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EOS

Earth & Space Science News

Exploring Natural Hazard Policies with Bike Helmets and Bus Fares

Satellite to Warn Earth of Solar Storms

Roman Aqueducts Could Spill Climate Secrets

A Path Forward for Ocean Sciences

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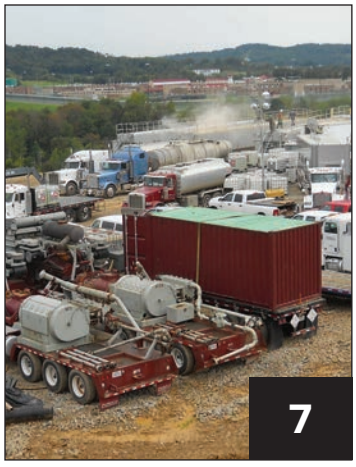

On the Cover
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Ancient Roman Aqueducts Could Spill Climate Secrets

Many ancient Roman aqueducts contain layers of carbonate minerals that store information about the paleoclimate of the Roman Empire.

For hundreds of years, water that rushed through Roman aqueducts left behind thick layers of sediment caked to the channels' walls. These sediments—mostly calcium carbonate—may contain chemical records of the region's climate, similar to the stalactites and stalagmites that scientists study in caves.

"What we hope to do is to obtain information about paleoenvironmental conditions during Roman times and see if it's different from nowadays," Cees Passchier, a structural geologist at the Johannes Gutenberg University in Mainz, Germany, and leader of a research project investigating the layers of sediment, told *Eos*.

Studying these ancient sediments "is a brilliant idea," said Amy Frappier, an assistant professor in paleoclimatology at Skidmore College. Because aqueducts, one of the greatest engineering feats of the Roman Empire, were so widespread—stitching across Europe and northern Africa—they could offer a unique look at how climate changed on all sides of the Mediterranean from approximately 31 BCE to 476 CE.

"Those aqueducts have been around for thousands of years," Frappier said. They "should have been recording all sorts of environmental changes that were happening."

Depositing Minerals

Many large and reliable Roman aqueducts were sourced from limestone cave springs. Waters deep within these springs are rich in dissolved calcium carbonate and carbon dioxide, thanks to material dissolving from cave walls and the closed environment of the cave system, which prevents carbon dioxide from escaping.

When the water emptied into an aqueduct from a spring high in the hills, it equilibrated with the open air, releasing carbon dioxide, which lowered the water's acidity. The lower acidity caused crystals of calcium carbonate to rain out along the aqueduct. These deposits of calcium carbonate are called sinter.

In the same way that hard water residue cakes the insides of today's pipes, groundwater rushing through Roman aqueducts over hundreds of years deposited layers upon layers of sinter. In fact, nearly 40% of the 1400 known major aqueducts from Roman times are lined with sinter, according to Passchier and colleagues.

Extracting Climate Signatures

Similar to rings of growth found within cave stalactites and stalagmites, layers of calcium carbonate in aqueducts roughly follow annual seasonal cycles. These tend to manifest as alternating dark and light stripes that each keep a chemical record of the environment in which it was formed, said Gül Sürmelihindi, a postdoctoral researcher at Johannes Gutenberg University.

To study these seasonal cycles, Sürmelihindi turned to geochemical analysis. She looked at the abundance of an isotope of oxygen—oxygen-18 (^{18}O)—within the layers. Because ^{18}O has two more neutrons than the more common ^{16}O, it is slightly heavier and will be more likely to precipitate out of the rushing water to form sinter.

Because calcium carbonate can more readily stay dissolved in colder water, any sinter that forms during the chill of winter will contain higher concentrations of ^{18}O because heavy oxygen will be the first oxygen isotope to precipitate out of solution, Sürmelihindi said.

In many of the darker-colored stripes, Sürmelihindi found a higher abundance of the heavy oxygen isotope, which meant that these dark stripes were formed during the colder parts of the year. In contrast, the lighter-colored stripes tended to have less of

Cees Passchier

Two samples of sinter from Roman aqueducts, showing distinct banded layers. These layers typically represent seasonal cycles.

the heavy oxygen isotope, which told Sürmelihindi that these layers were deposited in a warmer environment.

However, other factors also may create the banding. "These distinct layers can mean many things, such as a drought period, very wet period, or even human activity like a cleaning process of the subject aqueduct," Sürmelihindi said. Another factor adding to the dark color of these stripes could be the presence of biological material, she noted.

Unlike stalactites and stalagmites, however, the layers of carbonate mineral formed in aqueducts provide a more highly resolved look into the past because of their thickness, Passchier said. Whereas mineral layers in cave formations can be less than a millimeter thick, the layers on aqueducts can be a centimeter thick.

In fact, some sequences of sinter coating the aqueducts can be about a meter thick, representing hundreds of years of deposition, Passchier noted. The more material there is for scientists to analyze, the better picture they can get of the depositional environment.

The layers of carbonate mineral formed in aqueducts provide a more highly resolved look into the past because of their thickness.

Climate and Society

From these chemical signatures, it should be possible to study how climate changes affected ancient societies, said Frappier, who has used cave deposits to study climate changes faced by the ancient Mayan empire.

Scientists have found that human activity has been responsible for air pollution as far back as the Roman Empire, so "these aqueducts could possibly be picking up signatures from regional air pollution, which would be interesting to look at," Frappier said.

Dating the Past

However, before they can piece together a climatic history of the region, Passchier and Sürmelihindi must first be able to accurately date each layer. Although the relative ages of the layers are apparent, the exact age can be gleaned only from radioactive dating and comparing those relative ages to known, finely detailed climate records sourced from tree rings. This comparison has the potential to resolve the age of each layer to within 5 years, said Passchier.

The better scientists can understand the environmental changes that occurred during historical periods such as the rise and fall of the Roman Empire, "the better we can learn about the cultural context and how people responded to changes," Frappier said.

By **JoAnna Wendel,** Staff Writer

Open Records Laws Increasingly Used to Harass Scientists

Special interests are increasingly using broad open records requests to intimidate scientists, and researchers and universities need to be prepared to respond to these demands, according to a new report that comes as the debate over transparency heats up in Congress.

The report, "Freedom to Bully: How Laws Intended to Free Information Are Used to Harass Researchers," issued by the Union of Concerned Scientists (UCS), finds that the practice of using open records requests to intimidate scientists emerged with the growing use of electronic communication over the past 2 decades (see http://bit.ly/UCSReport).

The practice roughly follows a pattern: Individuals, companies, organizations, activists, and other special interests across the political spectrum utilize states' freedom of information laws to make broad requests for materials on topics that they disagree with to "attack and harass scientists and other researchers and shut down conversation at public universities," according to the report.

In many cases, these groups request all materials on a topic in a university's or researcher's possession, including emails, draft papers, and handwritten notes. Researchers and universities are often unprepared to respond to these requests, the report notes.

"This strategy can curb the ability of researchers to pursue their work, chill their speech and discourage them from tackling contentious topics," the report states. The report was released 13 February at the annual meeting of the American Association for the Advancement of Science (AAAS), held in San Jose, Calif.

Flare-Ups over Funding Sources

The report provided prescient context for groups, including the American Geophysical Union, the American Meteorological Society, and UCS, which expressed concern over a series of letters dated 24 February written by Rep. Raul Grijalva (D-Ariz.) asking scientists known to be climate change deniers for information on their funding sources as well as drafts and communications about their testimonies before Congress (see, e.g., http://bit.ly/AMSconcern). Grijalva, the ranking Democrat on the House Natural Resources Committee, wrote the letters after news reports disclosed the funding sources of Wei-Hock "Willie" Soon, a scientist at the Harvard-Smithsonian Center for Astrophysics and a frequent critic of research linking human actions to climate change.

The groups said that asking for unpublished communications impinges on scientists' academic freedom. Grijalva has since said his request seeking the records of correspondence likely went too far, but the issue has put a spotlight on the debate about transparency and disclosure.

> The strategy can "curb the ability of researchers to pursue their work, chill their speech and discourage them from tackling contentions topics."

"There is a growing need for academic societies, public interest organizations, journalists, the National Academies, industry and other stakeholders to come up with common disclosure standards that balance the public's interest in transparency with the public's interest in reasonable privacy and the ability of researchers to do their best work," Michael Halpern, program manager at the Center for Science and Democracy at UCS, wrote in a blog post (http://bit.ly/UCSblog).

Quelling Science Through Freedom of Information Laws

Freedom of information laws allow citizens to request public records from government agencies and other taxpayer-funded institutions. These laws are intended to increase government transparency and accountability while also limiting access to sensitive information. State open records laws can also be used to make broad freedom of information requests to taxpayer-funded institutions and researchers.

The report says that special interests use these broad requests to attack scientists or fields of study with which they disagree, such as climate change. In a now famous example, former Virginia attorney general Ken Cuccinelli used the state's Fraud Against Taxpayers Act to subpoena all of climate scientist Michael Mann's correspondence from his time at the University of Virginia. The state supreme court eventually ruled that the university did not have to disclose records that could harm research efforts, damage faculty recruitment and retention, undermine faculty expectations of privacy and confidentiality, and impair free thought and expression.

"To be sure, open records requests are there to hold governments accountable. In general, the more transparent government is, the more officials are likely to serve the public interest and resist efforts to suppress, censor or otherwise unduly influence scientific research," Halpern wrote in a blog post. "But there's an unexpected dark side to these laws that needs to be dealt with."

What Can Scientists Do?

Halpern said that scientists and institutions need to be prepared to deal with these open records requests. Researchers should be aware of how their university handles open records requests. Institutions should clarify their policies in this area, including how they will respond to requests and which materials they consider public and which they consider private, the report suggests.

Universities and researchers should also be aware of the context of a request and fulfill requests with full awareness of what disclosure will mean, Halpern said. In addition, researchers and professional societies need to recognize that what may be in the best interest of a university is not always in the best interest of an individual researcher, the report notes.

Mann, who has come under other similar attacks in addition to the University of Virginia case, said that scientists cannot allow the abuse of open records requests to change the way they do their work, which includes communicating with colleagues over email.

"It is crucial that we prevail in this battle to protect academic freedom and the right of scientists to have frank and internal discussions with each other," he said during a panel on the issue at the AAAS meeting. "If we fail in that battle, all of society loses out."

By **Nanci Bompey,** Writer; email: nbompey@agu.org

Sea Level Rise Added $2 Billion to Sandy's Toll in New York City

To those who think that climate change is an abstract concept, one that might possibly affect their grandchildren in the far-off future, scientists at Climate Central have a ready response. They have calculated that sea level rise over the 20th century caused more than $2 billion in additional damage during Hurricane Sandy in New York City alone.

That additional damage can be attributed to largely human-induced climate change that has already occurred, says Scott Kulp of Climate Central.

"We cannot say that Sandy itself was a result of climate change," Kulp told *Eos*, but "we can attribute at least part of the flooding damage from Hurricane Sandy to climate change. It's a warning for the next decades to come."

Making "Floodprints"

Sandy hit the U.S. East Coast on 29 October 2012, with a storm surge measuring 2.8 meters, causing extensive flooding in Manhattan and the four outer boroughs of New York City. The last 20 centimeters of that surge would not have existed were it not for sea level rise since 1900, according to Kulp and his colleagues in the United States and the Netherlands.

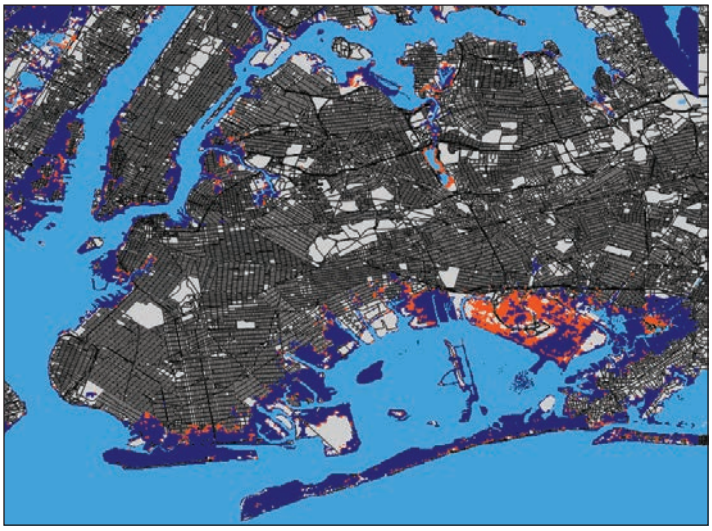
According to Ben Strauss, also of Climate Central, the group became interested in studying how climate change affected Sandy's impact after Strauss attended a presentation by Philip Orton of the Stevens Institute of Technology in Hoboken, N.J. Orton discussed modeling Sandy's "floodprint," a map showing the areas inundated by the storm surge.

"I proposed that we collaborate," said Strauss "and that we basically simulate the same flood, but using a starting sea level 20 centimeters lower, to remove climate-driven sea level rise over the last century." How would that change the floodprint?

Using modeling programs developed by the University of North Carolina, the scientists simulated the observed flooding of Sandy as it hit New York City and also what would have occurred in the absence of the 20-centimeter sea level rise. They applied wind and atmospheric pressure data from Sandy and elevation maps of the city, along with information from the city's Office of Emergency Management, which identified 33 different types of buildings in flooded areas and their locations within each census block.

Flooding from Sandy actually affected 579,529 people in 250,569 housing units, totaling $11.9 billion in damage, according to the simulation. In the absence of 20th century sea level rise, those figures would have been 520,115 people, 224,540 housing units, and $9.6 billion in damage, said Kulp.

In other words, he said, "The last 7% of the storm surge affected 11.4% more people and 11.6% more housing units than it would have without sea level rise, as well as 24% of the total New York City property damage due to Hurricane Sandy."



A map, prepared by Kulp et al., of areas in New York City flooded by Hurricane Sandy. Both blue and orange areas were flooded, but the orange areas would not have flooded were it not for the 20-centimeter rise in sea level over the 20th century. The large orange and blue area at the lower right of the map is John F. Kennedy International Airport. The map was created by the simulation program, and the authors stress that it is provisional and subject to refinement.

The estimates of economic damages were calculated by Hans de Moel of the Institute for Environmental Studies at VU University Amsterdam in the Netherlands. "What's interesting," Strauss told *Eos*, "is that the contrast in economic damages is greater than the contrast in simple exposure, because the simple exposure represents only the difference in area covered by flood water, whereas the economic damages also reflect the greater depth of water throughout the entire flooded area. Greater depth translates to greater damage, nonlinearly."

