *D″* region.

So far, I've only described one aspect of Thorne's research, the one most relevant to the "theme" of the Inge Lehmann Medal. I also wish to mention his important contributions to the question of howmegaearthquake ruptures develop on the rupture plane. Starting as a graduate student with the development of the "asperity" model with Hiroo Kanamori, he has picked up this question very actively in recent years, taking advantage of the newly available high-quality seismic broadband array data, which have coincided with the occurrence of several megaearthquakes in the last decade, and he has often been among the first to document their unusual rupture behaviors.

Finally, it is important to stress Thorne Lay's community leadership, as manifested by his role in the Incorporated Research Institutions for Seismology and his endless dedication as a spokesman for the solid Earth community, where we often rely on his clear and articulate thinking.

—**Barbara Romanowicz,** *University of California, Berkeley, and Collège de France, Paris, France*

Response

Thank you, Barbara, for the generous citation and for working with other colleagues to advance my nomination for the Lehmann Medal. I am very aware that recognition like this stems from the efforts of many folks, and it is humbling and deeply satisfying to be selected as a contributor to our understanding of the deep Earth.

I first became an AGU member in 1978, and it is remarkable to recall the limited state of understanding of the vast region of the lower mantle at that time. Seismic velocity models and associated geodynamical and mineralogical interpretations were not dramatically different from those available in the days of Inge Lehmann's seminal work on the inner core. The accumulation of analog recordings by the worldwide standardized seismological network and advances in numerical methods for computing seismic waves for one-dimensional Earth models had set the stage for moving forward, but few seismologists were working on deep-mantle problems. Indeed, my own work with Don Helmberger was initially focused on quantifying upper mantle lateral variations, and when we first advanced interpretations of deep-mantle discontinuity structure, the general response by the few who cared was rather dismissive skepticism.

Fast-forwarding to today, progress has been dazzling, with a large and vigorous international interdisciplinary research community advancing the frontiers of our knowledge. This is reflected in a proliferation of unpronounceable acronyms like LLSVP (large low-shear velocity provinces), ULVZ (ultralow velocity zones), and pPv (postperovskite) and the integrated efforts by organizations like SEDI (Study of the Earth's Deep Interior) to understand the detailed chemistry, transport properties, and evolution of the deep mantle and core. Topics such as deep-mantle anisotropy, barely suggested in work preceding 1978, now engage joint seismological, geodynamical, and mineralogical modeling efforts that build upon state-of-the-art capabilities of different disciplinary efforts.

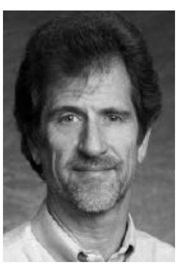
Our understanding of the deep mantle and core is now sophisticated, but great uncertainties and challenges remain; I am sure that the next generation of results will revise some of our current paradigms, and hopefully, it will provide new acronyms that are easier to say.

I've been very fortunate to work on seismology of the deep mantle and core with wonderful mentors, colleagues, and graduate students, along with receiving institutional support from great programs at the California Institute of Technology (Caltech), the University of Michigan, and the University of California, Santa Cruz. This recognition is shared among us all, and I deeply appreciate the many collaborations.

—**Thorne Lay,** *University of California, Santa Cruz, Calif.*

Paul Segall Receives 2014 Charles A. Whitten Medal

Paul Segall was awarded the 2014 Charles A. Whitten Medal at the AGU Fall Meeting Honors Ceremony, held on 17 December 2014 in San Francisco, Calif. The medal is for "outstanding achievement in research on the form and dynamics of the Earth and planets."



Paul Segall

Citation

Paul Segall has contributed to observation, theory, and modeling of earthquake and volcanic processes inferred from surface geodetic measurements. Many practitioners in these fields, including past Whitten medalists, have had an impact on one of these specialist areas. His research on the earthquake deformation cycle has led to new kinematic and dynamical models and analysis methods that extract maximum information from space geodetic data and has shed new light on previously poorly understood earthquake processes. His work has quantified and constrained how volcanoes grow, evolve, and deform, and he has made state-of-the-art space geodetic measurements using models he has himself defined and developed from fundamental principles. Paul has made major contributions in all of them, his work defines where these fields are going, and Paul is their preeminent leader. Since 1990 he has trained a generation of graduate students and postdoctoral scholars, many of whom are now leaders in their fields in academia and government laboratories. His 2010 textbook *Earthquake and Volcano Deformation,* developed and refined over a decade of teaching, has become an instant classic, an essential reference for all researchers in this field.

Since the mid-1980s, Paul has led his field in modeling and understanding the earthquake cycle, its analysis, and state-of-the-art modeling of seismic processes. From the mid-1980s to the mid-2000s, he tested the prevailing models of earthquake recurrence. Paul and his coworkers developed creative and innovative methods entirely new to the field. These methods were strictly rigorous inversions and statistically defensible methods that showed the recurrence of earthquakes obeyed neither of the popular and prevailing models in use at the time (characteristic, time predictable and slip predictable).

Paul recognized early on significant methodological gaps in analysis of earthquake-related geodetic data. He developed ingenious new methods to extract maximum signal from sparse or incomplete data when the actual candidate models were at least approximately known (the now classic network inversion filter). The method is extremely flexible and versatile and is applicable to classical triangulation data to infer coseismic slip in historical earthquakes as well as to identify anomalies in GPS time series (for example, slow slip events or suspected earthquake precursors).

Paul and his students have developed geodetic methods to innovatively model the large-scale kinematics and dynamics of magmatic extension and intrusion, particularly on Hawaii. This work has shown not only that the south flank of the island is inexorably sliding toward the sea but also that it is driven by magma injection into the rift zones. Previously unknown silent slip events, associated with smaller triggered earthquakes and coupled to the injection events, have been identified.

—**Wayne Thatcher,** *Earthquake Science Center, U.S. Geological Survey, Menlo Park, Calif*

Response

Thank you, Wayne, for the overly generous citation. Thanks also to those who took the time to support my nomination. It's a particular honor for me to receive this award given the phenomenal group of prior medalists, including my former U.S. Geological Survey (USGS) colleagues Wayne Thatcher and Jim Savage. Charles Whitten himself was the chief geodesist of the U.S. Coast and Geodetic Survey, following in the footsteps of William Bowie and John Hayford. Hayford analyzed the triangulation data following the 1906 San Francisco earthquake, leading to H. F. Reid's elastic rebound theory. Much later, I had the opportunity to reanalyze these same data, attempting to tease out more information about the 1906 quake, as well as the 1868 Hayward Fault earthquake.

I entered graduate school in 1976 at a time of great anticipation about earthquake prediction and was excited to work on problems with such potential for societal benefit. At Stanford, Arvid Johnson captured my interest and wisely directed me to work with Dave Pollard studying the formation of faults in granite. Following my Ph.D. work, I moved to USGS, where I was impressed with Jim Savage and Will Prescott's crustal strain program. Following in Whitten's footsteps, they were measuring strain accumulation on faults, but now with lasers. This struck me as providing unique information for long-term earthquake forecasting and tied in well with my interest in continuum mechanical models of earthquakes. They generously allowed me to work on data from the Parkfield area, beginning my exploration of tectonic geodesy.

Moving back to Stanford gave me the opportunity to work with an amazing group of students and postdocs. Thanks to all of you for helping me explore new Earth processes and learn new analysis methods. I continue to believe strongly that measurements of contemporary deformation, combined with physically consistent models, can contribute to reducing both earthquake and volcanic hazards. GPS and, later, interferometric synthetic aperture radar opened up new opportunities for data collection. What started as an attempt to write lecture notes of sufficient clarity that I could understand them 2 years later led to a textbook on active deformation processes. It's a real pleasure when students tell me they have found it to be useful.

I'm so fortunate to have the opportunity to work with such outstanding colleagues. Coteaching with Greg Beroza has been both rewarding and informative. Jim Rice has been a generous collaborator and a role model of a scientist and teacher. Thanks, finally, to my friends, including my cycling buddies, and my family and most especially to my wife, Joan, for keeping me grounded.

—**Paul Segal,** *Stanford University, Stanford, Calif.*

Katerina Michaelides

Hillslopes are an important contributor of sediment to valley floors in dryland basins.

Hillslopes Regulate Sediment Supply to River Channels

Sediment that erodes off hillslopes and enters rivers plays a key role in the short- and long-term evolution of river basins. In dryland environments dominated by surface runoff on hillslopes, it is challenging to determine or observe the impact of hillslope sediment supply to rivers because of the episodic and variable nature of erosion driven by rainstorms.

Michaelides and Singer investigate the dynamics of runoff-driven hillslope erosion in a dryland basin dominated by brief, high-intensity rainstorms where sediment moves infrequently. The researchers found that the amount and size of sediment delivered from hillslopes to the valley floor depend on interactions between hillslope angle and length and the intensity and duration of the rainstorm.

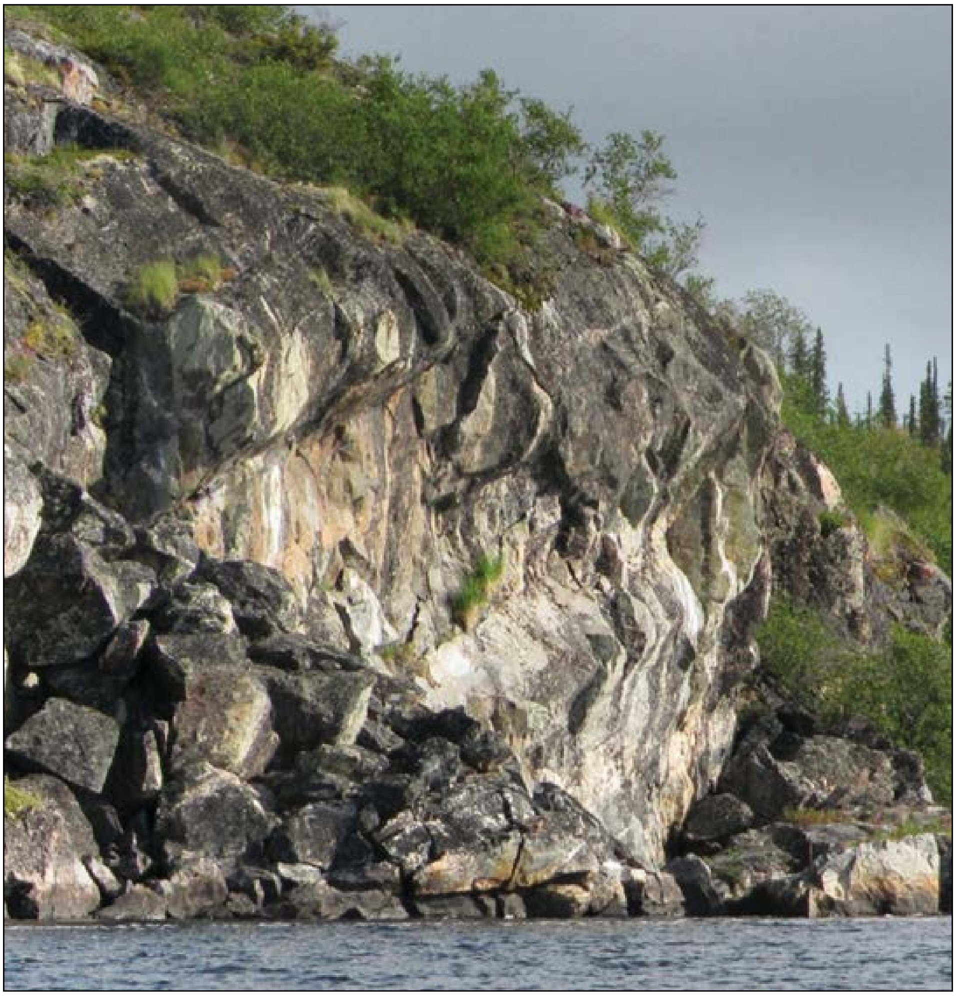
The researchers combined field measurements with numerical modeling to investigate how rainstorms produce runoff and erosion on hillslopes within a dryland basin situated in southeast Spain. They discovered that long slopes, in particular, were more sensitive to storm runoff and produced highly variable mass and sediment sizes in different rainstorms. Moreover, runoff during typically short storms produces sediment redistribution within hillslopes before being delivered to the river channel, resulting in grain size–selective sediment contributions to the valley floor. These findings have implications for the interpretation of basin-wide erosion rates derived from cosmogenic radionuclides.

After taking measurements of topography and sediment grain sizes on hillslopes and in the river channel at 29 valley cross sections and modeling various rainstorms over the basin, the researchers discovered a relationship between the grain sizes on the hillslope and in the river channel. Specifically, the results suggest that the larger sediments measured in the river bed, which are assumed to constitute the hydraulic roughness in the channel, are likely derived from the median sediment sizes eroded off the hillslope.

This discovery suggests that hillslope erosion in dryland environments is the primary contributor to characteristic channel roughness.

The results of this study have implications for understanding the long-term evolution of dryland basins. *(Journal of Geophysical Research: Earth Surface,* doi:10.1002/2013JF002959, 2014) **—Jessica Orwig, Freelance Writer**

Archean Rocks in the Acasta Gneiss Complex



Outcrop of dark tonalitic gneisses near the discovery locality of the Acasta Gneiss Complex in the Northwest Territories of Canada. This picture shows the sample locality for Acasta_AG09008. Field of view is approximately 10 meters across.

The Acasta Gneiss Complex, located at the Slave Craton in the Northwest Territories of Canada, contains 3.9-billion-year-old Archean rocks that, according to *Roth et al.*, can be explained by crust extraction during the first few hundred million years after Earth formed and by relatively slow recycling of Earth's crust.

The researchers collected multiple samples of two types of Archean rocks: 11 granitoid gneisses and 2 hornblende-plagioclase schists. Using a mass spectrometer at ETH Zurich, they measured the concentrations of the elements samarium and neodymium (Nd) in each rock and also examined Nd isotope ratios.

Their results indicate a deficit of a particular Nd isotope called ^{142}Nd—this is the first time anyone has discovered this type of deficiency in gneiss rock from the Acasta Gneiss Complex. Their discovery suggests that the reservoir from which the samples came formed early during Hadean times, about 4.3 billion years ago.

From this result, the researchers conclude that their study site developed soon after Earth formed through slow recycling of Earth's young crust into the lower mantle and crust extraction. Their explanation is compatible with the existence of plate tectonics throughout most of Earth's history. *(Geochemistry, Geophysics, Geosystems*, doi:10.1002/ 2014GC005313, 2014) **—Jessica Orwig, Freelance Writer**

Isotopes in Ancient Corals Offer a Record of Past Ocean Variability

Ancient corals off the coast of New England, collected a kilometer or two underwater, reveal that rapid shifts in ocean circulation occurred as glaciers receded and the planet moved out of the last ice age. *Wilson et al.* determined this information using neodymium (Nd) isotopes measured in samples of fossil coral collected by the deep-sea submersible *Alvin*.

In the modern Atlantic Ocean, warm Gulf Stream waters flow northward at shallow depths, whereas cold waters sink around Greenland and Iceland and flow southward at great depths. Measurements of Nd isotopes recorded in fossil corals dated to 15,000 to 16,000 years ago reveal that this picture was not always so simple.

Waters formed around Antarctica bathed the deepest Atlantic at that time, and the corals witnessed a complex interplay between water coming from both the north and south polar regions. Significant shifts in Nd isotopes occurred over time periods as short as 100 years, within the lifetimes of individual corals in some cases, indicating a highly dynamic ocean.

The authors also noted that deep-sea corals offer a unique and detailed archive of the ancient ocean on submillennial to centennial timescales. This information can be exploited to learn about the ocean's role in transitions between cold and warm climate states. *(Paleoceanography*, doi:10.1002/2014PA002674, 2014)

—Shannon Palus, Freelance Writer

Fossil deep-sea coral Desmophyllum dianthus collected from the New England Seamounts and analysed to reconstruct past ocean chemistry.

Bubbles as a Possible Mechanism Behind Magnetic Substorms

The Earth's magnetic field extends out into space, influencing charged particles in a region known as the magnetosphere. The magnetosphere is short and squat on the side of Earth that faces the Sun—the dayside—but it has a long tail extending away from the star on the nightside. This magnetotail is shaped by the powerful force of the solar wind, and huge amounts of plasma flow within it. On Earth, we see the effects of this flow in the dazzling lights of the auroras.

Dramatic bursts of energy in the magnetotail, known as substorms, cause the aurora to flicker and dance when they send ions tumbling earthward, but their cause has long remained a mystery. Now *Pritchett et al.* propose that substorms may arise from the properties of Earth-sized "bubbles" of low-density plasma that ride magnetic field lines through the magnetotail toward Earth.

Using a computer model that simulates how charged particles behave in magnetic fields, the researchers show that these bubbles preferentially form in parts of the magnetotail where entropy decreases with distance from the Earth. The properties of these bubbles and the "auroral streamers" they send earthward change as they move through the magnetic field. Eventually, these changes trigger a full-blown substorm, disrupting the structure of the aurora.

The researchers' model helps explain the link between the magnetic perturbations that seem to accompany substorms and auroral streamers. Their predictions also match observations of the structure and behavior of auroral streamers made by NASA's Time History of Events and Macroscale Interactions during Substorms (THEMIS) suite of satellites. (*Journal of Geophysical Research: Space Physics*, doi:10.1002/2014JA019890, 2014) **—Julia Rosen, Freelance Writer**

Southwest's Four Corners Home to Largest U.S. Methane Signal

To better understand sources of emission of methane, which is a more potent greenhouse gas than carbon dioxide (CO_2), climatologists are seeking a catalog of the planet's entire methane budget. As part of that effort, *Kort et al.* looked at significant methane sources using satellite imagery of the United States from the Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (SCIAMACHY), a spectrometer on the European Space Agency's Envisat satellite.

Barb Richman

They found that America's largest methane signal comes from the Southwest's Four Corners region. The spectrometer recorded a vast but previously undetected spot over the region that was visible in the data back to 2003, the team says. Previous studies that lacked observations in the region had indicated that emissions should be lower in the Four Corners region.

However, the researchers' observations agree with those made by instruments on the ground. The Four Corners region is the largest coal bed methane production site in the United States. That activity is likely an important contributor to the high methane signal. It is possible that emissions from these sources are underestimated more broadly.