Connecting Climate Scientists with the Public

Climate Central is a nonprofit climate research organization based in Princeton, N.J. Kulp said that it tries to bridge what he called "the huge disconnect" between what scientists know about climate change and what "a very large percentage of the United States population" understands or considers to be a pressing problem. One way to do this is to take events like Sandy and project what would have happened had known consequences of climate change not amplified effects.

The organization is staffed both by scientists studying the near-term impact of climate change and by journalists who translate those findings for the general public. It is funded by grants from major foundations, Kulp said, including Kresge and Rockefeller.

The results of the Hurricane Sandy study were first presented at AGU's 2014 Fall Meeting. The researchers stress that their percentage conclusions are tentative and are being refined with new computer runs, prior to submission to peer review in the coming months. Strauss told *Eos* that he does not expect the final results to differ significantly from those presented at the Fall Meeting.

By **Harvey Leifert,** Freelance Writer; email: Leifert@nasw.org

Interior Department Issues Fracking Standards

Doug Duncan, USGS

A drill pad in Pennsylvania's Marcellus Shale.

Final standards on hydraulic fracturing on public and American Indian lands, which the U.S. Department of the Interior (DOI) announced on 20 March, are good for development and the environment, according to the agency.

The new rule on hydraulic fracturing (commonly known as fracking) serves as "a much-needed complement" to existing regulations, according to the agency's Bureau of Land Management (BLM), which issued the standards. The standards are designed to ensure environmentally responsible oil and gas development on federal and Indian lands "in light of the increasing use and complexity of hydraulic fracturing coupled with advanced horizontal drilling technology," according to the final agency draft of the rule (http://bit.ly/DOIFrackingRule).

Provisions of the rule, which takes effect in June, include measures to protect groundwater supplies, monitor well integrity, disclose chemical use to the public (with some exceptions for trade secrets), and safely manage recovered waste fluids in rigid enclosed aboveground storage tanks.

Bringing Regulations into the 21st Century

Fracking is a process that involves injecting water, sand, and chemicals into bedrock formations to increase the oil or gas flow to a well. About 25% of such unconventional oil and gas extraction efforts in the United States are located on public and tribal lands, according to DOI. That totals about 100,000 oil and gas wells.

Secretary of the Interior Sally Jewell stated in a 20 March briefing that the new standards will bring decades-old regulations into the 21st century.

"We need to update our regulations to make sure they can keep up with evolving technologies and innovation by industry," said Jewell, a former petroleum engineer. "As we continue to offer millions of acres of America's public lands for oil and gas development, it is absolutely critical that the public has confidence that robust safety and environmental protections are in place."

According to BLM, compliance with the standards will cost about $11,400 per well, between 0.13% and 0.21% of the cost of drilling a well.

Jewell said that despite potential efforts by some in Congress and in industry to try to block the rule, the agency "is upholding the public trust."

"There is a lot of fear and a lot of public concern, particularly about the safety of groundwater and the impact of the operations," she said. "We believe that these standards are essential."

"We expect that these rules will in fact stick, that it would be a mistake to take a very thoughtful long-term [rule-making] process and overrule it through congressional action," she said. "The standards "are really very consistent with best practices going on in the industry and best practices going on in many of the states."

Seismicity Concerns

The new fracking standards do not deal with seismicity. The rule notes, "Several comments stated that the rule should be modified to limit hydraulic fracturing activities in those areas with seismic zones. The BLM did not revise the rule as a result of these comments. The research on the phenomena of induced seismicity from hydraulic fracturing operations is still ongoing and inconclusive."

The rule continues, "For hydraulic fracturing operations proposed in seismically active areas or when the BLM determines through the internal and public scoping process that seismic impacts are an issue, risks of induced seismicity would be evaluated through the NEPA [National Environmental Policy Act] analysis, including analysis of the proposed drilling and fracturing operations. These final regulations also require submittal of additional geologic information prior to hydraulic fracturing to help further that review."

Responses to the Standards

Erik Milito, director of upstream and industry operations with the American Petroleum Industry (API), said that the rule imposes new costs and delays on energy development without improving on existing state and federal regulations. "Despite the renaissance on state and private lands, energy production on federal lands has fallen, and this rule is just one more barrier to growth," he said.

"Under the strong environmental stewardship of state regulators, hydraulic fracturing and horizontal drilling have opened up a new era of energy security, job growth, and economic strength," Milito continued. "Increased production and use of natural gas has helped cut U.S. carbon emissions to a nearly 20-year low, and this decision only stands in the way of further progress."

Dan Chu, senior director for Sierra Club's Our Wild America campaign, said that the regulations "represent important progress in holding the oil and gas industry accountable for the full economic and environmental cost of extracting dirty fuels from our public lands."

He added, "When fully enforced, this new rule will reduce the harm caused by fracking to our land, water, and health near communities where leasing has already occurred. However, the only true way to protect communities from fracking is to not frack at all."

By **Randy Showstack,** Staff Writer

What Instruments Are Available for Polar Studies?

Instrumentation for Polar Glaciology and Geophysics Research Workshop
Baltimore, Maryland, 9–10 October 2014

The study of Earth's ice sheets involves a variety of in situ, ground-based, airborne, and satellite instrumentation. This breadth means that many scientists are unfamiliar with the full scope of available polar technologies, which are often complementary to their own research.

Therefore, a workshop was held last fall in Baltimore, Md., to bring together scientists and engineers to discuss these technologies. The workshop sought to identify a means of communicating instrumentation capabilities for polar glaciological and geophysical research to the broader community.

The workshop was organized into sessions based on various technologies (e.g., radar, seismology, etc.) and platforms (e.g., ground based, airborne, or space based). A valuable outcome of the workshop was the development of "A Summary of Current Instrumentation for Polar Glaciology and Geophysics Research," a 40-page document detailing the technologies that were presented during the meeting. This document is intended to assist researchers in the preparation of Arctic and Antarctic proposals by informing those new to polar science of current technological capabilities.

This document is also intended to assist scientists during the data analysis and publication phases by linking them to scientists with complementary data sets. The document and other information are available on the workshop website (see http://bit.ly/polarinstrumentation).

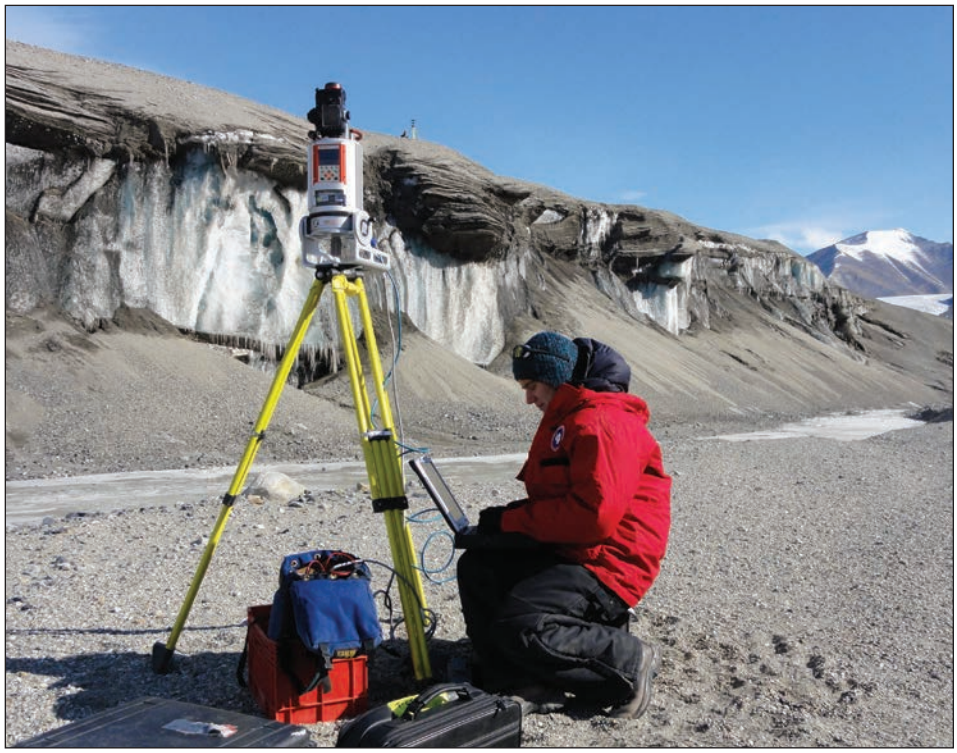
Meeting discussions were often unique to specific instruments, but several common themes emerged:

• *Communication of concentrated logistics.* Large surveys often require deep-field logistics, and there are opportunities to benefit from synergistic research activities through coordination. The U.S. Ice Drilling Program (http://icedrill.org/) and the Transantarctic Mountain Science field camp (http://tamcamp.org/) were cited as excellent models of community-driven decision making. Participants concluded that information about upcoming large polar surveys should be disseminated through Web-based geographic information systems (GIS; e.g., the Operation IceBridge Planning Tool, http://icebridge.sr.unh.edu/) to allow researchers to coordinate logistics with minimal additional cost.

• *Instrument weight and size.* Researchers want both sufficient power to meet operational requirements and lightweight batteries to reduce logistical costs. Participants concluded that a transition from lead-acid batteries to lithium-based batteries would meet these requirements. Miniaturization of airborne instruments offers the opportunity to increase flight range and facilitate future integration into unmanned aerial systems.

• *Data archiving and discovery.* Data archiving is expensive. Workshop participants identified preferred established data formats (e.g., HDF5 and SEG-Y) and archiving centers (e.g., the National Snow and Ice Data Center). For data discovery, attendees recognized the utility of modern GIS applications and agreed that the combination of uniformly archived data and suitable data discovery tools should accelerate scientific discovery.

• *Communication of available instrumentation.* To update workshop documents as new technologies emerge, participants concluded that a regular polar instrumentation session should be convened each year at AGU's Fall Meeting.



Joseph Levy

Marianne Okal, a UNAVCO field engineer, operating ground-based lidar in Garwood Valley, Antarctica. This technology is relatively new to polar applications and is used here to study thermokarst erosion.

The workshop was jointly supported by the National Science Foundation and NASA.

By **Kelly M. Brunt,** Earth System Science Interdisciplinary Center, University of Maryland, College Park; and Cryospheric Sciences Laboratory, NASA Goddard Space Flight Center, Greenbelt, Md.; email: kelly.m.brunt@nasa.gov; and **Joseph A. MacGregor,** Institute for Geophysics, The University of Texas at Austin, Austin

Exploring Earthquakes, Slow Slip, and Triggering

Earthquakes: Nucleation, Triggering, and Relationships with Aseismic Processes
Cargèse, Corsica, France, 3–10 November 2014

Answers to two related fundamental questions about earthquakes remain elusive: Are there observable precursory processes that foreshadow an imminent earthquake? Is earthquake size predetermined or the result of the random chance encounter of conditions that stop its growth? Dramatic increases in the ranges of scales over which scientists observe fault slip have revealed unanticipated complexity.

Researchers now understand that faults do not just remain totally locked between earthquakes (rapid slip events that efficiently radiate seismic waves) or creep steadily and slowly (without radiating). Instead, faults may be better described as patchworks of slip behaviors spanning a complete spectrum between these end members.

Given this new view, it seems to be time to assess scientific understanding, to determine how to continue moving forward, and to inspire and train tomorrow's researchers. Toward these ends, an international week-long course was held in November 2014 at the Cargèse Institute of Scientific Studies in Corsica, France. Below are some key lessons learned.

Slow, aseismic slip acts as a significant means of relieving stress applied to faults and as a means of accelerating stress accumulation on neighboring stuck fault patches that eventually break and radiate seismic waves. Innovative seismic waveform and statistical analyses have revealed highly varied seismic radiation and seismicity patterns, inferred to be proxies for the more significant, but harder to observe, aseismic slip that drives them. Course participants agreed that the next challenges are to verify this proxy status by detecting aseismic deformation directly and to evaluate how seismic and aseismic modes interact.

Laboratory studies and theoretical models also suggest that earthquakes are the culmination of accelerating processes that may manifest as growing aseismic slip, often accompanied by foreshocks, tremor, and other seismic phenomena. Recent observations of these phenomena and measurements of seismic *P*-wave characteristics that scale with magnitude suggest that earthquake size may be predetermined. However, attendees stressed that the community still needs to assess the robustness and uniqueness of these observations, particularly when not made retrospectively.

Cristiano Colletini

The exposed surface of the Vuache fault, near Annecy in the French Alps. This 30-kilometer-long plane cuts across Cretaceous limestones (145–66 million years old) and has accumulated several kilometers of left-lateral slip.

Earthquakes are the culmination of accelerating processes that may manifest as growing aseismic slip, often accompanied by foreshocks, tremor, and other seismic phenomena.

The course concluded with student-led discussions of new ways to meet the above challenges, two of which we highlight. First, the exponential growth of seismicity rates associated with human activities, principally wastewater injection, presents opportunities to conduct unprecedented experiments on real crustal faults. Second, the physical conditions that determine which fault slip mode dominates remain a matter of speculation. New methods show promise for four-dimensional imaging of the properties that may control the mode of slip.

Of the 98 attendees, 77 were students and postdocs, and 18 countries were represented. The Centre National de la Recherche Scientifique (France), the Laboratory of Excellence program OSUG@2020 of the National Research Agency (France), the U.S. National Science Foundation, the European Geophysical Union, and the Université de Savoie (France) provided support.

For more information about the course, visit http://earthquakes.sciencesconf.org/.

By **David Marsan,** Université de Savoie, Le Bourget du Lac, France; email: david.marsan@univ-savoie.fr; **Joan Gomberg,** U.S. Geological Survey and University of Washington, Seattle, Wash.; and **Michel Bouchon,** Centre National de la Recherche Scientifique and Université Joseph Fourier, Grenoble, France

A Transformational Path Forward for the Ocean Sciences Community

In what may be a milestone in the history of U.S. ocean sciences, the National Research Council (NRC) released the first-ever Decadal Survey of Ocean Sciences (DSOS) report on 23 January 2015 [*National Research Council,* 2015].

Commissioned by the National Science Foundation's (NSF) Division of Ocean Sciences (OCE), this report looks at the past decade's key breakthroughs in understanding the oceans, identifies high-level research priorities for the coming decade, and makes bold recommendations for changes needed in the OCE budget to address these priorities.

No matter the outcome, the report is groundbreaking for one simple reason: This is the first time the community was asked to generate research priorities constrained by funding availability and to examine holistically the entire OCE portfolio. Although there have been previous community efforts to define future research objectives [e.g., *National Science and Technology Council,* 2007] and needed infrastructure [e.g., *National Research Council,* 2011], no prior reports grappled with the difference between what could be done with infinite resources versus what is affordable and the financial trade-offs between programs within the OCE portfolio.

Why Now?

The motivation to conduct a decadal survey was the gradual shift over the past decade from an OCE budget where support of researchers to do science comprised more than 60% of the portfolio to one now dominated by investments in infrastructure.

More important, flat or declining budgets meant that increased funding for facilities was subtracted from investments in science. Projections showed that if the OCE budget remained flat or increased only due to inflation, this trend would continue to the point where 60% of OCE funds would go to institutions to operate facilities while funds to support scientists would dwindle dramatically (Figure 1).

Why Are Facilities Costs Rising So Fast?

Part of the huge increase in facilities costs is inflation, but the bigger reason is the construction of new major facilities that were begun when the NSF budget was anticipated to double in 10 years.

In the past decade, OCE has received Congressional approval for three major construction projects: an upgrade of the drillship *JOIDES Resolution* (2006), the Arctic research vessel *Sikuliaq* (2009), and the Ocean Observatories Initiative(OOI; 2009). The latter two were launched as part of the American Recovery and Reinvestment Act of 2009.

It is important to note that the build costs for such projects come from NSF's facility construction account, not the OCE budget. This might be viewed as an incentive to build facilities, but it merely delays a major budgetary impact on OCE. Over the lifetime of most facilities, the cumulative cost of operations will far outweigh those of construction. Under current NSF policy, operating expenses are covered solely from divisional budgets, yet instead of doubling, OCE's inflation-corrected budget has declined by 15% over the past decade (Figure 1).

A New Strategic Approach

Ironically, as budget pressures intensified, the importance of advancing knowledge of the oceans has soared. A major oil spill, tsunamis, mammoth coastal storms, declines of marine ecosystems, and the causes and consequences of a changing climate (to name a few) all brought the societal relevance of understanding the oceans into ever-sharper focus.

The many compelling new research topics, the shifting balance between science and infrastructure, and the flat budget necessitated a new strategic approach. OCE sought a mechanism for community input on the crisis it was confronting, and DSOS was born.

We commend the DSOS Committee for tackling the issues described above head-on. Prior to the study's launch, some questioned whether 20 leading scientists from all sectors of the ocean sciences could reach a consensus. The problems were too difficult, the camps were too entrenched, and the effort may fail, or so we heard. This report proves that those fears were unfounded.

We will not review the remarkable accomplishments of the past decade highlighted within the report nor comment on the eight high-level research priorities. We urge you to read the report yourself (see http://nas-sites.org/dsos2015/) and to make reference to it in research proposals.

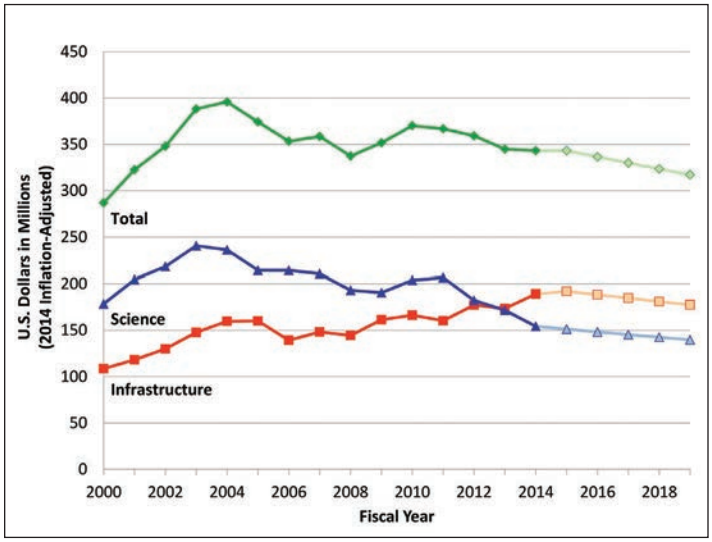
The report also makes clear that the list of priorities should not be exclusionary and that NSF should continue to fund novel ideas. Findings that no one anticipated often become groundbreaking discoveries.

Controversial Recommendations in the Report

Two things stand out in the report that will no doubt be controversial.

First is the matrix approach to mapping the eight priorities onto the three major infrastructure categories. The outcome is that the fleet is critical or important to the largest number of priorities, ocean drilling comes in second, and OOI is third. This is not surprising, given that the fleet is designed to be multipurpose, the *JOIDES Resolution* is limited solely to drilling, and OOI is still under construction and so has yet to operate and prove its worth.

The second major revelation is the recommendation to immediately reduce infrastruc-



NRC [2015]

Fig. 1. Trends in total funding for the Division of Ocean Sciences (green) and funds allocated to science (blue) and infrastructure (orange) in 2014 inflation-adjusted dollars. A standard rate of inflation was assumed for years past 2014. Projections for 2015 and beyond assume total funding, and the operating costs for infrastructure are held constant.

Val Idhe, UAF

R/V Sikuliaq *breaking through ice during trials on the Great Lakes.*

ture expenses by 10% and implement a further 10%–20% reduction within 5 years, with the savings invested back in the core science programs. This rebalancing will eventually return the portfolio to a ratio nearing 60% science and 40% facilities.

The cuts to facilities are weighted according to their synergy with the research priorities. Suggested reductions to the fleet are the smallest, OOI takes the largest hit, and ocean drilling is in between. The DSOS Committee considered but rejected, at least for now, the alternative approach of discontinuing any of these infrastructure categories to save the others from reductions.

The report makes numerous suggestions about how to achieve greater operational efficiency by reducing the number of assets or platforms, contracting for services on an as-needed basis instead of owning or leasing full time, building partnerships with industry and private foundations, and, in the case of ocean drilling, asking other nations to foot a more equitable fraction of operating costs. If these operational efficiencies cannot be enacted, then termination is an alternative.

Recommendation: A Regime Shift

The resounding message of the DSOS report is clear. There must be an immediate regime shift in funding from facilities toward investigator-based core science.

This call deserves strong community support. The report points out the importance of the three major facilities in relation to addressing the research priorities and to the research careers of scientists who depend on these facilities. It is also true, however, that these same scientists and many others depend on science grants to fund their laboratories.

Facilities are useless if you cannot provide grants for scientists to use them. Moreover, many ocean scientists do not use major facilities (e.g., only about 25% of proposals submitted to OCE request University-National Oceanographic Laboratory System ship time).

Importance of Supporting the Survey's Findings

The DSOS report also pulls no punches. Many will disagree with one or more of the recommendations. If so, then the committee likely did its job well because there are no easy answers and no way to satisfy all demands while maintaining a robust research community through individual science grants.

Whether researchers agree with the report in its entirety or not, we urge all members of the ocean sciences community to support it. Nothing is more powerful in government than an entire community speaking with one voice.

In the early stages of planning for this study, NSF heard from congressional staff members, the president's Office of Management and Budget (OMB), and representatives from other decadal survey efforts. The message was clear: Congress and OMB easily disregard agency-generated reports and wish lists. In contrast, when NRC convenes a decadal survey composed of independent scientists willing to resolve internal differences and set priorities for the whole in the context of relative value, affordability, and national interests, its recommendations are hard for either branch of government to ignore. If supported by the community, this decadal survey will empower NSF for years to come in making the case for funding of the leading ocean science priorities.

What You Can Do to Support Ocean Science

We view this report as transformational for the ocean sciences because it employs an "ecosystem-based" approach to managing all OCE investments based on community input. The role of the community, however, does not end there. The community must hold NSF accountable for using these recommendations as guidance in future budgetary decisions, especially given that the leadership of OCE and the Directorate for Geosciences changes every 3–4 years.

DSOS also represents an opportunity to establish the ocean science community as a unified force. Now that we have defined our priorities, we are in a stronger position to lobby for more funds for ocean sciences as a whole.

The collective will of the community that DSOS represents will be undermined, however, if special interest groups lobby Congress to insert language in the budget appropriations bill directing NSF to fund their own priorities. We discourage such practices.

We also encourage NSF to sponsor a "refresh" of the report to be completed 5 years hence, with planning for the next decadal survey beginning shortly thereafter.

Most important, we urge that future plans for major initiatives or infrastructure be vetted through the decadal survey process before they are launched. The true value of a decadal survey accrues when it becomes the standard means by which a community comes together on a regular basis to speak with one voice about priorities for advancing knowledge.

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Disclosure

D.O.C. was the director of the Division of Ocean Sciences at NSF from July 2010 to December 2013. D.A.B. held that same position from December 2013 to January 2015. The views expressed are solely the authors' and not do represent those of NSF or of their current institutions.

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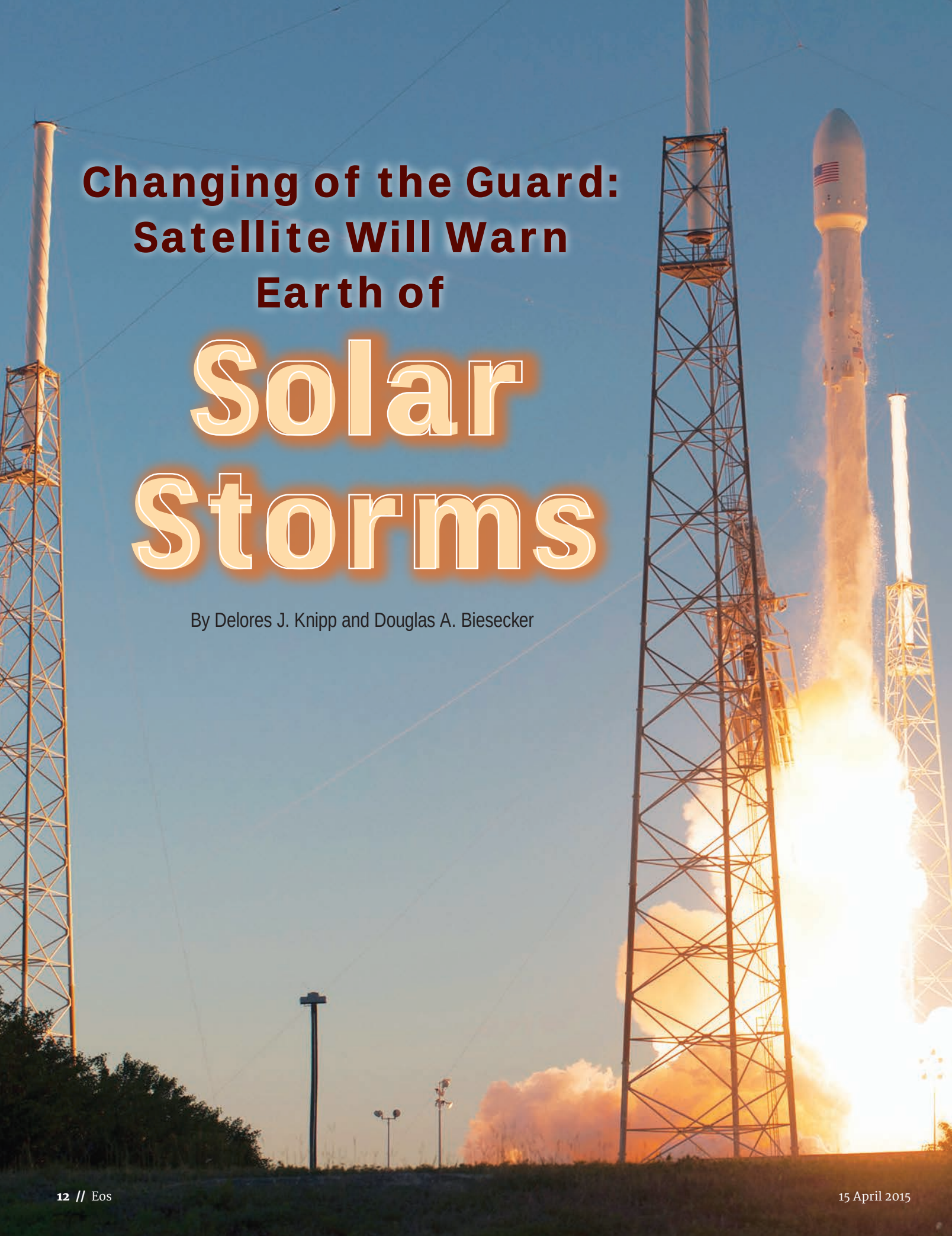

Changing of the Guard: Satellite Will Warn Earth of Solar Storms

By Delores J. Knipp and Douglas A. Biesecker

This summer, Earth gets a new guardian—the Deep Space Climate Observatory—to help warn astronauts and operators of critical planetary infrastructure about the Sun's raging magnetic storms.

When the Sun unleashes its magnetic fury in the form of solar storms, it pays to have warning. The most powerful of solar storms, if they strike Earth's magnetic field, can block communications, destabilize power grids, damage satellites, and force astronauts aboard the International Space Station to take shelter to avoid harmful radiation doses.

In July, Earth's new sentinel in space, the Deep Space Climate Observatory (DSCOVR), is expected to be fully operational. DSCOVR will hover between the Earth and Sun to monitor the solar wind and warn of looming space weather storms. Launched on 11 February 2015 from Cape Canaveral, the satellite (Figure 1, top) is currently on a 116-day journey to its new interplanetary home—the L1 libration point, where forces balance between the Sun and Earth (Figure 1, bottom).

There, roughly 1.5 million kilometers (932,000 miles) upwind from Earth, DSCOVR will become the U.S. National Oceanic and Atmospheric Administration's (NOAA) primary solar wind monitoring sentinel, taking over from NASA's venerable Advanced Composition Explorer (ACE), which has been stationed at L1 since the late 1990s. At L1, a sentinel spacecraft can detect disturbances in the solar wind roughly 15 to 60 minutes before they strike Earth,

NASA/Tim Powers & Tony Gray

The 11 February launch of the Deep Space Climate Observatory (DSCOVR).

At L1, DSCOVR will be in position to monitor the large-scale eruptions of the Sun's magnetic field that blast into interplanetary space as well as other disturbances that develop in the solar atmosphere and its extension, the solar wind.

providing valuable lead time for NOAA's space weather alerts and forecasts.

DSCOVR represents an important partnership between NOAA, NASA, and the U.S. Air Force to ensure the continuity of space weather information and forecasting.

The Origins of DSCOVR

DSCOVR, formerly known as Triana, was originally conceived in 1998 as a mission to monitor Earth's climate with a secondary mission to observe aspects of space weather. Lacking a ride to space, NASA put Triana into environmentally controlled storage at Goddard Space Flight Center in Maryland. It might still have been there today were it not for the multiagency interest in the craft's secondary mission: monitoring space weather.