The team says that the Four Corners emissions they observed would make up roughly 5% of total U.S. methane emissions from natural gas, coal mining, and petroleum extraction combined. Past studies have shown that the region's coal power plants are already among the top emitters of CO_2 in the country. This work demonstrates that space-basedobservations can play an important role in locating and quantifying regions with surprising methane emissions. (*Geophysical Research Letters*, doi:10.1002/2014GL061503, 2014) **—Eric O. Betz, Freelance Writer**

Estimates of Anthropogenic Nitrogen in the Ocean May Be High

Inundation of nitrogen into the atmosphere and terrestrial environments, through fossil fuel combustion and extensive fertilization, has risen tenfold since preindustrial times. Excess nitrogen can infiltrate water tables and can trigger extensive algal blooms that deplete aquatic environments of oxygen, among other damaging effects.

Although scientists have extensively studied the effects of excess nitrogen in terrestrial habitats, the effect on the open ocean remains unknown. *Altieri et al.* point out that it is incredibly important to understand where excess nitrogen is ending up so that scientists can better quantify the human impact on the Earth's biogeochemical processes.

To investigate the origin of nitrogen that reaches the open ocean, the authors analyzed rain samples from Bermuda. They specifically looked at the different isotopes of nitrogen found in the rainwater's ammonium molecules, which indicate whether the nitrogen originated from anthropogenic sources, from land, or from the ocean.

Using a model that described sources and sinks of the nitrogen, the authors found that certain nitrogen isotopes likely represent ammonium recycled from the ocean rather than ammonium inputted from an external source, such as pollution from human activities. The authors note that although these findings imply that the anthropogenic contribution of ammonium to the open ocean could be smaller than previously thought, further research is needed on a larger scale to fully understand nitrogen transfer in the marine atmosphere. (*Global Biogeochemical Cycles*, doi:10.1002/2014GB004809, 2014)
—JoAnna Wendel, Staff Writer

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POSITIONS AVAILABLE

Atmospheric Sciences

Aerosol Researcher in Atmospheric Processes and Chemistry at Princeton University

The Atmospheric and Oceanic Sciences Program at Princeton University in cooperation with NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) seeks a postdoctoral fellow to develop and apply satellite based dust emission parametrization to improve our understanding of dust effects on climate and air quality, with a particular focus on anthropogenic contribution. Topics of particular interest include: statistical methods of parameter estimation, analysis of satellite aerosol products, advancing numerical representation of chemical and optical properties of dust, modeling heterogeneous reactions on aerosol surface, modeling aerosol interactions with radiation and cloud properties. Personnel will join an active group at Princeton and GFDL conducting research to advance the fundamental understanding of atmospheric and land processes in governing climate variability and change (http://www.gfdl.noaa.gov/atmospheric-processes). We are seeking candidates with quantitative, interdisciplinary knowledge from subsets of fields including aerosol modeling, statistical analysis, and atmospheric chemistry. Experience analyzing large data sets and/or model output is also critical, as is model development experience. These are two-year positions (subject to renewal after the first year) based at GFDL in Princeton, New Jersey. Complete applications, including a CV, publication list, contact information for 3 references, who will be contacted automatically in order to solicit letters of recommendation, and a one-to-two page statement of research interests should be submitted by February 28, 2015 for full consideration, though evaluation will be ongoing. Applicants should apply online to http://jobs.princeton.edu, Requisition # 1400940. For additional information, please contact Paul Ginoux (paul.ginoux@noaa.gov). This position is subject to the University's background check policy. Princeton University is an equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability status, protected veteran status, or any other characteristic protected by law.

The Foster and Coco Stanback Postdoctoral Fellowship

The California Institute of Technology invites applications for a postdoctoral fellowship in global environmental science beginning in

ASSISTANT OR ASSOCIATE PROFESSOR, DEPARTMENT OF ATMOSPHERIC SCIENCE

The University of Alabama in Huntsville

The Department of Atmospheric Science at the University of Alabama in Huntsville (UAH) seeks applicants for an assistant or associate professor faculty position. The successful candidate will be asked to enthusiastically contribute to the Department of Atmospheric Science includng the B.S. and M.S. in Earth System Science (ESS) and M.S. and Ph.D. in Atmospheric Science. Responsibilities of the professor will include teaching graduate and undergraduate courses and providing effective service to the University and the larger community while also enhancing their own highly dynamic and growing research program through submission of peer reviewed proposals and papers.

Candidates should have an emerging or established, vibrant research program that can respond to evolving funding opportunities. The candidate's research program should complement and enhance the existing strengths of departmental research in the physics, chemistry, and dynamics of the atmospheric or Earth surface system. Experience in one or more of the department's core research areas such as satellite remote sensing of atmospheric constituents or water resources, modeling/data assimilation, ground-based remote sensing, or GIS and remote sensing is desired (http://www.uah.edu/science/departments/atmospheric-science/research).

This successful candidate will benefit from potential collaborations within a wide array of nationally and internationally recognized research and operational organizations hosted at the National Space Science and Technology Center (NSSTC), including NASA Marshall Space Flight Center's Earth Science Office, the co located Huntsville National Weather Service Forecast Office, the Earth System Science Center (ESSC), and the Severe Weather Institute and Radar & Lightning Laboratories (SWIRLL).

Applicants must have a Ph.D. in Atmospheric or Earth Science or related field. To be considered at the associate professor level, applicants should have at least 3 years of experience with demonstrated success in securing research grants and contracts, a community recognized record of scholarship, and teaching experience at the undergraduate or graduate level. Candidates at the assistant professor level should have a developing record of scholarship and teaching experience and demonstrate significant future promise in securing research funding. The chosen candidate will be offered a highly competitive salary and start-up package, and have full access to high-quality research space, state-of-the-art instrumentation and observational datasets, as well as to computing and facilities in academic and research center units.

Required application materials include curriculum vitae, names of four references and statements of teaching and research philosophies. The candidate must also outline how their scientific skills will enhance the department's ongoing research, teaching and outreach activities. Email the application material to chair@nsstc.uah.edu. Please contact Dr. Larry D. Carey, Interim Chair of the Atmospheric Science Department at the University of Alabama in Huntsville for further information (chair@nsstc.uah.edu). Information about the department can be found at: http://www.nsstc.uah.edu/atmos/.

Review of applications will begin on 26 January 2015 and continue until the position is filled.

The University of Alabama in Huntsville is an affirmative action / equal opportunity employer of minorities / females / veterans / disabled . Please refer to log number 15/16-566 fall 2015. The fellowship is funded by an endowment provided by Foster and Coco Stanback. It carries an annual stipend of $61,000 plus a research expense fund of $5,000 and one-way travel costs to Pasadena. The duration of each appointment is normally two years, contingent upon completion of the Ph.D. degree and good progress in the first year. Fellows are eligible to participate in Caltech's benefit programs, including health and dental plans.

This fellowship has been established to support the research of scientists typically within two years after receipt of the Ph.D. The intent of the program is to identify and support innovative and creative work in global environmental science, including areas such as biogeochemistry, glaciology, paleo-climatology, and the atmosphere and ocean sciences. It is expected that each fellowship recipient be hosted by one or more professors, who will provide mentorship and additional financial support.

For fellowship details and to apply online, please visit: www.gps.caltech.edu/content/postdoctoral-positions. Materials in support of an application should include curriculum vitae, list of publications, a one-page statement of research interests, and three letters of reference. All applications and references are due by Friday, January 30, 2015.

Caltech is an equal employment opportunity and affirmative action employer and will, whenever possible, actively recruit and include for employment members of underrepresented minority groups, females, disabled veterans, other eligible veterans, and otherwise qualified persons with disabilities. Caltech will hire, transfer, and promote based on the qualifications of the individual to ensure equal consideration and fair treatment of all. Caltech is a VEVRAA Federal Contractor.

Hydrology

THE UNIVERSITY OF TEXAS AT SAN ANTONIO DEPARTMENT OF GEOLOGICAL SCIENCES ENDOWED DISTINGUISHED PROFESSORSHIP IN HYDROGEOLOGY

The University of Texas at San Antonio (UTSA) seeks applications from senior scholars in the field of Hydrology to fill a tenured position at the Professor or Associate Professor level, subject to qualifications, to begin Fall 2015 in the Department of Geological Sciences. The successful candidate will be awarded the Dr. Weldon W. Hammond, Jr. Endowed Distinguished Professorship in Hydrogeology. Read more about the endowed chair at http://www.utsa.edu/geosci/pdf/wwh_endowment_brief.pdf. Information on the geoscience program and details on what to include in an application can be viewed at http://www.utsa.edu/geosci/positions.html. Review of completed applications will begin February 5, 2015 and continue until the position is filled. UTSA is an AA/EEO employer.

Ocean Sciences

Faculty Positions in the Department of Geological Oceanography? Xiamen University, China

Xiamen University (XMU) is located in the city of Xiamen, a "garden on the sea" in southern China, and has established a new Department of Geological Oceanography as part of the College of Ocean and Earth Sciences (http://coe.xmu.edu.cn/) that offers undergraduate and graduate degrees. The college is one of the top oceanographic programs in China. We are also building a 3600-ton (78 m) research vessel and a marine station for cutting-edge education and research in oceanography. XMU envisions the development of a world-class program in Geological Oceanography with focus on interdisciplinary studies of sediment processes and the sedimentary record in China's unique marginal seas.