The Space Weather Threat

Long considered interesting from a physical science perspective, space weather has also become a pressing civil and military issue addressed in many publications (e.g., http://bit.ly/AGU_SW). Humans have grown more dependent on electronics, space-based global navigation and civil and military communications, transcontinental airline flights over the poles, and interconnected power grids. All of these systems are exposed to the whims of the Sun's magnetized atmosphere, which can affect Earth's tenuous upper atmosphere and surrounding magnetic field.

NOAA is tasked with protecting life and property and monitoring day-to-day and long-term changes in the space environment. To that end, NOAA's Space Weather Prediction Center (SWPC) operates 24/7, providing real-time civil space weather forecasts and information to the nation. SWPC personnel work closely with partner centers in other countries such as Australia, South Korea, and the United Kingdom.

Since the mid-1970s, NOAA satellites in geostationary orbit (called Geostationary Operational Environment Satellites (GOES)) have monitored two forms of these dangerous disturbances. The most common are solar flares, flashes of intense radiation from the Sun's atmosphere created when local regions of its coiled magnetic field suddenly and violently reconfigure into a new shape. These can disrupt high-frequency radio communications on the dayside of Earth. Sometimes the Sun can also eject high-energy protons from its atmosphere, which, if aimed at Earth, can damage satellites, disrupt radio communications in the polar regions, and increase radiation risk to astronauts and passengers on transpolar flights.

At L1, DSCOVR will be in position to monitor the large-scale eruptions of the Sun's magnetic field that blast into interplanetary space, known as coronal mass ejections (CMEs), as well as other disturbances that develop in the solar atmosphere and its extension, the solar wind. As a particularly potent third form of space weather, CMEs are potentially very disruptive to Earth's space environment. The fastest of these can reach Earth in less than a day and generate currents that flow along magnetic field lines into the upper atmosphere, where they can deposit vast amounts of energy.

The obvious visible manifestation of these solar wind disturbances is the aurora, but there are numerous other effects. During the worst of storms, these effects include causing satellites to lose altitude by increasing their drag, inducing currents in power grids that can reduce their capacity or cause them to fail, degrading the accuracy of satellite navigation systems such as GPS, and causing aircraft that use the Federal Aviation Administration's GPS-reliant Wide Area Augmentation System for precision flight approaches to rely on the older, more limited Instrument Landing System.

Reviving DSCOVR

In the mid-2000s, as space weather became a growing societal concern—and as NASA's ACE

mission aged well beyond its intended lifespan—the three agencies recalled Triana's space weather capabilities and sought to revive the carefully stored craft, since renamed DSCOVR. Under a series of interagency agreements, NOAA funded NASA to refurbish the satellite for a primary space weather mission while retaining most of the instruments to perform climate monitoring as a secondary role. The U.S. Air Force funded the Falcon 9 launch vehicle through its launch services contract with the commercial space company SpaceX, and NOAA became responsible for mission operations.

To ready the craft for its new job, NASA installed new electrical components and a fresh battery and recalibrated all of the science instruments. In addition, the agency relocated the position of some space weather instruments to ensure that the highest-priority measurements would meet NOAA requirements.

DSCOVR's Solar Instruments

DSCOVR's three solar wind sensors are collectively known as PlasMag. The first is a Faraday cup—a conductive metal cup that measures the solar wind's positive ions—and the second is a "top-hat" electron spectrometer that provides high temporal resolution observations of the electrons in the solar wind. Together, they collect data on the solar wind's speed, temperature, and density.

Finally, a magnetometer senses the strength and direction of the magnetic field embedded in the solar wind plasma. This information is important to

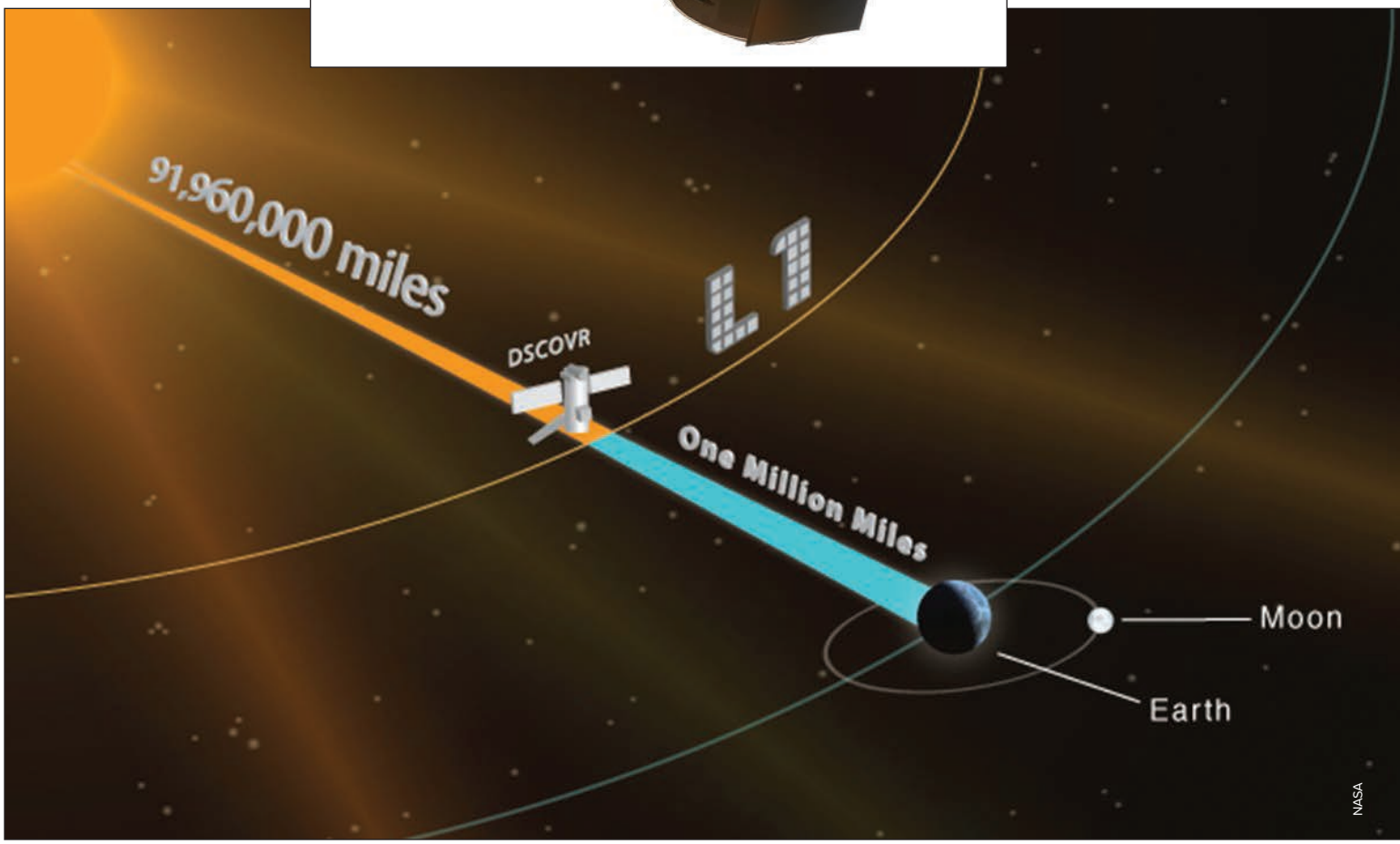

Fig. 1. (top) An artist's rendering of the Deep Space Climate Observatory (DSCOVR) satellite, which will detect potentially hazardous solar storms on their way to Earth and provide up to 60 minutes of early warning. (bottom) DSCOVR will be located roughly 1.5 million kilometers (932,000 miles) away from the Earth at the L1 libration point, where the balance of gravitational and centripetal forces allows satellites to remain in nearly stable orbit. At L1, DSCOVR can hover in place with a minimum amount of fuel consumption.

forecasters because it determines how the Sun's magnetic field connects to Earth's magnetic field. If the fields are in opposite directions, they can merge more easily, thus allowing solar wind energy access to Earth's space environment. Knowing the solar wind magnetic field orientation is crucial for accurate short-term space weather forecasts.

Replacing ACE

DSCOVR's observations will maintain the continuity of observations of the solar wind at L1, which is essential for space weather forecasting, and it will also bring some improvements over ACE's capabilities. Powerful storms sometimes saturated the ACE plasma sensor. With DSCOVR, NOAA expects to have data coverage for all but portions of the rarest, most severe space weather events.

In addition, measurements of the solar wind will be made at a cadence several times faster than ACE's. NOAA will be providing averages of these high-cadence data every second for the magnetometer and every 3 seconds for the Faraday cup. As with NASA's ACE, NOAA will publicly release the PlasMag data to scientists for sensor calibration, validation, and research purposes.

As DSCOVR transits to L1, its space weather instruments are operational and performing well. Scientists from NASA, NOAA, and the Harvard Smithsonian Astrophysical Observatory are comparing DSCOVR's transit data with similar observations from ACE and NASA's Wind spacecraft—which focuses on measuring solar wind dynamics at L1—with encouraging results.

DSCOVR's observations will maintain the continuity of observations of the solar wind at L1, which is essential for space weather forecasting.

An Earth Observatory Realized

DSCOVR's original mission—to act as an Earth climate observatory—has also been revived. For this investigation, DSCOVR carries two instruments designed to work in tandem.

One is a radiometer called the National Institute of Standards and Technology Advanced Radiometer (NISTAR). It will measure the total amount of sunlight that Earth reflects and the energy it emits on its sunlit face.

The second is the Earth Polychromatic Imaging Camera (EPIC), which will provide global images of Earth's dayside in numerous wavelength filters. EPIC's observations will be used to measure ozone and aerosols in the atmosphere, to measure properties of clouds and land and vegetation, and to estimate the amount of ultraviolet radiation at Earth's surface.

By combining EPIC's images with NISTAR's radiation measurements, scientists hope to better understand how aerosols and clouds affect the balance of radiation striking and leaving the Earth. EPIC's snapshots of the whole Earth will also be posted online.

Maintaining Vigilance

Upon DSCOVR's arrival at L1 in early June, NASA will test and calibrate its instruments for 40 days. If all goes as planned, the satellite will be turned over to NOAA, and SWPC will begin using DSCOVR as its primary solar wind sentinel in mid- to late July 2015. The mission will last at least 5 years.

The main limitation is propellant, which was sized for a 5-year life. However, the launch trajectory provided by SpaceX was near perfect, and fuel usage on the way to L1 is coming in under budget. Once DSCOVR is in orbit, a better determination of the fuel-constrained lifetime will be possible.

Plans are already afoot to ensure solar wind data remain flowing from L1 after the DSCOVR mission ends. A replacement, known as the Space Weather Follow-on, is planned to take over. The replacement mission is proposed in President Obama's fiscal year 2016 budget request and will provide continuity of solar-observing data products essential for space weather specification and forecasting.

Acknowledgments

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Exploring Natural Hazard Policies with Bike Helmets and Bus Fares

By Seth Stein, Jonas Kley, David Hindle, and Anke Friedrich

Defending society against natural hazards is a high-stakes game of chance against nature, involving tough decisions. How should a developing nation allocate its budget between building schools for towns that have none and making existing schools earthquake resistant? Does it make more sense to build levees to protect against floods or to prevent new development in the areas at risk? Would more lives be saved by making hospitals earthquake resistant or by using the funds for patient care?

Such topics challenge educators teaching natural hazards classes for several reasons. They are far from students' experience because they involve rare events and large sums of money. They cross the lines between traditional academic disciplines. Unlike other academic exercises, many of these questions have no unique or right answers.

To help students at two German universities (the University of Göttingen and the University of Munich) to conceptualize such topics, we designed a class that posed thought-provoking questions about complex issues and explored them by analogy with students' daily decisions. Using lectures, news stories, field trips, and in-class questions, students delved into the concept of risk and how to choose policies to mitigate risks to help

Seth Stein

Bicycle parking outside Göttingen train station.

prevent natural hazards from causing disasters. A similar class started at Northwestern University this spring.

Everyday Decisions Provide a Starting Point

We used a textbook [*Stein and Stein,* 2014] that covered topics in probability, statistics, economics, and risk analysis. Because most geoscience students have not studied these topics, we used the students' own experiences to make abstract concepts like risk perception, cost-benefit analysis, and alternative mitigation strategies more understandable.

We used the students' own experiences to make abstract concepts like risk perception, cost-benefit analysis, and alternative mitigation strategies more understandable.

For example, when asked whether they wear bicycle helmets, most students said "no" because they view themselves as skilled riders. This discussion gained unexpected immediacy when a student missed classes after a bike accident in which she sustained a concussion. The student returned and announced that she would now wear a helmet. We mentioned how similar informal surveys that we conducted show that a much larger fraction of American students wear helmets, and British students were in between the U.S. and German ones. We then generalized this example to discuss how societies' approaches depend on their perception of and tolerance for risk, which can differ between societies and vary significantly from actual risk.

Cost-Benefit Analysis

We explored the seemingly abstract concepts of expected loss (the product of a disaster's probability and the anticipated loss if it occurs) and cost-benefit analysis by examining a choice that students faced daily: Should they buy a ticket or sneak on the bus or subway?

Tickets cost 2 euros (€), but it is easy for a rider to avoid paying by not buying a ticket or sneaking on the bus through the back door. However, occasional inspections catch fare cheaters (schwartzfahrer) and fine them 40€. Students quickly understood comparing the benefit to the cost: saving the ticket price versus the expected loss if caught. However, they said we needed to tell them the probability of inspection and were puzzled when we did not know.

After discussion, they realized that by combining their experiences, they could reasonably estimate the occurrence rate of an event that is rare on an individual basis. We then used this concept to estimate the probability of earthquakes, hurricanes, floods, and similar events from a limited historic record and the uncertainties involved.

Weighing the Options

We introduced alternative mitigation strategies using another familiar example: what students do with their bicycles when they take the train. Approaches range from not taking bikes to the station—risk avoidance—to using secure parking for 2€ per night, an expensive but high level of mitigation.

Most students lock their bikes outside for free. This inexpensive solution provides a low level of mitigation, but most students consider it appropriate compared with the risk of theft. Garage users noted that a theft had a total cost that included both the actual cost and the effort of replacing the bike, leading to the concept of direct and indirect losses.

Who pays to replace a stolen bike, the students or their parents? This question led to a discussion of transferring risk via insurance. We extended this concept to analogous disaster issues, such as whether Japanese communities should protect themselves against tsunamis using expensive seawalls that cut them off from the coast or via warnings and evacuations [*Craft,* 2014].