POSITION ONE: HEAD OF DEPARTMENT

We are seeking applications from international scientists for the position of the head of the department. The search will remain open until the position is filled.

Duties:

1. Be in charge of the organization and general operation of the Geological Oceanography Department, formulating and implementing the strategy in the development of the Geological Oceanography discipline, and leading the Department towards growth and excellence.

2. Be responsible for building up a strong teaching and research team; and improving the overall academic level of the team in such efforts as devising a long-term team-building plan, recruiting high-level talents, cultivating young researchers and enhancing teamwork.

3. Explore new approach for talent cultivation and nurture talents with creative thinking.

Qualifications:

1. The applicant should hold a doctoral degree and a full professorship (or an equivalent position) in a prominent overseas university (or research institutes).

2. The candidate may be a specialist in any field related to geological oceanography, including (but not exclusively): sedimentology, sedimentary geochemistry, sediment transport, seismic stratigraphy, sediment acoustics, geotechnology, remote sensing, and numerical modeling of sediment transport and sedimentation.

3. Overseas experience (study or work) is required for this position. The candidate should have international perspective, strategic and creative thinking on the discipline development.

4. The candidate is expected to have distinguished academic credentials and international recognition for his/her achievements in research, scholarship and teaching.

5. The candidate should have a proven record of high-level administrative and leadership experience in a university setting, such as a department, a research institute or a laboratory, and will be able to take charge of teaching, research, team-building, discipline development, social services and administration.

Salary and Benefits:

1. Contract term: 4 years;

2. Annual Salary: 600K-900K RMB (1 US$~ 6.18 CYN) ;

3. Other benefits and issues can be negotiated.

POSITION TWO: FACULTY MEMBERS

We are seeking applications from international scientists for up to

UF | UNIVERSITY of FLORIDA

UF Water Institute
Graduate Fellows Program

We are seeking applicants for 6 Ph.D. Fellows to join an interdisciplinary team working on the impacts of hydroelectric dams in the Amazon. The 4-year fellowships include an annual stipend, tuition waiver and health insurance. The student/faculty teams will have shared interests, but distinct disciplinary backgrounds (geography, forestry, fisheries, and environmental engineering). For details and online application, visit http://waterinstitute.ufl.edu/WIGF or contact Dr. Wendy Graham, Director of the UF Water Institute at wgraham@ufl.edu.

Applications are due by 1/23/2015.

Department of Geosciences
PRINCETON UNIVERSITY

HARRY HESS FELLOWS PROGRAM

The Department of Geosciences at Princeton University announces competition for the **2015-2016 Harry Hess Fellows Program**. This honorific postdoctoral fellowship program provides opportunities for outstanding geoscientists to work in the field of their choice. Research may be carried out independently or in collaboration with members of the Geosciences Department. One or more Hess Fellows may be appointed. Applicants must have obtained a Ph.D. at the time of the start of the fellowship, but not more than five years before. Current areas of research include:

- Biogeochemical Cycles
- Environmental Chemistry
- Geochemistry
- Geodynamics
- Geomicrobiology
- Mineral Physics
- Oceanography
- Paleoclimatology
- Paleontology
- Petrology
- Seismology
- Tectonics
- Atmospheric Science
- Planetary Science

Applications are due before February 1st, 2015, but will continue to be accepted until the available positions are filled. Evaluation of applications and interviews of candidates will begin immediately. Applicants should include a cover letter, a curriculum vitae including a publication list, a 1-2 page statement of research interests and goals, and name, address and email address of three referees familiar with their work by applying on the Princeton University jobsite at https://jobs.princeton.edu. Hess Fellowships provide a competitive annual salary, depending upon experience, along with a significant allowance for travel to meetings and for research support. Initial awards are for one year, with the possibility of renewal for additional years depending upon satisfactory performance and available funding. A preferred starting date is before September 1st, 2015. Applicants for the Hess Fellowship may also be considered for other available postdoctoral positions in the Geosciences Department.

Princeton University is an equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability status, protected veteran status, or any other characteristic protected by law. This position is subject to the University's background check policy.

Information about the research activities of the Department of Geosciences may be viewed at http://www.princeton.edu/geosciences/research.

15 faculty positions. The search will remain open until positions are filled.

Duties:

1. To teach undergraduate and graduate courses in a full English or bi-lingual capacity;

2. Be capable to obtain university and outside funding to establish their own research laboratories and facilities and build a research program of global interests;

3. Be able to participate in research cruises.

Qualifications:

1. Applicants must hold a doctoral degree in any field related to geological oceanography, and be a specialist in any field related to geological oceanography, including (but not exclusively): sedimentology, sedimentary geochemistry, sediment transport, seismic stratigraphy, sediment acoustics, geotechnology, remote sensing, and numerical modeling of sediment transport and sedimentation.

2. The applicants should be able to work across disciplinary boundaries, and have essential qualities for teamwork.

3. The rank of the appointment will be commensurate with the applicant's qualifications and experiences.

Salary and Benefits:

1. Contract term: 3 years for assistant professor; 5 years for associate professor and full professor.

2. The appointment system will be applied to the successful candidates. The selected candidates will receive the standard compensation for the faculty members of Xiamen University at the same rank.

HOW TO APPLY

Interested applicants should send a cover letter indicating the intent of the application (department head or faculty), his/her CV, contact information for 3-5 references, a statement of purpose that includes courses intended to teach and research interests and professional goals, and other supporting materials for the evaluation process to the Dean, Prof. Kejian Wang (wkjian@xmu.edu.cn).

Postdoctoral Research Opportunity.

The Naval Research Laboratory (NRL) is seeking a postdoctoral associate in physical oceanography to expand our understanding of Arctic Ocean dynamics important for increasing the forecast capabilities of the Navy's state-of-the-art coupled ice-ocean and ice-ocean-atmosphere model prediction systems. The candidate will work with NRL researchers in developing new techniques for the assimilation of snow and ice thickness data into the Community Ice Code (CICE) and study Arctic processes with global and relocatable ice-ocean-atmosphere coupled modeling systems. This challenging work requires a broad understanding of physical oceanography and Arctic processes. The selected applicant will work with NRL to study the impact of reduced ice volume in the Arctic using satellite, airborne, and in situ observations with our coupled models. Strong programming skills, especially with MATLAB and FORTRAN, are required. Familiarity with CICE, HYCOM and WaveWatch III models and data assimilation would be beneficial.

The Naval Research Laboratory provides an opportunity to work with a large group of highly skilled and internationally recognized physical oceanographic researchers. We have access to excellent supercomputing and general computational resources in addition to extensive historical and real-time regional and global data sources. For an overview of research projects in the Ocean Dynamics and Prediction branch of the Naval Research Laboratory located at the Stennis Space Center in Mississippi, visit http://www7320.nrlssc.navy.mil/projects.php.

A postdoc will be hired with stipends approximately of $75,621 through the National Research Council (NRC) Research Associateship Programs (RAP; http://sites.nationalacademies.org/pga/rap/), or the American Society for Engineering Education (ASEE; http://www.asee.org/fellowships/nrl) Naval Postdoctoral Programs. NRL is an equal opportunity employer and this position is open to U.S. citizens and foreign nationals with green cards. Interested applicants should contact Mr. Richard Allard (Richard.allard@nrlssc.navy.mil).

Vacancy Announcement

Tenure Track Assistant Professor in Chemical Oceanography

December 2014

The School of Fisheries and Ocean Sciences (SFOS) at the University of Alaska Fairbanks (UAF) seeks applications from exceptional candidates for a tenure-track assistant professor position in chemical oceanography. Specialties of interest include ocean acidification, marine inorganic carbon chemistry, carbon biogeochemistry, carbon cycle-climate interactions, isotope biogeochemistry, and evaluation of the biological impact of ocean acidification. We are particularly interested in applicants whose research plan involves the new ice-capable, Global Class Research Vessel Sikuliaq.

UAF is Alaska's research university, North America's Arctic university and a world leader in Arctic and climate change research. The successful applicant will enjoy opportunities for collaboration within SFOS's vibrant high-latitude research program. The School offers a Minor in marine science, and MS and PhDs in oceanography and in marine biology. The UAF campus houses the Ocean Acidification Research Center (OARC), Alaska Stable Isotope Facility (ASIF), UAF's Advanced Instrumentation Laboratory (AIL), the Core Facility for Nucleic Acid Analysis, and is linked to the joint NOAA, UAF Kasitsna Bay Laboratory, Alaska SeaLife Center and the Seward Marine Center. SFOS has over 60 faculty based throughout Alaska and over 150 graduate students engaged in thesis research in Alaska waters, and throughout the world.

Applicants must hold a Ph.D. in oceanography or closely related discipline, and preferably have post-doctoral and teaching experience. The position requires research, education and service that support Alaska's ocean resources and the communities that rely on them. The successful candidate will be expected to teach core and/or develop specialty oceanography courses for the graduate and undergraduate academic programs, develop a vigorous externally-funded research program and mentor graduate students. Applicants must submit a statement of interest that outlines their qualifications for this position and includes a research plan, teaching statement, curriculum vitae, and names and contact information of at least three references. Applications must be submitted to Job Posting #0069942 at https:// www.uakjobs.com. For questions about the position, please contact Dr. Matthew Wooller, chair of the search committee, at mjwooller@alaska.edu. Review of applications will begin February 15th. For full consideration applications should be received by March 1st, 2015.

Solid Earth Geophysics

Assistant Professor

School of Earth and Climate Sciences

Endowed Professorship: Petrology/Mineralogy/High P-T Geochemistry

The University of Maine invites applications for the newly

CHAIR, DEPARTMENT OF ATMOSPHERIC SCIENCE

The University of Alabama in Huntsville

The Department of Atmospheric Science at the University of Alabama in Huntsville (UAH) seeks applicants for a mid to senior level faculty position who will serve as the Chair of the Atmospheric Science Department. The successful candidate will be asked to enthusiastically lead the Department including the B.S. and M.S. in Earth System Science (ESS) and M.S. and Ph.D. in Atmospheric Science. Responsibilities of the Chair will include coordination of advising activities at the graduate and undergraduate levels, teaching courses and providing effective service to the University and the larger community while also enhancing their own highly dynamic and growing research program through submission of peer reviewed proposals and papers.

The Chair will be privileged with maintaining and enhancing collaboration amongst the wide array of research and operational organizations hosted within the National Space Science and Technology Center (NSSTC), including NASA Marshall Space Flight Center's Earth Science Office, the Huntsville National Weather Service Forecast Office, the Earth System Science Center (ESSC), and the Severe Weather Institute and Radar & Lightning Laboratories (SWIRLL).

Candidates should have an established, vibrant research program that can respond to the changing research landscape, while being visionary of forthcoming opportunities over the coming decade. The candidate's research program should complement and enhance the existing strengths of departmental research in the physics, chemistry, and dynamics of the atmospheric or Earth surface system. Experience in one or more of the department's core research areas such as satellite remote sensing, modeling/data assimilation, ground-based remote sensing, or GIS and remote sensing is desired.

Applicants must have a Ph.D. in Atmospheric or Earth Science or related field, at least 5 years of experience with demonstrated success in securing research grants and contracts, a community recognized record of scholarship and leadership, and teaching experience at the graduate level. The chosen candidate will be offered a highly competitive salary and start-up package, and have full access to high quality research space and state-of-the-art instrumentation, observational datasets and computing facilities.

Required application materials include curriculum vitae, names of four references and statements of teaching, research and leadership philosophies. The candidate must also outline how their scientific and organizational leadership skills will enhance the department's ongoing research, teaching and outreach activities. Email the application material to chair@nsstc.uah.edu. For additional information, contact Dr. Larry D. Carey, Interim Chair of the UAH Department of Atmospheric Science (chair@nsstc.uah.edu) or visit http://www.nsstc.uah.edu/atmos.

Review of applications is ongoing and will continue until the position is filled. Applications should be submitted by 26 January 2015 to recieve full consideration.

The University of Alabama in Huntsville is an affirmative action / equal opportunity employer of minorities / females / veterans / disabled. Please refer to log number 15/16-561 established, endowed Edward Sturgis Grew Professorship in Petrology and Mineralogy in the School of Earth and Climate Sciences. This is a full-time tenure-track position with a focus on igneous and/or metamorphic petrology, geochemistry, and mineralogy. We seek a candidate who will complement the existing strengths in the Geodynamics, Crustal Studies, and Earth Rheology research group. The School of Earth and Climate Sciences has a highly interactive research and teaching environment, with staff-supported microprobe and electron microscopy laboratories. For more information on the School, please visit: http://umaine.edu/earthclimate.

Candidates must have an earned doctorate in the discipline or a closely related field by the date of appointment, a strong research and publication record in their field, and a demonstrated commitment to teaching. Postdoctoral experience is strongly preferred but not required. The position is an academic year appointment with preferred starting date of September 1, 2015. Materials must be submitted online at: https://umaine.hiretouch.com/job-details?jobID=23153. Review of applications will begin December 15, 2015. Please email esgppm@umit.maine.edu with questions about the position.

The University of Maine is an EEO/AA employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, sexual orientation, age, disability, protected veteran status, or any other characteristic protected by law.

Department of Marine, Earth, and Atmospheric Sciences Assistant Professor – Structural Geology and Tectonics

NC State University - Raleigh, NC

Founded in 1887, NC State is a land-grant institution distinguished by its exceptional quality of research, teaching, extension, and public service. Located in Raleigh, North Carolina, NC State is the largest university in North Carolina, with more than 34,000 students and 8,000 faculty and staff. National rankings consistently rate Raleigh and its surrounding region among the five best places in the country to live and work, with a highly educated workforce, moderate weather, reasonable cost of living, and a welcoming environment. A collaborative, supportive environment for business and innovation and research collaborations with area universities and the Research Triangle Park are compelling reasons for relocation to the area.

Located within the College of Sciences at NC State, MEAS is one of the largest interdisciplinary geoscience departments in the nation. Opportunities exist for disciplinary and interdisciplinary interactions with more than 30 marine, earth and atmospheric scientists. Additional information about the department and its facilities can be found on the web page: http://www.meas.ncsu.edu. NC State also hosts large programs in geotechnical and construction materials engineering http://www.ce.ncsu.edu, and has recently established the Center for Geospatial Analytics: http://geospatial.ncsu.edu.

The department seeks to fill a tenure-track faculty position at the rank of assistant professor in structural geology and tectonics. Possible research areas include, but are not limited to: rock mechanics, neotectonics, thermochronology, sedimentary basin analysis, plate kinematics and geodesy. Candidates that combine field observations with precision measurement techniques, numerical simulations, analogue models, or laboratory experiments are preferred, and applicants should have a strong interest in interdisciplinary collaborations across and beyond the geosciences.

Position Responsibilities: This position will teach an undergraduate-level course in structural geology, as well as other undergraduate and graduate classes commensurate with the candidate's interest and expertise. An interest in participating in the Department's capstone undergraduate geology field course also is desirable. MEAS places a high value on excellent instruction and the use of innovative teaching methods.

Minimum Education/ Experience: Applicants must hold a Ph.D. degree in the geosciences or a related field, or equivalent professional experience.

Department Required Skills: The successful candidate must demonstrate strong potential for outstanding accomplishments in research, research supervision, and teaching.

Application Instructions: Review of applications will begin on 10 February 2015; the position will remain open until filled. The start date of this position is 15 August 2015. Applications, including cover letters, curriculum vitae, teaching and research statements, and contact information for three references must be submitted online at https://jobs.ncsu.edu/. Please search for position number #00104417. You can also apply directly using the link below:

https://jobs.ncsu.edu/postings/46092

NC State University is an equal opportunity and affirmative action employer. All qualified applicants will receive consideration for employment without regard to race, color, national origin, religion, sex, age, veteran status, or disability. In addition, NC State University welcomes all persons without regard to sexual orientation. Persons with disabilities requiring accommodations in the application and interview process please call (919) 515-5575.

Tenure Track Asst. Professor of Structural Seismology University of California, Riverside Department of Earth Sciences

FACULTY POSITION IN STRUCTURAL SEISMOLOGY

The Department of Earth Sciences at the University of California, Riverside, invites applications for a faculty position in Structural Seismology at the Assistant Professor level, available July 1, 2015.

Research

We seek a seismologist who conducts research into the shallow structure of the Earth. We invite applications from researchers who focus on understanding the seismic structure of the Earth on local, crustal and/or lithospheric scales, using techniques including but not limited to reflection and/or refraction seismology, receiver functions, shear-wave splitting, travel time and/or ambient noise tomography. We are particularly interested in candidates who use these techniques to illuminate fault structures. The successful candidate will be expected to develop a research program complementary to our strengths in theoretical/numerical modeling of earthquakes and fault systems, space geodetic studies of crustal deformation, neotectonics, observational seismology, and experimental and theoretical investigations of rheological properties as they pertain to earthquakes.

Teaching

A successful candidate must have a strong commitment to excellence in both research and teaching. Teaching responsibilities will include undergraduate and graduate courses in or related to the area of specialty.

Application

A Ph.D. in a relevant field and a proven ability to conduct innovative research are required. Interested

TENURED/TENURE-TRACK PROFESSOR
Early Planetary Geological and Geophysical Processes
Department of Earth, Environmental and Planetary Sciences
Brown University

The Department of Earth, Environmental and Planetary Sciences (http://www.brown.edu/academics/earth-environmental-planetary-sciences), Brown University, invites applications for a faculty position in **Early Planetary Geological and Geophysical Processes**. Recent and ongoing missions to the Moon, Mars, Mercury, outer planet satellites and asteroids have produced unprecedented high spatial and spectral resolution data on the nature of ancient planetary crusts and the geological, geodynamic, accretion, differentiation, chemical, biological and atmospheric processes that modify them. These are providing new avenues for research on early planetary history. Candidates with interests in these broad areas are encouraged to apply. Candidates should complement our current planetary science strengths in crustal evolution, volcanism, impact cratering, and remote sensing and departmental focus areas of Earth system history, tectonophysics, and Earth materials and processes.