Anke Friedrich

Seth Stein

(left) Munich subway car. (right) A sign on a Göttingen city bus warning "Nice try. But fare cheating costs 40 euros."

How Much Mitigation Is Too Much?

To explore how much mitigation is enough, we considered the costs and benefits of strategies for dealing with home fires.

University of Munich class discusses flood issues at the Isar River.

Because fires are more common than natural disasters, students have some sense of the odds and costs involved. We considered options including relying on the fire department and insurance, a monitored alarm, and a fire-suppressing sprinkler system. More expensive strategies offer additional benefits, so the question is to how to decide which makes the most sense.

We generalized this approach to natural hazard mitigation. The more a community spends on mitigation, the better off it may be in the future, but the higher the cost is now. Although a community's first instinct might be to protect itself as much as possible, the community has finite resources. Resources used for mitigating potential hazards are not available for other purposes. Levees to reduce river flooding compete for funds with improving kindergartens. Money spent making schools earthquake resistant cannot be used to hire teachers.

Different Societies, Different Choices

Other discussions involved floods, the leading cause of natural disaster deaths worldwide [*Doocy et al.,* 2013]. We watched videos of the disastrous floods that covered much of central Europe in 2013 and asked why Germany's mitigation measures were less effective than neighboring Holland's [*Eddy,* 2013].

The class suggested societal differences. Germany treats flooding as a state problem, whereas Holland considers it a national problem [*Shorto,* 2014]. Moreover, the Dutch accept inconveniences associated with flood protection with much less opposition, the class agreed.

We discussed news reports showing that nominally 100-year floods are becoming common because of building on flood plains and shifting rainfall due to climate change. We also discussed time-independent and time-dependent probability models for floods, hurricanes, and earthquakes.

We extended this discussion on a field trip along the floodplain of the Isar River, asking whether Germany should have national hazard insurance. Geoscience students focused on the fact that such insurance makes society subsidize people who build in dangerous places like flood plains, where it is better not to build. In contrast, students in humanities and law focused on society's obligation to citizens and favored providing insurance to help people even when they acted unwisely.

Safety, but at What Cost?

Our final question was, "If you were a student in Los Angeles, how much more would you pay to live in an earthquake-safe building?" Most students decided that they would pay no more than $10/month.

This provided insight into the decades-long debate about strengthening unsafe buildings [*Nagourney,* 2013]. Because many tenants would not or could not pay more for safety, landlords could not pay the high cost of retrofits and still stay in business.

Although the whole community would benefit from buildings designed to not collapse during earthquakes, only landlords and their tenants would bear the costs. We also discussed the costs and benefits of retrofitting or demolishing the buildings and—if the community decided to—how to pay for it.

Lessons Learned

Judging by students' feedback, the class went well. From their experiences, students learned the need for interdisciplinary thinking about these issues and that because of uncertainties and sociocultural factors, no unique or right strategies exist for any community, much less all communities. However, students agreed that there may be ways to seek robust policies that give sensible results, given the uncertainties.

We sensed interest among students to move beyond a simple "disasters are bad" view to a more sophisticated and nuanced view of the complexities of making sensible policies given the limits of our knowledge and resources. Given that, we encourage instructors to consider approaches similar to this course, either by adding material to existing natural hazards classes or by developing hazard policy classes. Classes like these seem to lead to more interested and informed students and—in time—may help produce more natural hazard scientists.

Acknowledgment

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AGU Sections and Focus Groups Announce 2014 Awardees

Carslaw, Hastings, Sobel, and Weber Receive 2014 Atmospheric Sciences Ascent Awards

Kenneth Carslaw, Meredith Hastings, Adam Sobel, and Rodney J. Weber received 2014 Atmospheric Sciences Ascent Awards at the 2014 AGU Fall Meeting, held 15–19 December in San Francisco, Calif. The award recognizes "research contributions by exceptional mid-career scientists in the fields of atmospheric and climate sciences."

Kenneth Carslaw

Citation for Kenneth Carslaw

We congratulate Dr. Kenneth Carslaw, winner of a 2014 Ascent Award "for outstanding contributions to the modeling of aerosol properties and their impact on climate in the troposphere and lower stratosphere."

—Peter Webster, *Georgia Institute of Technology, Atlanta*

Response

I am honored to receive this award. I would like to thank my many excellent and generous collaborators over many years and to acknowledge in particular the creative and enjoyable interactions with members of my research group at Leeds.

—Ken Carslaw, *University of Leeds, Leeds, UK*

Meredith Hastings

Citation for Meredith Hastings

We congratulate Dr. Meredith Hastings, winner of a 2014 Ascent Award "for increasing our understanding of the interlocking nature of the chemistry of the atmosphere, biosphere and climate and the role humans play in the interconnection."

—Peter Webster, *Georgia Institute of Technology, Atlanta*

Response

I am grateful for the acknowledgement of this award. Thank you to my nominators, supporters, and the AGU Atmospheric Sciences section awards committee for this honor. There are many aspects of my career that I find exciting and fulfilling—from the big picture of trying to understand changes in the environment to mentoring students to watching the data come off the mass spec—and the recognition from an award like this is additionally inspiring and energizing.

My "village" is rich and diverse, and I have so much appreciation for all of those who have influenced my path inside and outside science, from Dr. Gottfried, my eighth-grade science teacher who related everything to how the ocean works, to my high school and college mentors (special thanks to Joe Zawodny, Frank Millero, Gay Ingram, Jamie Goen, Dan O'Sullivan, Esa Peltola, Linda Farmer, Dan DiResta, and Peter Milne), to the deep and enriching education I received at Princeton. I am a better scientist for having worked with Danny Sigman (and Michael Bender, Bess Ward, George Philander, and Jorge Sarmiento). I cannot thank Chip Levy enough for leading me into atmospheric sciences and for his support, confidence, excellent mentoring, and care in balancing work and life. Thanks too for the interactions, advice, and training in knowability I received at the University of Washington from Gerard Roe, David Battisti, Eric Steig, and Tom Ackerman. The amazing women that are members of the Earth Science Women's Network (ESWN) and my colleague, friend, and cheerleader Tracey Holloway, I have so benefited all along the way from your advice and support. Today, I am surrounded at Brown University by excellent colleagues, fantastic students, and Ruby Ho, without whom my lab would not be productive! To my amazing and supportive husband, Eric, and our beautiful girls, Anne and Lyla, thank you for being a constant source of joy.

—Meredith Hastings, *Brown University, Providence, R.I.*

Adam Sobel

Citation for Adam Sobel

We congratulate Dr. Adam Sobel, winner of a 2014 Ascent Award "for fundamental contributions leading to a better understanding of the dynamics of the tropical atmosphere."

—Peter Webster, *Georgia Institute of Technology, Atlanta*

Response

I wish to thank Professor Webster and the Atmospheric Sciences section awards committee for selecting me for this award and also those who nominated me for it. It's a great honor, and I am humbled to be in the company of previous recipients.

It takes a village, as the cliché goes. I learned the field first and foremost from my Ph.D. advisor, Alan Plumb, and my postdoctoral advisor, Chris Bretherton. Kerry Emanuel, Isaac Held, and David Neelin also stand out as mentors from whom I've been privileged to learn over the years. Lorenzo Polvani and Mark Cane have been my most important mentors and colleagues at Columbia, guiding me through academic life since I arrived here 15 years ago. Many more colleagues than I can name at my two Columbia homes—the Lamont-Doherty Earth Observatory and the Department of Applied Physics and Applied Math in Columbia's School of Engineering and Applied Sciences—have made this a wonderful place to go from junior to "midcareer."

I have been especially fortunate, though, to be able to sustain long-term collaborative relationships with several people here in particular, especially Suzana Camargo and Michela Biasutti and, more recently, Michael Tippett and Shuguang Wang as well. Whatever success I have had in research over the last decade is due in large part to them, as well as to an outstanding series of postdocs and graduate students. I consider myself truly fortunate for having had the opportunity to work with scientists of this exceptional caliber. I hope that we are able to keep working together for many more years.

Most of all, I thank my family: my parents and sister; my wife, Marit Larson; and our sons, Eli and Samuel, for their love and support.

—Adam Sobel, *Columbia University, New York, N.Y.*

Rodney J. Weber

Citation for Rodney J. Weber

We congratulate Dr. Rodney Weber, winner of a 2014 Ascent Award "for significant advances in our understanding of aerosols and for the development of novel instrumentation to measure particle formation."

—Peter Webster, *Georgia Institute of Technology, Atlanta*

Response

I feel very privileged to receive this award from the AGU Atmospheric Sciences section and am truly indebted to those who committed their valuable time and effort into putting together my nomination. Receiving the award is a highlight of my research career and provides motivation to continue to pursue topics of interest to me in my own way. Of course, what successes I have had are largely due to the people I have worked with and the generosity of the community of scientists in my research area. This started from Virgil Marple taking me on as new graduate student with dubious background to Peter McMurry, my Ph.D. adviser, who was a role model and provided guidance and opportunities primed for success. After graduate school it was my many friends and colleagues at Brookhaven National Laboratory who showed by example the effort and rigor needed to do good science. But having spent most of my career at Georgia Institute of Technology (Georgia Tech), it is the efforts of my graduate students and postdocs and collaborations with Georgia Tech colleagues that have contributed the most. All of this would have been impossible and meaningless without the support of my family. I thank you all.

—Rodney J. Weber, *Georgia Institute of Technology, Atlanta*

Barnes and Merlis Receive 2014 James R. Holton Junior Scientist Awards

Elizabeth A. Barnes and Timothy M. Merlis received 2014 James R. Holton Junior Scientist Awards at the 2014 AGU Fall Meeting, held 15–19 December in San Francisco, Calif. The award recognizes "outstanding research contributions by a junior atmospheric scientist within three years of his or her Ph.D."

Elizabeth A. Barnes

Citation for Elizabeth A. Barnes

The Atmospheric Sciences section of AGU awards the 2014 James R. Holton Junior Scientist Award to Elizabeth A. Barnes. Dr. Barnes is an assistant professor in the Department of Atmospheric Sciences at Colorado State University. She has already made major contributions to our understanding of midlatitude atmospheric circulation. Although receiving her Ph.D. only 2 years ago, at the time of her nomination she had published 23 papers in high-quality journals and was the lead author on 18 of them.

Elizabeth "Libby" Barnes's accomplishments can best be described by quoting from her nomination letters. "I cannot think of a more deserving candidate among her peers. She is an extraordinarily good scientist. … The amazing fact is this: the quality of her scientific work matches the quantity." "Bottom line: Libby Barnes is spectacularly good. I have no doubt she will become a major force in atmospheric and climate science in the next decade. … She is destined for greatness."

"The diversity of Dr. Barnes' research interests and skills is impressive, particularly for someone so early in their career. She is equally adept at working with observations and numerical models. She has used both a barotropic model and the dynamical core of a GCM to great effect in her research, and has considerable expertise in the analysis and diagnosis of observations. She is widely sought for and gives very clear presentations. Her physical arguments are lucid and her papers are clearly written. Dr. Barnes is a 'star' junior scientist by any measure. She is highly productive, very well known, and has already made fundamental contributions to our understanding of the climate system."

For these reasons, the AGU Atmospheric Sciences section is proud to award the 2014 Holton Award to Elizabeth A. Barnes.

—Alan Robock, *Rutgers University, New Brunswick, N.J.*

Response

I wish to begin by simply saying thank you.

It is an honor to receive this award, but even more so, a humbling experience. I must admit I was surprised to have even been nominated, let alone to have received this award. I suppose that is why one does not nominate oneself!

While there are many people who have helped me along the way, I wish to explicitly express my gratitude to a few key people who supported and guided my enthusiasm for science over the past decade or so: Efi Foufoula-Georgiou, for giving me the opportunity to explore a whole new world of questions; Julia Slingo, for providing me with my very first look at atmospheric science; Dennis Hartmann, for many things, but especially for consistently setting the bar one rung higher than was comfortable while continuing to nurture my scientific development; Lorenzo Polvani, for showing me how to ask interesting questions; and Arlene Fiore, for putting up with me, a dynamicist, while I tried to learn a little bit of chemistry.

Although I received my Ph.D. from the University of Washington, where Jim Holton was a professor for 38 years, I never had the honor of meeting him. I am told he was a wonderful mentor and teacher, and it is, of course, evident that he was also an outstanding scientist. It goes without saying that it is an incredible honor to receive this award bearing his name.

—Elizabeth Barnes, *Colorado State University, Fort Collins*

Timothy M. Merlis

Citation for Timothy M. Merlis

The Atmospheric Sciences section of AGU awards the 2014 James R. Holton Junior Scientist Award to Timothy M. Merlis. Dr. Merlis is an assistant professor at McGill University in Montreal, Canada.

Dr. Merlis is an atmospheric and climate dynamicist who works on baroclinic instability, the dynamics of extrasolar planets, tropical circulation, volcanic eruptions, and global hurricane frequency.

Timothy Merlis's accomplishments can best be described by quoting from his nomination letters. "Tim Merlis ranks at or very near the top of his age group in atmospheric science. His contributions to date are first-rate and are among the very best papers in our field over the last decade. His work is marked by an excellent choice of questions to pose and issues to address, a meticulous but creative approach to addressing these issues, and a clear and effective writing and speaking style. He is both broad and deep." "Tim is the best recent graduate in atmosphere/ocean physics I know. His versatility and familiarity both with large-scale dynamics and mesoscale dynamics is unmatched by anyone else I know at a similar career stage."

"The common thread to all of his papers is his extraordinary ability to isolate simple physical mechanisms within very complex dynamical systems. In most cases, he has done so by performing elegant numerical simulations with idealized models." "The breadth of his research interests, together with his desire to tackle fundamental questions, his rigorous thinking, his creativity and originality, all make Tim a truly exceptional young scientist, who promises to be an intellectual leader in his generation."

For these reasons, the AGU Atmospheric Sciences section is proud to award the 2014 Holton Award to Timothy Merlis.

—Alan Robock, *Rutgers University, New Brunswick, N.J.*

Response

I am grateful to receive the AGU Atmospheric Science section's James R. Holton Junior Scientist Award. It is excellent to receive the award in the same years as Elizabeth Barnes, whose research I admire.

This is a wonderful opportunity to acknowledge the support from which I have benefited greatly. My advisers, Tapio Schneider and Isaac Held, have played an invaluable role in my development. The time I spent as a Ph.D. student with Tapio was truly exceptional. Beyond his scientific insights, Tapio guided my growth in all aspects of the profession. I am deeply appreciative of Isaac's thoughtful scientific advising. It has been wonderful to discuss a wide range of ideas with him.

I am grateful to the group of early career scientists with whom I have had the opportunity to extensively discuss research and other important topics. I treasure interacting with Paul O'Gorman, Simona Bordoni, Yohai Kaspi, Ian Eisenman, Xavier Levine, Gretchen Keppel-Aleks, Nicole Feldl, and others. I also thank the senior scientists who have generously spent time supporting me: Adam Sobel, George Philander, and Kerry Emanuel, among others.

Last, I thank Shanon Fitzpatrick and the rest of my family.

—Timothy M. Merlis, *McGill University, Montreal, Canada*

Visit http://eos.org/agu-news to read more announcements of AGU section and focus group awards.

Li Receives 2014 Yoram J. Kaufman Unselfish Cooperation in Research Award

Zhanqing Li received the 2014 Yoram J. Kaufman Unselfish Cooperation in Research Award at the 2014 AGU Fall Meeting, held 15–19 December in San Francisco, Calif. The award recognizes "broad influence in atmospheric science through exceptional creativity, inspiration of younger scientists, mentoring, international collaborations, and unselfish cooperation in research."

Zhanqing Li

Citation for Zhanqing Li

Professor Zhanqing Li of the University of Maryland's Atmospheric and Oceanic Sciences Department and Earth System Science Interdisciplinary Center is the 2014 recipient of the AGU Atmospheric Sciences section's Yoram J. Kaufman Unselfish Cooperation in Research Award. The award was established in 2009 to honor the memory of NASA Goddard's distinguished scientist, Yoram J. Kaufman, "for broad influence in atmospheric science through exceptional creativity, inspiration of younger scientists, mentoring, international collaborations, and unselfish cooperation in research."

Professor Li, a specialist in remote sensing of radiation budget, aerosol, cloud, land, and their applications for studying Earth's climate, worked in China and Canada prior to joining the University of Maryland in 2001. As a scientist at the Canadian Centre for Remote Sensing, Professor Li led a team of scientists to convince the Canadian Space Agency to join the United States on the NASA satellite mission CloudSat to study impacts of clouds on weather and climate. He developed a satellite-based wildfire monitoring system for Canadian forest agencies that is the basis for the National Oceanic and Atmospheric Administration's fire products today. At Maryland, over the past decade, Professor Li forged educational ties with China and spearheaded a very successful international field campaign called East Asian Study of Tropospheric Aerosols, a Regional International Experiment (EAST-AIRE), including deployment of the U.S. Department of Energy's (DOE's) Atmospheric Radiation Measurement (ARM) Mobile Facility to China. This was a singularly remarkable achievement; in the words of one letter writer, "Only a scientist with extraordinary diplomatic skills and scientific leadership could get these done over Mainland China." These efforts led to many publications in three special issues in the *Journal of Geophysical Research*, with lasting contributions to pollution and climate science over East Asia. Possibly the most lasting impact of Professor Li's scientific research through wide-ranging and unselfish collaboration will be his *Nature Geoscience* paper (2011) on observations that "verified theories that predicted pollution would inhibit gentle, warm rains that nurture crops while exacerbating severe storms."

For these reasons, the AGU Atmospheric Sciences section is proud to present the 2014 Yoram Kaufman Award to Professor Zhanqing Li.

—Anne Thompson, *Earth Science Division, NASA Goddard Space Flight Center, Greenbelt, Md.*

Response

I am humbled to receive the Yoram J. Kaufman Award, not so much because the award recognizes my personal achievement, which has already been honored by my election as an AGU Fellow this year, but more because it rewards the collective efforts made by a large number of collaborators with whom I have the privilege of working with in the United States, Canada, and China. Living in these great countries is the most valuable treasure of my life. The Chinese cultural tradition of making education a top priority motivated me to build a solid foundation that has been beneficial to my whole career. In Canada, teamwork led to the award-winning project on fire monitoring, mapping, and modeling. In the United States, the unparalleled freedom and ample resources in choosing and pursuing any research topic helped realize my American dreams. In the era of globalization, especially when we are facing such global challenges as climate and environmental changes, international cooperation is the key for the well-being of all mankind. In this regard, I feel particularly fortunate to have been in the right place at the right time to promote two major international cooperative initiatives with ample support by all three countries, namely, CloudSat between the United States and Canada and EAST-AIRE and AMF between China and the United States. These initiatives allowed my team to better understand the impact and interactions between atmospheric environment and climate change on global scales. This would not be possible without unselfish collaborations with scientists and engineers from many institutions, including the NASA Goddard Space Flight Center, DOE laboratories, Beijing Normal University, Nanjing University of Information Science and Technology, and the Institute of Atmospheric Physics, among others. I am most indebted to the tens of graduate students and postdoctoral fellows working with me in the past and present.

Winning this award reminds me of how much I miss my dear friend and a genius colleague, the late Yoram J. Kaufman, who helped change the trajectory of my research career. I vividly recall his visit to Canada at a time when my research interests had only a glancing connection with aerosols from the perspective of wild fires and Earth's radiation budget. His enlightening talk about aerosol-cloud interactions inspired me to shift my research more toward the new frontier of broad aerosol-climate interactions. His spirit of unselfish collaboration during our interactions was infectious and instilled in me the desire to work with others in a similar way.

—Zhanqing Li, *Department of Atmospheric and Oceanic Science and the Earth System Science Interdisciplinary Center, University of Maryland, College Park; and Beijing Normal University, Beijing, China*

Benitez-Nelson Receives 2014 Sulzman Award for Excellence in Education and Mentoring

Claudia Benitez-Nelson received the 2014 Sulzman Award for Excellence in Education and Mentoring at the 2014 AGU Fall Meeting, held 15–19 December in San Francisco, Calif. The award is given for "significant contributions by a mid-career female scientist as a role model and mentor for the next generation of biogeoscientists."

Claudia Benitez-Nelson

Citation for Claudia Benitez-Nelson

Dr. Claudia Benitez-Nelson is a College of Arts and Sciences Distinguished Professor in the Marine Science Program and Department of Earth and Ocean Sciences at the University of South Carolina (USC). She is the recipient of the 2014 Sulzman Award for Excellence in Education and Mentoring, which "recognizes women in AGU who have sustained an active research career in a field related to biogeosciences, while excelling in teaching, mentoring young scientists, and serving as critical role models for the next generation of female scientists."

Dr. Benitez-Nelson has made mentoring, teaching, and outreach a critical component of her career. Her impact at South Carolina was immediate, resulting in her being named the 2002 South Carolina Alliance for Minority Participation Outstanding Mentor. In 2005, she received the Michael J. Mungo Undergraduate Teaching Award and was named Outstanding Faculty of the Year by the National Society of Collegiate Scholars. Since then, she has continued to receive awards for excellence in outreach and teaching. In 2013 she was named USC Distinguished Professor of the Year, USC's highest honor.

What makes Dr. Benitez-Nelson so special is that she also maintains a high profile and active research program. Her research focuses on understanding the ocean's role in climate change, as well as human impacts on nutrient biogeochemistry and coastal ecology. She has authored or coauthored over 80 publications in a wide range of journals and is the recipient of over $4 million in research funds. In 2006, Dr. Benitez-Nelson's research was recognized by AGU, who awarded her the Ocean Sciences Early Career Award.

Those who know her best agree that Dr. Benitez-Nelson's many accomplishments in her career, her vast con-

nections within the oceanography community, her service on prestigious committees and boards, and her passion for education, mentoring, and outreach are why she is the recipient of the 2014 Sulzman Award for Excellence in Education and Mentoring.

—Deidre Gibson, *Hampton University, Hampton, Va.; and Adina Paytan, University of California, Santa Cruz*

Response

It is a great honor to receive the 2014 Sulzman Award. Dr. Sulzman is a true inspiration to many, and it is a privilege to receive an honor established on her behalf.

I believe that the mentoring and education of scientists throughout their career is critical to the success of our field. Creating a diverse population of researchers brings new insights and allows for novel interactions that might otherwise be lost within more homogeneous groups. Indeed, we now recognize how important biodiversity is to the Earth's ecosystem; is it so hard to believe that the same is true for the geosciences? The difficulty is to convince students from varied backgrounds just how exciting, challenging, and, ultimately, rewarding a science career can be. I feel I have the best job ever! I have the opportunity to conduct research in any area that I choose and to interact with scientists and students from cultures all over the world.

I am fortunate to be surrounded by a truly wonderful support group—strong female mentors and colleagues; the faculty, staff, and administration at the University of South Carolina who have allowed me to be innovative in both research and education; and an incredible partner who always supports me in everything that I do.

I thank Dr. Adina Paytan and Dr. Deidre Gibson for nominating me for this wonderful award, Dr. John Farrington and Dr. Mary Jo Richardson for their letters of support, and the Biogeosciences section of AGU for giving me this wonderful honor.

—Claudia Benitez-Nelson, *University of South Carolina, Columbia*

Hewitt Receives 2014 Cryosphere Early Career Award

Ian Hewitt received the 2014 Cryosphere Early Career Award at the 2014 AGU Fall Meeting, held 15–19 December in San Francisco, Calif. The award is for "a significant contribution to cryospheric science and technology."

Ian Hewitt

Citation

Despite his young age, Ian Hewitt is one of the most impressive theoretical glaciologists active today. His work has focused on the interplay between subglacial drainage and ice flow dynamics, a topic that has attracted much attention inside and outside of our discipline ever since the velocity of the Greenland Ice Sheet was observed to speed up in response to surface melting. Evolving channelized drainage systems are key to understanding how more melt is likely to affect ice flow in future. As part of his Ph.D., Ian constructed, to my knowledge, the first mathematical model for how channels interact in two dimensions, setting the stage for a new generation of subglacial hydrology models currently being implemented more widely.

This was followed up with work explaining the physics behind melt-driven velocity changes in ice sheets, complementing the large body of observational work generated by many researchers over the last decade. The novelty of this work lies not only in the sophistication of its drainage model but in finally providing a fully coupled ice flow-drainage modeling framework.

Like many successful theoreticians, Ian's background lies outside of glaciology, in his case modeling magma migration in the Earth's mantle and applied mathematics more generally. The culture of applied mathematics does not often lend itself to an easy knowledge transfer between modeling and application, but Ian seems not only to know instinctively how to communicate his own results to the wider glaciological community but also to have as good a grasp of the realities of many areas of glaciology—especially field work and operational numerical modeling—as any theoretician. In fact, he was one of the best field assistants I have ever taken on a glacier.

I cannot think of a more deserving candidate for the Cryosphere Early Career Award at AGU.

—Christian Schoof, *University of British Columbia, Vancouver, Canada*

Response

I am extremely grateful to the Cryosphere focus group for selecting me for this award. To say it was a surprise is a great understatement, but it is no less of an honor for that. I can think of many colleagues who I feel are more deserving of this recognition, and that makes me all the more touched to have been chosen. I take the award as encouragement and motivation to continue my work and endeavor to live up to it.

As a mathematician by training, I am particularly honored to have been recognized by AGU. Since starting to research theoretical aspects of glaciers during my Ph.D., I have been constantly inspired by the opportunity to discover and wonder at these amazing forces of nature. The science is unerringly fascinating and challenging, and I feel privileged to have the chance to try and help advance it.

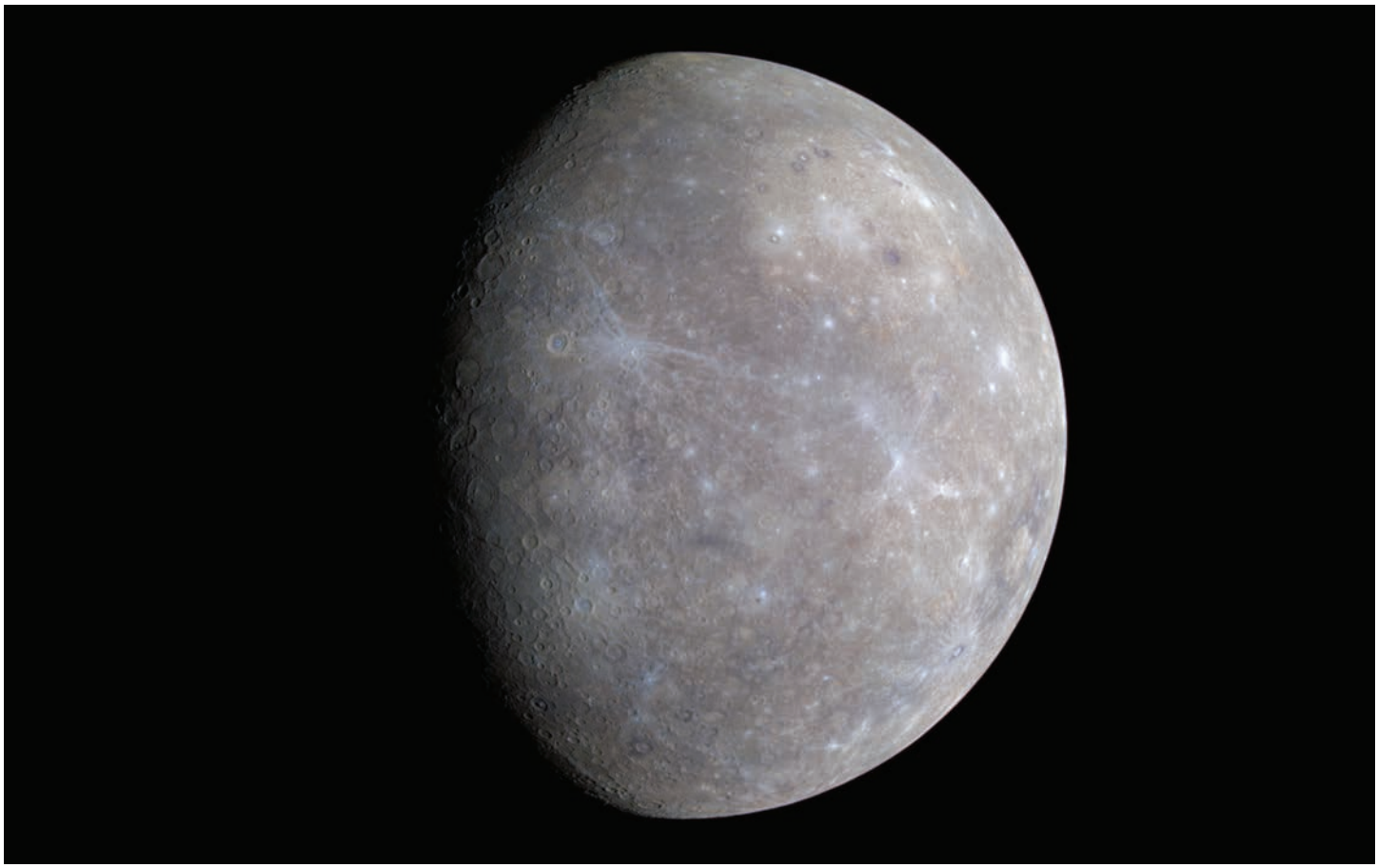
As much as the science itself, I have been constantly uplifted by the opportunity to meet and work with fantastic colleagues. I have found the cryospheric community to be just that—a community—and it has a spirit of shared inquiry which I think sets it apart from other branches of science. It is this lively sense of community which makes glaciology—for me—uniquely fulfilling.