The successful candidate will maintain an active, externally funded research program and enjoy a commitment to teaching at both undergraduate and graduate levels. Appointment is expected at the Assistant Professor level. However, appointment at a more senior level is possible for exceptional candidates. A Ph.D. degree or equivalent is required. This position will be available as soon as July 1, 2015 but will remain open until filled. Review and evaluation of applications will begin on February 1, 2015.

Applicants should forward a letter of interest, current CV,statements of research and teaching interests, and the names of three references to http://www.interfolio.com/apply/24379. Brown University is an equal opportunity/affirmative action employer. We encourage applications from minority and women scientists.

CIDER
Cooperative Institute for Dynamic Earth Research

2015 CIDER SUMMER PROGRAM –
June 30 – July 31, 2015
"Solid Earth and Climate: Dynamic Interactions with the Hydrosphere and Carbosphere"

CIDER announces their annual summer program on behalf of the geosciences Community (*http://www.deep-earth.org/*). *Organizers:* Meredith Nettles, Terry Plank, Louis Derry and Jeff Freymueller.

The purpose of CIDER 2015 is to bring together scientists from different disciplines to better understand how interactions between the mantle and the major surface reservoirs of water and carbon influence sea level, icesheet dynamics, the volume of the ocean, magma production, the volcanic flux 0f CO2 to the atmosphere, and the loss of carbon via subduction into the mantle. CIDER 2015 will involve cross-disciplinary discussions among geophysicists, geochemists, geodynamicists and paleoclimate scientists. *The program includes a 4 week tutorial program for about 35 advanced graduate students and post-docs, (July 5-31, 2015), while more senior scientists are also welcome at any point in the program.*

A Deep Carbon Observatory Thematic Institute workshop, "Carbon from the Mantle to the Surface" will be held in conjunction with the CIDER program on July 1-3, 2015.

The tutorial program will include lectures and hands-on tutorials. Concurrently, junior and senior scientists will engage in collaborative multidisciplinary research ventures defined on site.

This summer program will be held at the University of California, Berkeley. It is supported by the NSF/FESD program. Applications are invited for both senior and junior participants at:

http://www.deep-earth.org/summer15.shtml
Application deadline: February 1, 2015

individuals should submit a cover letter, curriculum vitae and statements of research and teaching interests online at: https://aprecruit.ucr.edu/apply/JPF00277. The candidate is also required to submit the details of 3-5 referees using the APRecruit system. For additional information, please contact the chair of the search committee, Dr. Gareth Funning: gareth.funning@ucr.edu. Review of applications will begin January 15, 2015 and will continue until the position is filled. Salary will be commensurate with education and experience.

Information about Earth Sciences at UCR is available at http://earthsciences.ucr.edu; information about our Earthquake Processes and Geophysics program can be found at http://ep.ucr.edu. UCR is a core member of the Southern California Earthquake Center.

The University of California, Riverside is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, age, disability, protected veteran status, or any other characteristic protected by law.

Space Physics

Experimental Space Science Faculty Position

The Department of Physics at Montana State University invites applications for a tenure-track Assistant Professor position in the field of Space Sciences, with an emphasis on instrumentation development, to start in the fall of 2015. Candidates with expertise in any area of space sciences are encouraged to apply. This includes, but is not limited to: astro, helio, atmospheric, and planetary physics, utilizing space-based or near-space platforms. For more information and application instructions, please visit: http://jobs.montana.edu/postings/1141

Jovian Magnetic Field and Magnetosphere Postdoctoral Researcher

Applications are now being accepted for a Postdoctoral Research Associate, funded through the University of Maryland College Park (UMCP) and the Center for Research and Exploration in Space Science and Technology (CRESST), to work in the Planetary Magnetospheres Laboratory of the NASA Goddard Space Flight Center (GSFC) in the area of Jupiter's magnetic field and magnetosphere, using data from the Juno (New Frontier) mission. Additional details are available on the AGU Career Center posting or at http://www.astro.umd.edu/employment/#Juno.

The appointment will be initially for one year, with the possibility of renewal in subsequent years. Applicants may be new postdocs or may be more senior. Candidates should have a Ph.D. in a relevant scientific discipline with prior experience conducting scientific research. Experience with magnetometer instrumentation and data, disciplined programming skills (primarily Fortran and IDL), and scientific writing experience are desired.

Each applicant should send a Curriculum Vita, list of publications, statement of research interests, and contact information for three references to:

Juno Magnetometer
CRESST/UMCP
Mail Code 660.8, NASA/GSFC
Greenbelt, MD 20771, or
Via e-mail to virginia.c.peles@nasa.gov

Information regarding the Juno mission is found at http://missionjuno.swri.edu/ and http://www.nasa.gov/mission_pages/juno/main/. For information on CRESST and the UMCP's Department of Astronomy, please contact Tracy Huard (thuard@astro.umd.edu).

The University of Maryland is an Affirmative Action, Equal Opportunity Employer. Women and minorities are encouraged to apply.

Applications will be accepted on an ongoing basis until the position is filled.

Interdisciplinary/Other

A Bloomberg Distinguished Professorship in the broad area of exoplanets and extra-solar planetary science is available at the Johns Hopkins University. This position is one of 50 new Bloomberg Distinguished Professorships designated for outstanding scholars who carry out interdisciplinary research and teaching in areas identified for significant growth at the University. The position will include joint tenure in the Department of Earth and Planetary Sciences and the Department of Physics and Astronomy of the Johns Hopkins Krieger School of Arts and Sciences, and will be at the rank of tenured Associate Professor or Full Professor. The holder of this Bloomberg Distinguished Professorship will participate in research and teaching in both of the above departments. In addition, opportunities exist for collaborations with the Space Telescope Science Institute and the Space Department of the Johns Hopkins Applied Physics Laboratory. Applicants should possess distinguished records of achievement in research in the area of exoplanets, as

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Research Associate and Lecturer Position Landslide Processes Research

The Chair of Engineering Geology at the ETH Zurich is looking for a research associate and lecturer in landslide processes research. The successful candidate must have a Ph.D. or equivalent degree in earth sciences, geotechnical engineering or related field. Excellence in research, experience in experimental data collection, and understanding of hydraulic, mechanical or thermal processes in fractured rocks are of prime importance. A top-level research record related to landslide processes or landslide monitoring is desirable.
The candidate will be expected (1) to contribute to our graduate and/or undergraduate teaching programs, (2) to develop funded research programs addressing formation or hazards of rock slope instabilities, (3) to supervise undergraduate and graduate students and their thesis work, and (4) to develop, maintain and operate landslide monitoring or testing facilities.
The position can be filled in spring or summer 2015 for a period of about 6 years. The Chair of Engineering Geology offers an attractive research environment (in-situ laboratories, rock mechanical lab testing, field investigations in the Alps and other continents) and salary in accordance with ETH standards.
Information about the Chair of Engineering Geology is available at our Web Site www.engineering-geology.ethz.ch. Questions related to the open position can be addressed to Dr. Andrea Wolter or Prof. Dr. Simon Löw, ETH Zurich, Switzerland (e-mail: andrea.wolter@erdw.ethz.ch; simon.loew@erdw.ethz.ch).

Complete applications should be sent to Prof. Dr. Simon Loew, Chair of Engineering Geology, Sonneggstrasse 5, ETH Zürich, 8092 Zürich, Switzerland, and must include the following: 1) cover letter; 2) curriculum vitae, which describes your complete personal details and career history; 3) statement of research interests and; 4) letters of recommendation. Applications should be submitted until January 31, 2015 and will be accepted until the position is filled.

RESEARCH FELLOW (ATMOSPHERIC OBSERVATION SITE)

Young and research-intensive, Nanyang Technological University (NTU Singapore) is the fastest-rising university in the world's Top 50 and ranked 39th globally. NTU is also placed 1st amongst the world's best young universities. The Earth Observatory in Singapore (EOS) at NTU is a national science Research Center of Excellence. Its mission is to conduct fundamental research on earthquakes, volcanic eruptions, tsunami and climate change in and around Southeast Asia, toward safer and more sustainable societies.

We invite applicants for the position of a Research Fellow who will work on our atmospheric observation site.

RESPONSIBILITIES

- Implementation, operation, and maintenance of atmospheric observation instruments, including gas analysers and aerosol instruments
- Analysis of atmospheric observation data
- Actively participating international collaborations
- Publish research output to scientific journals

REQUIREMENTS

- Ph.D degree in atmospheric chemistry or related fields
- Experience with atmospheric observation or laboratory experiments on atmospheric chemistry
- Strong analytical skills
- Independent individual who is creative, self-driven, and highly motivated
- Willing and able to collaborate with team members and international collaborators
- Great written and oral communication
- Excellent proficiency in English

Interested applicants are invited to submit a full CV, including academic qualifications and names and contact details of three referees to **eos_humanresources@ntu.edu.sg**. Selection will commence immediately.

NANYANG TECHNOLOGICAL UNIVERSITY

EARTH OBSERVATORY OF SINGAPORE

well as commitment to the teaching of undergraduate and graduate students compatible with appointment to tenure at the Johns Hopkins University. Applicants should have the ability to provide major scientific and technical leadership at JHU and a demonstrated commitment to cross-disciplinary collaborations.