I would like to extend special thanks to those I have worked closely with and those who wrote supporting letters for this award. I would like to highlight my thesis supervisor, Andrew Fowler, who pointed me in the direction of the Alps to begin with; lecturers and fellow students at the Karthaus summer school, who got me hooked on ice; and Christian Schoof, Mauro Werder, and Gwenn Flowers for widening my horizons and for providing constant ideas, support, and inspiration.

Thank you!

—Ian Hewitt, *University of Oxford, Oxford, UK*

Large-Scale Currents May Flow Through Mercury's Crust



True-color image of Mercury taken by Mercury Surface, Space Environment, Geochemistry, and Ranging's (MESSENGER) Wide Angle Camera on 14 January 2008.

NASA's Mercury Surface, Space Environment, Geochemistry, and Ranging (MESSENGER) spacecraft became the first satellite to orbit Mercury on 18 March 2011. One of its goals has been to collect data on the planet's magnetic field. A recent paper by *Anderson et al.* reports the first observations of Birkeland currents over Mercury's northern hemisphere.

Birkeland currents, first proposed by Kristian Birkeland in 1908 and confirmed at Earth in the 1960s, are produced by the interaction of the solar wind with the planetary magnetic field. These electric currents flow along magnetic field lines, connecting a planet's magnetosphere to its upper atmosphere. At Earth, the currents link to the ionosphere, but Mercury has no ionosphere, so it was not clear whether a similar current system could exist at Mercury.

Scientists first discovered hints of Birkeland currents at Mercury in 1997 from data acquired by Mariner 10 during flybys of the planet in 1974 and 1975. However, they could not determine whether there was a global-scale current system, similar to that seen at Earth. The question is especially intriguing because Mercury is essentially airless, and the way the currents would close, forming an uninterrupted path for the flow of charge, would necessarily be radically different from that at Earth. Basic questions remained: Are there persistent field-aligned currents at Mercury? If so, how do they close at low altitudes?

MESSENGER data from 23 March 2011 to 28 April 2012 have been studied to resolve this puzzle. MESSENGER's magnetometer collected measurements that gave complete coverage of Mercury's magnetosphere every 88 days. Researchers processed these data between latitudes 20°N and 83°N to resolve magnetic signals of Birkeland currents. From Ampere's law, the researchers calculated the strength, density, and polarity of the currents. The results show that steady Birkeland currents are indeed present and are strongest between 60°N and 80°N, with a typical magnitude of 30,000 amperes.

Because there is no ionosphere at Mercury, the researchers modeled how the currents might close through the planet itself. The most likely solution, consistent with nominal electrical conductance values for silicates, is that the currents flow radially through the planet's crust, which is made of low-conductivity material, and then close laterally at depths where the temperature, and hence electrical conductivity, is much higher than at the surface. The results imply a truly intimate connection between the planetary interior and its solar wind interaction. (*Geophysical Research Letters*, doi:10.1002/2014GL061677, 2014) **—Jessica Orwig, Freelance Writer**

Do Cities Cause Thundersnow?

Flashes of lightning and booming sounds from the sky typically accompany rain, not cold white flakes. So-called thundersnow is rare. However, on Groundhog Day in February 2011, a storm in the central United States saw up to 75 centimeters of white fluff and 282 lightning flashes. The National Lightning Detection Network (NLDN) reported nearly all as negative-polarity cloud-to-ground (CG) flashes—typical of thundersnow events. Closer inspection revealed something very untypical.

During the height of the blizzard, media reporters noted lightning apparently striking Chicago's skyscrapers. Curiously, despite strong northeast winds blowing in from Lake Michigan, no lightning was detected anywhere over the warm lake waters. In a recent paper, *Warner et al.* compared the reported lightning locations for each flash in a multistate region with databases for tall buildings, wind turbines, and towers. They found that up to 93% of the thundersnow flashes were likely self-initiated upward lightning (interpreted as "ordinary" negative CG lightning by NLDN).

Upward positive lightning leaders often are triggered from tall structures in thunderstorms when there is a positive-polarity CG strike nearby. However, in this case, the upward leader initiation required no prior triggering event. It appears that the strong winds were blowing away the corona discharge shielding that forms on tall objects, allowing the charge accumulating on towers and skyscrapers to more readily "strike the sky."

Were it not for the "human-built environment" and the blizzard's strong winds, the authors note, the February 2011 storm might have produced very little thundersnow.

Ken Douglas, CC BY-NC-ND 2.0 (http://bit.ly/ccbyncnd2-0)

Chicago skyscrapers poke into clouds as snow falls over the city.

Similar events were detected in the early October 2013 blizzard in western South Dakota, in which TV and communication towers appeared to launch numerous self-initiated upward positive leaders. (*Journal of Geophysical Research: Atmospheres,* doi:10.1002/2014JD021691, 2014) **—Shannon Palus, Freelance Writer**

How Do Tiny Ice Crystals Help Sea Ice Stay Thick?

In Antarctica, disk-shaped crystals known as frazil ice can seed growth under an ice cover. The crystals are part of ice shelf water (ISW) plumes, supercooled water beneath the sheets of ice.

Over large areas, ice shelf and sea ice growth depends on the plume, and the existence of the plume depends directly on the size and concentration of the frazil ice crystals within it. In a recent paper, *Hughes et al.* examined the growth of sea ice in McMurdo Sound, Antarctica, to improve and expand on a previous model of ISW plumes and the physics behind their contribution to ice shelf and sea ice growth.

The authors modified an existing one-dimensional plume model to focus on the sea ice–ocean interface. The model takes the frazil ice concentration of the plume into consideration, as well as the temperature and salinity of the plume. Oceanographic stations in the McMurdo Sound provided data input for the model. Eighteen trials of the model determined which variables affected the ice plume–sea ice interaction the most.

The material traveling through the plume reveals the rate of growth that the plume contributes to the sea ice. The authors concluded that the ISW plume contributes a tenth of a meter of growth to McMurdo Sound sea ice each year—accounting for about 5% of the total average thickness, they say. (*Journal of Geophysical Research: Oceans*, doi:10.1002/2013JC009411, 2014) **—Shannon Palus, Freelance Writer**

Blue°Canoe, CC BY-NC-ND 2.0 (http://bit.ly/ccbyncnd2-0)

Sea ice in Antarctica's McMurdo Sound.

Chris Vogel

A view looking down from an observation tower in an unaltered forest within the University of Michigan Biological Station. From this tower, scientists measure gas exchange, transpiration rates, and other variables.

As Forests Age, Their Climate Effects Shift

Although it may be difficult for us to observe in our short lifetimes, the composition of trees in a forest can be a very variable thing. When a forest is clear-cut or thinned by fire, the first trees to rebound are often the fastest growing—those that can sprout quicker than their competitors. However, over time, these speedy forerunners often get supplanted by sturdier, slower species that eventually grow taller and cast their predecessors into shadow and eventual obscurity.

As the composition of the forest changes, its influence on the climate at large also shifts: Some trees produce more oxygen, some consume more carbon dioxide, and others release more water into the air. To investigate how these dynamics change as the forest ages, researchers at the University of Michigan Biological Station artificially accelerated the natural succession of a deciduous forest in northern Michigan by killing off a large number of aspen and birch trees to make way for the up-and-coming red maples, red oaks, and white pines that typically characterize a more mature forest. Over the course of a 3-year study, *Matheny et al.* measured differences in gas exchange, transpiration rates, and other variables between the altered forest and plots that were left alone.

Overall, transpiration—the process that carries moisture from roots to leaves and eventually into the air—was found to be reduced by approximately 15% in the altered plots. However, several individual tree species, including red oaks and white pines, showed an increase in the amount of water they released into the atmosphere.

The total transpiration was also discovered to be influenced by a species-specific relationship between sap flux and how saturated the atmosphere is with water. This relationship changes as the day progresses, with transpiration occurring most in the morning and tapering off as the day goes on.

The researchers concluded that understanding how the rates of nutrient exchange between trees and the atmosphere change as forests age may help modelers understand how the climate as a whole will be affected in the future. It may also shed light on how the management of forests may influence future climate. (*Journal of Geophysical Research: Biogeosciences*, doi:10.1002/2014JG002804, 2014) **—David Shultz, Freelance Writer**

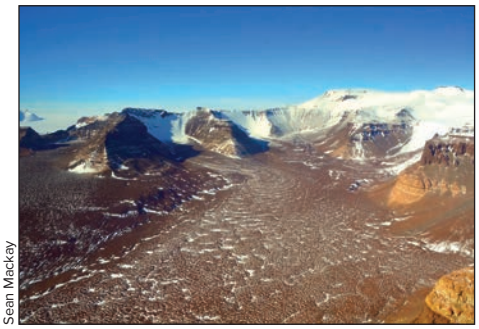
Glacial Debris Hints at Ancient Climate Change

Antarctica's coastal McMurdo Dry Valleys rank among the most extreme deserts on Earth. Nearby mountains block out inland ice and have left the region largely devoid of ice cover. The neighboring valleys, however, hold alpine glaciers like the Mullins and Friedman ice floes, both of which may contain some of the oldest ice on the planet. The ice is preserved beneath a layer of surface dust and rocks that can range from just a few inches to more than 2 feet thick.

Mackay et al. used radar, ice cores, mapping, and numerical modeling to study these glaciers and found that their upper reaches are largely devoid of debris. After that, thin bands of internal debris occur at regularly spaced intervals and intersect the ice surface to produce curved ridges. The authors think this pattern could hold clues to ancient climate conditions.

The researchers conclude that the layers are caused by cyclical environmental changes at valley headwalls. They believe the debris layers build up on the surface during times of reduced ice accumulation, only to be buried by snow and ice when the cycle begins again. The implication is that the internal structure and surface morphology of these cold-based, debris-covered glaciers preserves a record of climate and environmental change over the past several hundred thousand years.

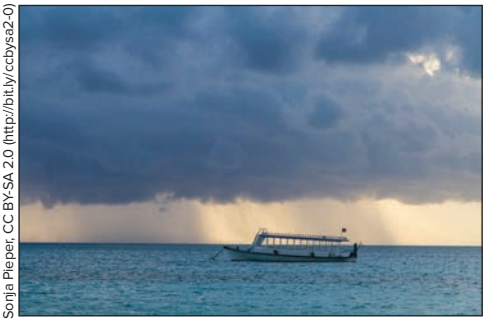
Cold-based debris-covered glaciers are common in Antarctica and have been reported on Mars, so the interpretation could also have important implications for climate research elsewhere. (*Journal of Geophysical Research: Earth Surface*, doi:10.1002/2014JF003178, 2014) **—Eric Betz, Freelance Writer**



Sean Mackay

The Mullins and Friedman debris-covered glaciers descend from steep cliffs and advance northward toward central Beacon Valley in the Quartermain Mountains, Antarctica.

Radar Shows Where Water and Ice Occur in Large Storms



A storm gathers near the Maldives Islands.

Rain and snow are familiar phenomena, but in tropical clouds, snow only exists in the upper, colder parts of the clouds. Yet the ice falls into the warmer air below, melts, and becomes part of the rain. The atmospheric conditions that cause different rain intensities and types of ice to occur are important to understand but difficult to observe.

In a new study, *Barnes and Houze* catalog different types of "hydrometeors"—particles of water and ice—that occur in tropical cumulonimbus clouds. Although past studies have used radars to study how ice and liquid hydrometeors occur in rainstorms, this study is the first of this type to examine how ice and liquid particles form in the airflow through the large rainclouds that populate equatorial oceanic regions. The heat released as these particles form in tropical clouds plays a critical role in the energy balance of the atmosphere.

The authors focused specifically on airflow through organized groups of storms known as mesoscale convective systems, which are larger than 100 kilometers in size and are one of the main conduits by which heat from the warm ocean is conveyed to the upper atmosphere. Two main types of airflow influence these groups of clouds: Convective updrafts travel upward and then outward, and midlevel inflows travel laterally and gradually descend. This study shows how the formation of the liquid and ice particles of the clouds is organized and controlled by the unique air motions of mesoscale convective systems.

This study used data from the Indian Ocean collected by a powerful National Center for Atmospheric Research radar. The radar viewed the clouds with Doppler-shifted signals that show the in-cloud air motions and with horizontally and vertically polarized microwaves that allow the nature of the particles in the cloud to be determined. This radar saw clouds in 11 different instances of major rainfall, each spanning 2 days. A particle identification algorithm picked through the extensive data, revealing the type of hydrometeor in different parts of the cloud.

The resulting schematic of these cloud systems showed that in their convective updrafts, the heaviest rain occurred below the upward flowing air. In regions of midlevel inflow, hydrometeors were found in layers with small ice particles forming in the uppermost region of the clouds, with aggregates of ice particles forming toward the middle levels before becoming soggy and melting long before falling to the sea surface.

The observations indicate that processes that produce the liquid and ice particles are very systematically organized with respect to the airflow in the storm. Such a picture of the precipitation-forming processes in large tropical clouds has never before been available. (*Journal of Geophysical Research: Atmospheres*, doi:10.1002/2014JD022241, 2014)

—Shannon Palus, Freelance Writer

Gravity Waves Drive Global Upper Atmosphere Changes

Scientists watched Earth's upper atmosphere intently as the Sun went quiet during the recent solar minimum, which lasted from 2007 to 2010. At that time, spacecraft saw temperatures and densities decline in our planet's thermosphere as a result of the shift in the Sun's activity. Simultaneously, however, deep convection—caused by solar heating near Earth's surface—remained similar to levels seen during the prior solar maximum.

Vadas et al. looked at the influence of gravity waves—created by disturbing a stable fluid or gas—which scientists widely suspect can transport energy and momentum across layers of Earth's atmosphere. The team started by identifying deep convective objects such as plumes of air that travel to high altitudes in the lower stratosphere and then modeled the gravity waves they create. The study used almost 2 weeks' worth of data, which was collected by a handful of weather satellites during a period of low sunspot activity in the summer of 2009, as well as a corresponding period 9 years earlier during solar maximum.