The Johns Hopkins University is committed to enhancing the diversity of its faculty and encourages applications from women and minorities. Please submit a covering letter with a statement on vision for research and teaching, plus a full curriculum vitae and publication list via Interfolio at apply.interfolio.com/28171. For administrative questions concerning submission of applications, please contact Kristen Gaines at kgaines@jhu.edu or (410) 516-7034. The review of applications will begin immediately; to ensure the fullest consideration, applications should be received by February 1, 2015.

Adam Riess, Department of Physics and Astronomy

Darrell Strobel, Department of Earth and Planetary Sciences

Co-Chairs Search Committee

The Johns Hopkins University

Baltimore, MD 21218

Assistant Professor in Geosciences - Colorado State University

We seek to fill a 9-month tenure-track appointment to strengthen our offerings in Petroleum Geosciences. The preferred start date is August 2015. Requirements are a Ph.D. in geology or a closely related discipline, a strong research record and future potential in geosciences, evidence of research interests that complement and enhance existing departmental strengths, and that catalyze new interdisciplinary directions in the future, and evidence of teaching interests that strengthen the department's offerings in petroleum geosciences and related areas. Preference will be given to candidates with a commitment to geo-education and potential for excellence in teaching, including field education and professional career preparation of undergraduate and graduate students, an interest in research and associated activities related to geosciences hydrocarbon industries, an established or promising peer-reviewed publication record, the ability to obtain and manage external research funding, and the ability to establish strong research and industry partnership programs within the department, college and/or university. The successful applicant is expected to teach at both undergraduate and graduate levels and develop a vigorous externally funded research program supporting graduate students.

To view a complete position description and apply, please visit: http://warnercnr.colostate.edu/employment-opportunities.html by 5:00 pm January 23, 2015.

CSU is an EO/EA/AA employer. CSU conducts background checks on all final candidates.

Associate/Full Professor for Dept. Chair, Earth and Environmental Systems, Indiana State University starting as early as June 1, 2015

The Department of Earth and Environmental Systems at Indiana State University seeks an interdisciplinary scientist, with an environmental focus, at the Associate or Professor level to Chair a recently developed, multidisciplinary Department. Review of applications begins Feb 15, 2015, and remains open until filled, for full consideration apply by March 15, 2015. For more information contact Dr. Kathleen Heath (Kathleen.Heath@indstate.edu) and visit: www.indstate.edu/ees. Candidates must apply at https://jobs.indstate.edu. EOE/Minority/Female/Individual with Disability/Veteran.

CIRES/GMD Research Associate

The Cooperative Institute for Research in Environmental Sciences (CIRES) is seeking a Research Associate to support the NOAA/ESRL/GMD/CCGG Aircraft Project.

This project is part of a larger CCGG program to study the carbon cycle with specific emphasis on understanding the North American continent's carbon budget and identifying and understanding carbon sources and sinks on regional and continental scales.

Duties

"Assist in the acquisition and quality control of in-situ (analysis during flight) and flask (post flight analysis at Boulder Lab) measurements from a network of airborne platforms in North America.

"Interpret the airborne atmospheric data over North America and the surrounding marine regions to better understand the carbon budget of the North American continent and the carbon cycle

"Improve techniques, procedures, and instrumentation used in the network; in particular in-situ measurements of the atmospheric CO_2, CH_4, CO and possibly other species.

"Lead CCGG's effort in development of new instrumentation and measurement techniques for use on regularly scheduled commercial aircraft.

"Implement field campaigns on behalf of CCGG within the framework of the North American Carbon Program

POST-DOCTORAL/RESEARCH FELLOW IN ATMOSPHERIC CHEMISTRY

Young and research-intensive, Nanyang Technological University (NTU Singapore) is the fastest-rising university in the world's Top 50 and ranked 39th globally. NTU is also placed 1st amongst the world's best young universities. The Earth Observatory in Singapore (EOS) at NTU is a national science Research Center of Excellence. Its mission is to conduct fundamental research on earthquakes, volcanic eruptions, tsunami and climate change in and around Southeast Asia, toward safer and more sustainable societies.

We invite applicants for a Research Fellow (post-doctoral) position to join the climate group of the Observatory.

The successful applicant will work on investigating haze in Southeast Asian countries, such as Singapore, by conducting atmospheric observation as well as laboratory experiments, which will focus on chemistry of smoke from smoldering peat fires in Southeast Asia. An aerosol mass spectrometric technique will be employed for the project. Candidates who have expertise in atmospheric chemistry, aerosol chemistry, and aerosol mass spectrometry are highly welcomed.

A Ph.D degree in atmospheric chemistry (or related field) is required. For further details, please email to **eos_humanresources@ntu.edu.sg**.

Interested applicants are invited to submit a full CV, including academic qualifications and names and contact details of three referees to **eos_humanresources@ntu.edu.sg**. Selection will commence immediately.

NANYANG TECHNOLOGICAL UNIVERSITY

EARTH OBSERVATORY OF SINGAPORE

ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Research Associate Position in Deep Geological Waste Disposal

The Chair of Engineering Geology at ETH Zurich invites applications for a research scientist position in the field of deep geological waste disposal. The successful candidate must have a Ph.D. or equivalent degree in earth sciences, geotechnical engineering, or related field. Experience in underground constructions, quantitative analysis of hydro-mechanical behavior of clay-rich formations or thermo-hydro-mechanically coupled processes are of prime importance. Hi-level coordination and communication (both oral and in writing) skills are strongly desired.

The position is funded by a joint research project of the Engineering Geology Chair of ETH and the Swiss Federal Nuclear Safety Inspectorate ENSI. The candidate will lead experimental research projects and support the repository design and site selection process. His/her job profile include (1) participation in the planning and supervision of future research activities related to coupled near-field processes in over-consolidated clay shale host rocks of potential repository sites in Switzerland; (2) supervision of MSc and PhD students; (3) reviews of project documents submitted by the implementer and; (4) contribution to our graduate and/or undergraduate teaching program. The duration of the position is at least 5 years and can be filled by the successful candidate between spring and fall 2015. The project offers an attractive research environment (rock mechanical lab testing, underground rock laboratory experiments, repository site investigations) and salary in accordance with ETH standards.

For further information regarding the advertised position please contact Dr. Florian Amann or Prof. Dr. Simon Löw at ETH Zurich (e-mail: florian.amann@erdw.ethz.ch).

Complete applications should be sent to Prof. Dr. Simon Loew, Chair of Engineering Geology, Sonneggstrasse 5, ETH Zürich, 8092 Zürich, Switzerland, and must include the following: 1) cover letter; 2) curriculum vitae, which describes your complete personal details and career history; 3) statement of research interests and; 4) letters of recommendation. Applications should be submitted until January 31, 2015 and will be accepted until the position is filled.

"Publish papers in peer-reviewed journals and present results at scientific conferences.

Requirements

"PhD in atmospheric physics or chemistry, oceanography, or a related discipline

"Demonstrated experience making high-accuracy measurements of trace gases

"Basic understanding of atmospheric dynamics, particularly boundary layer processes

"Demonstrated ability to analyze and interpret field measurements and to communicate results in a clear fashion to the scientific community via peer-reviewed publications and presentations at scientific meetings

"Demonstrated ability to work in a collaborative environment

Questions regarding the position can be answered by Colm Sweeney at 303-497-4771 or colm.sweeney@noaa.gov.

The position will be filled as a Research Associate at the University of Colorado Boulder and will be eligible for employee benefits, including 22 days of vacation per year (for a 100% position).

To Apply

http://www.jobsatcu.com/postings/92525

Applicants must complete the Faculty/University staff and EEO Data (application) form, and upload the required documents:

1-Resume

2-A cover letter

3-Poof of highest degree earned (copy of diploma or unofficial transcripts)

4-List of three Professional References with all contact information, from whom an official written letter of recommendation will be requested by the hiring unit at the appropriate time during the search.

DIRECTOR NEW MEXICO BUREAU OF GEOLOGY & MINERAL RESOURCES

The New Mexico Bureau of Geology and Mineral Resources, Socorro, NM, is seeking a new director and state geologist. The bureau, with ~60 employees, is a prominent research and service division of New Mexico Tech and serves as the state geological survey, with a long-standing reputation for excellence in research, service, and outreach. Our mission includes research on the geologic framework of the state, with an emphasis on applied geoscience evaluation of water and energy resources. The bureau works closely with the university academic divisions as well as many state agencies. Full details of the position and information regarding application procedures may be found at http://geoinfo.nmt.edu/DirectorSearch and at www.nmt.edu/hr-jobs-at-nmt. For more information about the application process, contact JoAnn Salome in Human Resources at 575-835-5955 (JSalome@admin.nmt.edu). For more information about the position itself, contact Warren Ostergren, search committee chair, at 575-835-5363 (warreno@nmt.edu).

Joint Tenure-Track Faculty Position in Exoplanetary Science

Earth and Planetary Sciences and Physics Department, McGill University

The Department of Earth and Planetary Sciences (www.mcgill.ca/eps) and the Department of Physics (www.physics.mcgill.ca) at McGill University invite applications for a joint tenure-track position at the rank of Assistant Professor, beginning as early as September 2015 in the area of Exoplanetary Sciences. We encourage qualified individuals with relevant research interests in experimental, instrumentation, observational or theoretical aspects of exoplanetary sciences to apply.

This is the first of two faculty positions being created in support of the new McGill Space Institute (http://msi.mcgill.ca), bringing together researchers in astrophysical, geological, atmospheric and astrobiological areas from multiple departments on campus. Existing complementary research strengths at McGill include early Universe cosmology, galaxy evolution and compact objects in the Department of Physics, as well as geology, astrobiology and atmospheric sciences in Earth and Planetary Science and other departments.

We seek candidates with a proven record of excellence in research and the capacity for excellence in teaching. The successful candidate will be supported by a generous start-up package. Applicants should submit a detailed curriculum vitae, a statement of teaching interests, and a research plan. They should also arrange for three letters of reference. All of these materials should be uploaded to http://dualcore.physics.mcgill.ca/FACULTY/

Review of applications will begin 15 January 2015, and continue until the position is filled.

McGill University is committed to equity in employment.

All qualified applicants are encouraged to apply; however, in accordance with Canadian immigration requirements, Canadians and permanent residents will be given priority.

Postdoctoral position in lunar magnetism at the Institut de Physique du Globe de Paris

The Institut de Physique du Globe de Paris (IPGP) is inviting applications for a postdoctoral position in the broad field of lunar magnetism. This one-year position (renewable for a second year) aims to decipher the origin of crustal magnetism by modeling spacecraft-derived magnetic field data. Potential research projects include modeling the direction of crustal magnetization, comparisons of derived crustal magnetization with measured properties of lunar samples, and correlations between magnetic anomalies and GRAIL gravity. As part of a larger project, the applicant will have the opportunity to collaborate with paleomagnetists, geophysicists, and geodynamo modelers at CEREGE (Aix en Provence) and ISTerre (Grenoble).

To apply, please provide a CV, publication list, contact information of two references, and a 2-page letter that motivates the applicant's interest in the topic and that describes prior relevant research experience. Please respond by email to Mark Wieczorek (wieczor@ipgp.fr) before March 23, 2015.

Seeking Executive Director & Lead Scientist—Center for Snow and Avalanche Studies, Silverton, CO

The Center for Snow and Avalanche Studies (www.snowstudies.org) is an independent, 501(c)(3), research, monitoring, and education organization based in Silverton, Colorado. CSAS operates the Senator Beck Basin Study Area near Red Mountain Pass. Preferred candidates for the Executive Director/Lead Scientist role will possess, among other attributes, a PhD in mountain science, interdisciplinary field research and/or monitoring program experience, organizational management skills, and demonstrated success in engaging stakeholders. For a complete job description contact clandry@snowstudies.org. All qualified applicants will be considered without regard to, among other things, race, religion, color, national origin, sex, age, status as protected veterans, or status as qualified individuals with disabilities.

Student Opportunities

NASA Student Research Opportunity - Summer 2015

The NASA Airborne Science Program invites highly motivated advanced undergraduates to apply for participation in the NASA Student Airborne Research Program (SARP 2015). The purpose of the Student Airborne Research Program is to provide students with hands-on research experience in all aspects of a major scientific campaign, from detailed planning on how to achieve mission objectives to formal presentation of results and conclusions to peers and others. Students will work in multidisciplinary teams to study surface, atmospheric, and oceanographic processes. Participants will assist in the operation of instruments onboard the DC-8 research aircraft to sample and measure atmospheric gases and to image land and water surfaces in multiple spectral bands. Along with airborne data collection, students will participate in taking measurements at field sites.

Outstanding faculty and staff for this program will be drawn from several universities and NASA centers, as well as from NASA flight operations and engineering personnel. The eight-week program begins June 14, 2015 and concludes August 7, 2015. Instrument and flight preparations, and the research flights themselves, will take place during the first two weeks of the program at NASA's Armstrong Flight Research Center, in Palmdale, CA. Post-flight data analysis and interpretation will take place during the final six weeks of the program at the University of California, Irvine.

SARP participants will receive a $3,000 stipend, free housing during the 8-week program, local transportation, and a $3,000 travel and food allowance. Applicants must be US citizens.

Selection criteria will include:

• Excellent Academic performance

• Current undergraduate junior at the time of application (rising senior in summer 2015)

• Potential for contributing to the nation's future workforce as judged by career plans

• Evidence of interest in Earth system science and hands-on research

• Leadership qualities and ability to perform in teams

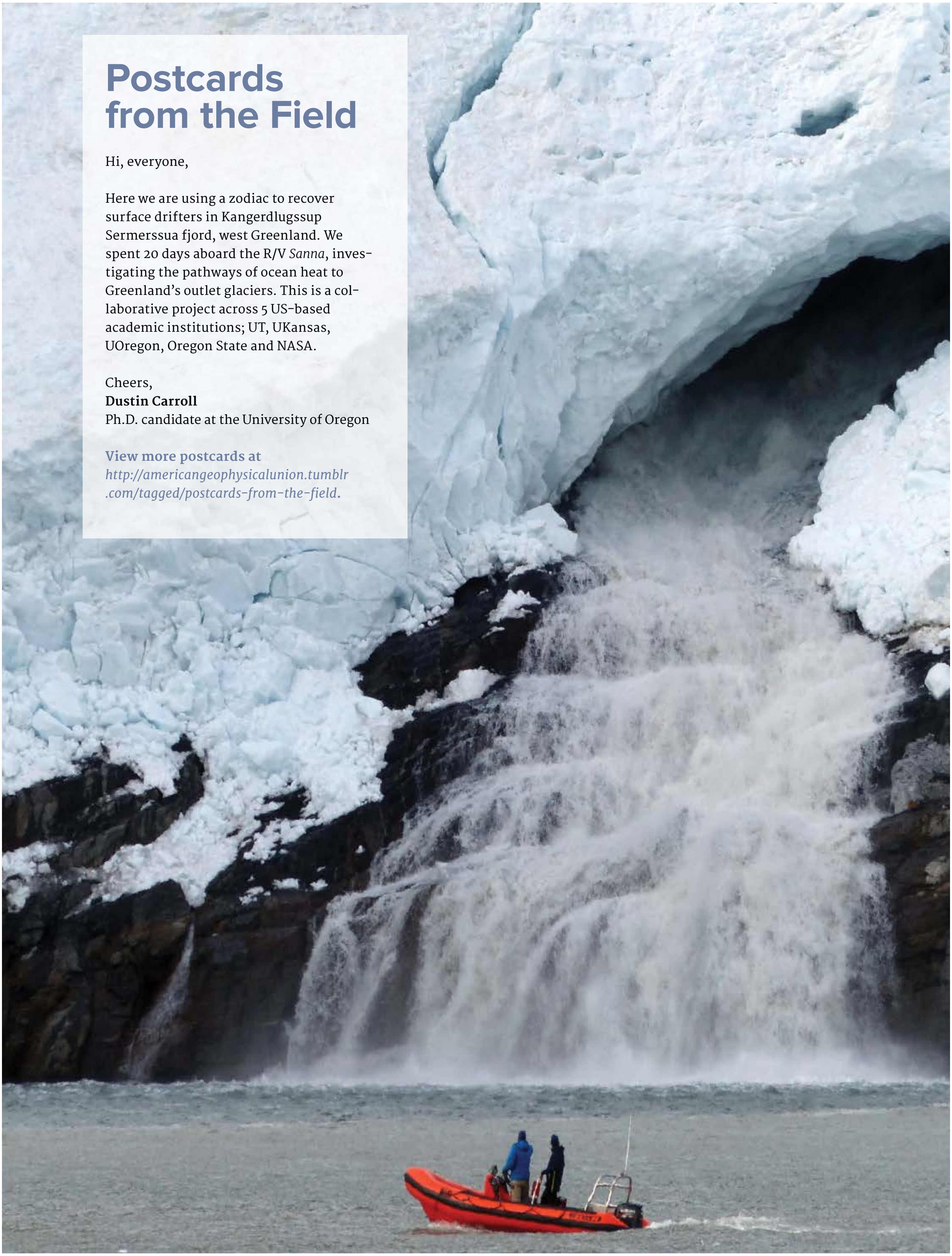
Applications can be found at the SARP 2015 website www.nserc.und.edu/sarp/sarp-2015

Deadline for all applications is February 5, 2015.

Specific questions about the program can be emailed to:

SARP2015@nserc.und.edu

PhD Fellowship, Hydrologic Science and Engineering, Colorado School of Mines. Research assistantship available on a new NSF-sponsored project concerning chemical reactions in poorly-mixed systems, and the proper upscaling of reactions at the field-scale. The preferred candidate will have experience in stochastic processes, applied mathematics (including particle methods for PDEs), and/or advanced fluid mechanics. The RA covers tuition, fees, and provides a monthly stipend. Contact PI David Benson (dbenson@mines.edu). MS in related science or eng. field preferred.



Postcards from the Field

Hi, everyone,

Here we are using a zodiac to recover surface drifters in Kangerdlugssup Sermerssua fjord, west Greenland. We spent 20 days aboard the R/V *Sanna*, investigating the pathways of ocean heat to Greenland's outlet glaciers. This is a collaborative project across 5 US-based academic institutions; UT, UKansas, UOregon, Oregon State and NASA.

Cheers,
Dustin Carroll
Ph.D. candidate at the University of Oregon

View more postcards at
http://americangeophysicalunion.tumblr.com/tagged/postcards-from-the-field.