The researchers used a model that showed how the gravity waves are created and used another model that traced the paths of the gravity waves to the thermosphere, where they dissipate. The researchers then used a third model to show how these waves created global responses in Earth's thermosphere and ionosphere.

The dissipating gravity waves disturbed both the winds and temperature hundreds of kilometers above Earth's surface on a global scale. The researchers add that this is the first study to look at the global impacts on the dynamics of the upper atmosphere as a result of this deep convection. (*Journal of Geophysical Research: Space Physics*, doi:10.1002/2014JA020280) **—Eric Betz, Freelance Writer**

Thunderhead clouds allow for deep convection in the atmosphere. This convection triggers the formation of gravity waves as air becomes disturbed.

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Atmospheric Sciences

NASA Cyclone Global Navigation Satellite System, Science Operations Center Atmospheric, Oceanic and Space Sciences Dept., University of Michigan

CYGNSS is a NASA mission led by the University of Michigan to study tropical cyclones (TC) and tropical convection. The mission's two primary objectives are measurement of ocean surface wind speed with high temporal resolution, to resolve short time scale processes such as the rapid intensification phase of TC development, and penetration through the precipitation typically encountered in the TC inner core. The mission's goal is to support significant improvements in TC forecasting. CYGNSS is scheduled to launch in 2016. Its flight segment consists of a constellation of eight satellites, each carrying a 4-channel bistatic scatterometer receiver that measures GPS navigation signals scattered by the ocean surface. The ground segment consists of a global network of ground stations, a Mission Operations Center and a Science Operations Center (SOC). The SOC, located in the Space Physics Research Laboratory (SPRL) at the University of Michigan in Ann Arbor, implements the science data processing algorithms, supports calibration and validation of the science data products, coordinates the activation of special science modes on the spacecraft, and serves as the primary interface to the mission for the CYGNSS science team.

The University of Michigan is seeking an individual to join the CYGNSS science team and support the scientific activities of the SOC. The individual will work closely with the SPRL software engineers who are developing and operating the SOC, in support of its objectives, and with the other science team members directly involved with algorithm development, cal/val activities, and special modes operations. The individual may also pursue their own scientific research interests related to the CYGNSS mission and will have unique access to the early and low level data products to do so.

The position requires a Ph.D. degree in a related field (e.g. Atmospheric Science, Meteorology, Physics, Engineering). Familiarity with tropical meteorology and Earth remote sensing are desirable. The position is full time for a minimum of one year, with the possibility for an extension throughout the mission life. Starting salary and rank will depend on the qualifications of the candidate, with the expectation of advancement based on performance. The position opens in March 2015 and will remain open until a suitable candidate is selected. Interested individuals should submit a statement of interest and current CV to Prof. Chris Ruf <cruf@umich.edu>.

For more information about the CYGNSS mission, see <http://cygnss-michigan.org>, <http://www.sprl.umich.edu/>.

For more information about the University of Michigan, see <http://aoss.engin.umich.edu/>, <http://umich.edu/life-at-michigan/>.

NGGPS Subseasonal Prediction at Princeton University

The Atmospheric and Oceanic Sciences Program at Princeton University, in association with NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), seeks two postdoctoral or more senior scientists for subseasonal (14–30 day) prediction of extreme and disruptive weather events, with a focus on severe winter storms, warm-season severe weather outbreaks, and hurricanes. The successful candidates will aid development of diagnostics of high-impact events in sub-seasonal ensemble predictions from the convection-permitting GFDL HiRAM model, and carry out simulations in support of the seasonal forecast effort. This will include the automatic identification of tropical and extratropical cyclones, atmospheric rivers, cold air outbreaks, sudden stratospheric warmings, tropical waves, the MJO, and related phenomena important for subseasonal prediction. The candidates will also work to develop a database of observed severe weather events, both warm- and cold-season, against which verification of retrospective seasonal forecasts can be performed.

Each selected candidate must have a Ph.D. in meteorology, atmospheric sciences, or a closely related field. The candidates will have strong backgrounds in either tropical meteorology or synoptic-scale meteorology, and should have some experience using and analyzing weather and/or climate models. The positions are for one year renewable for up to three years pending satisfactory progress and continued funding.

Complete applications, including a CV, publication list, contact information for at least 3 references in order to solicit letters of recommendation, and a one-to-two page statement of research interests should be submitted by June 15, 2015 for full consideration. Applicants should apply online to http://jobs.princeton.edu, Requisition #1500226. For additional information contact Lucas Harris (lucas.harris@noaa.gov) and/or Shian-Jiann Lin (shian-jiann.lin@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.

Postdoctoral Scientist in Radiative Forcing Model Intercomparison Project

The Atmospheric and Oceanic Sciences Program at Princeton University, in association with NOAA's Geophysical Fluid Dynamics Laboratory (GFDL), seeks a postdoctoral scientist for research related to atmospheric radiative transfer modeling. The scientist will perform research into the transfer of solar and longwave radiation in the Earth's atmosphere with the aim of quantifying the roles of greenhouse gases, aerosols, and clouds.

A Ph. D. in Atmospheric Sciences or a related field is required, with specialization and demonstrated ability to carry out independent research in atmospheric radiative transfer. Skills in radiative transfer computations will be needed to use state-of-the-art benchmark models and climate model parameterizations. Programming skill in Fortran is essential. Knowledge of the role of aerosol radiative processes in climate and climate change, and skills in evaluating radiative transfer calculations with appropriate observations, are desirable.

Initial appointment is for one year with the possibility of renewal subject to satisfactory performance and continued funding. Complete applications, including a CV, publication list, contact information for three references, and a one-to-two page statement of research interests should be submitted by June 1, 2015 to ensure full consideration. For further information, contact David Paynter (David.Paynter@noaa.gov). Applications should apply online to http://jobs.princeton.edu, Requisition 1500204. These positions are

MAX-PLANCK-GESELLSCHAFT

Nominations sought for the position of Director at the Max-Planck-Institute for Biogeochemistry in Jena, Germany

The MPI for Biogeochemistry is in the process of identifying candidates for a new Scientific Director. The MPI for Biogeochemistry (http://www.bgc-jena.mpg.de) in Jena is committed to basic research on the role of biogeochemistry in the Earth System, with a special emphasis on the interaction between terrestrial ecosystems, the hydrosphere and the atmosphere. Founded in 1997, the institute has developed a research agenda comprising process studies, regional and global observations combined with model development and model-data integration. The institute has three Departments, several independent research groups and state-of-the-art technical and field facilities (chemical analysis, stable isotopes, gas analytics, eddy flux and tall towers and other field instrumentation, 14C analyses, high performance computing). The institute is strongly linked to the University of Jena via joint graduate schools and research programs, including an International Max Planck Research School for Global Biogeochemical Cycles. The three current departments are: Biogeochemical Processes (headed by Susan Trumbore), investigating biogeochemical processes with field and laboratory measurements and experiments; Biogeochemical Systems (headed by Martin Heimann), coupling atmospheric observation with models to investigate surface-atmosphere trace gas fluxes; and Biogeochemical Integration (headed by Markus Reichstein), with an emphasis on combining biosphere models with local to global observations for biogeochemical Earth System diagnosis and prediction.

We currently seek a **Scientific Director/ Department Head** to succeed Martin Heimann's directorship and to be filled in the 2016/2017 time frame. We seek an individual with a strong track record in and vision for using observations to diagnose interactions between the biosphere, hydrosphere, atmosphere/climate at regional to global scales. Nominees must have a record of innovative research at the highest international level, and will have demonstrated the potential to inspire and lead a department of researchers, technical staff and graduate students. Their scientific interests can complement existing research at the Institute or introduce completely new directions of research related to global biogeochemical cycles. The goal is to identify the strongest and most creative scientists worldwide, and to offer them decades of stable and predictable scientific funding.

Written nominations will be treated in strictest confidence, and must include a short description of the nominee's background and most significant scientific accomplishments. Self-nominations are considered when accompanied with a recommendation letter.

The Max Planck Society encourages the nomination of female scientists for these positions as it seeks to increase the number of women in areas where they are under-represented.

Contact: Prof. Dr. Markus Reichstein (mreichstein@bgc-jena.mpg.de, currently managing director) and Prof. Susan Trumbore, Ph.D. (trumbore@bgc-jena.mpg.de), Max-Planck-Institute for Biogeochemistry

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.

Hydrology

A researcher is sought to conduct hydrologic studies in the Congo Basin. This is a broadly defined position in terms of both the appointment type and specific research (note, however, that this is not a tenure-track faculty position). For example, a faculty member seeking a sabbatical would be considered and hired as a consultant, or a scientist several years beyond their Ph.D. who is seeking a new direction in their research could be hired as a consultant or a postdoctoral researcher. The successful candidate will study the hydrology of the Cuvette Centrale wetlands. However, the focus could instead be on the overall water balance of the basin, or involve wetland biogeochemistry, or be applications oriented, etc. Specifically, the researcher in this position will be expected to lead-author peer-reviewed papers on their Congo research and submit applications or proposals for funding on Congo related studies. The researcher is also expected to have demonstrated their research skills by having already published scientific papers. While not required, candidates who have a working ability in the French language are desired (not necessarily fluent, but passable). The position will be available at the Byrd Polar and Climate Research Center at The Ohio State University in Columbus Ohio. Contact Prof. Douglas Alsdorf (alsdorf.1@osu.edu) for more information. To submit an application, email a PDF of your CV and one relevant publication to Prof. Alsdorf. The position is open until filled. Ohio State is an equal opportunity employer. All final applications will have to complete a background check.

Hydrologist sought by SRK Consulting (U.S.), Inc. for its Lakewood, CO location (and other US locations as needed) to construct numerical hydrological models. Requires a Bachelors degree in Geology or a related field plus five years of experience in consulting. Experience in the construction of numerical hydrogeological models. Mine dewatering experience in underground and open pit mines. Knowledge in water supply and groundwater chemistry related to mining. Ability to provide proof of advice provided to mining clients (i.e. published reports, client references, presentations, etc.). Five years of experience using groundwater modeling software MODFLOW. Two years of experience using groundwater modeling software FEFLOW. Experience with numerical modeling of heap leach for process optimization. Requires travel to client sites. Must have authority to work permanently in the U.S. Apply online at www.jobpostingtoday.com, Reference #2084

Ocean Sciences

PHYSICAL OCEANOGRAPHER/ MARINE GEOPHYSICIST Experimental Ocean Electrodynamics

The University of Washington Applied Physics Laboratory (APL) seeks a sea-going experimental physical oceanographer or marine geophysicist to lead a program in ocean electrodynamics. The successful candidate will be expected to develop an observational/experimental ocean or coastal research program with an emphasis on innovative sensor development and use. Present activities include theory, modeling, instrumentation, and field programs spanning basic research to applied and classified efforts. Historically, this program has implemented motionally induced voltage sensors on many platforms (e.g., ships, profilers, gliders, floats, drifters, landers and submarine cables) to study oceanic flows and turbulence. Newer topics include adding turbulence sensors to EM-APEX floats, EM remote salinity profiling in marine estuaries, observing the global electric circuit and installing EM sensors on NSF's OOI submarine cable. Several measurement systems are available for immediate use for both ocean velocity and magnetotelluric studies.

Candidates should have a demonstrated record of research and development in the ocean. A senior candidate should have existing funded projects. A junior candidate should have strong potential to fund independent projects. APL will provide bridge salary and support for engineering services. Candidates who can obtain a US security clearance are preferred. The Seattle area has an active oceanographic community with a variety of strong institutions and active colleagues.

For more information and to apply for this position, visit: http://www.apl.washington.edu/jobs/jobs.php

UConn Marine Sciences - Postdoctoral Fellow I

The Department of Marine Sciences at UConn is seeking a postdoctoral scholar to study the impact of evaporation and precipitation on the salinity structure of the upper ocean as part of the NASA SPURS-2 program. The candidate will work with Dr. James Edson to deploy systems capable of measuring heat, momentum, radiative and evaporative fluxes from a surface mooring and research vessels. The candidate will participate in the field program in the eastern tropical pacific and assist in the analysis and publication of the collected data. For details on the position, visit www.jobs.uconn.edu. The University of Connecticut is an EEO/AA employer. (Search # 2015122)

Solid Earth Geophysics

Colorado School of Mines Department of Geophysics Baker Hughes Chair

Colorado School of Mines invites applications for the position of the Baker Hughes Chair of Petrophysics and Borehole Geophysics, a regular academic faculty position in Geophysics, which is anticipated to be filled at the rank of Associate or Full Professor. The Department is seeking an individual with a distinguished international reputation in the study of rock properties (e.g., physical, chemical, electrical, mechanical) and their interactions with fluids, in the context of exploration for, and development of, natural resources. The successful candidate will be one who investigates poroelastic and fractured media with a multi-scale perspective that considers information obtained in lab, borehole and field environments.

Candidates must have earned a doctoral degree in geophysics or a related discipline and have demonstrated success in their career as an educator and researcher commensurate to receiving tenure at a research-active university like Mines. The successful candidate must demonstrate leadership in scholarship, service, and teaching at the undergraduate and graduate levels. Applicants for consideration at the Professor rank must also demonstrate national or international recognition in their discipline. Candidates must possess superb interpersonal and communication skills and a collaborative style of research and teaching, and must have experience in collaboration with industry. Preference will be given to candidates whose research interests hold potential for multidisciplinary collaboration.

For the complete job announcements and directions on how to apply, visit: http://inside.mines.edu/HR-Academic-Faculty

Mines is an EEO/AA employer.

Interdisciplinary/Other

Director, Advanced Energy Technology Initiative Illinois State Geological Survey

Prairie Research Institute

University of Illinois at Urbana-Champaign

The Illinois State Geological Survey (ISGS) is part of the Prairie Research Institute (PRI) at the University of Illinois at Urbana-Champaign which is centrally located between Chicago, St. Louis, and Indianapolis. PRI houses five large scientific surveys covering a wide range of expertise including biology, water resources, climate, geology, sustainable technology and archaeology. The ISGS is a premier state geological survey, with over 200 scientists and technical support staff, serving the needs of the public, government, and industry with earth science information and research relevant to natural resources, environmental quality, economic vitality, and public safety. The University is a land-grant institution that provides access to world-class laboratory and academic facilities, Big Ten athletic events, and internationally acclaimed cultural opportunities.

We are seeking an individual to provide leadership, clear scientific vision, and direction to the subdisciplines and staff members that comprise the Advanced Energy Technology Initiative (AETI) at the ISGS. The leadership skills of the individual will encourage multidisciplinary, project-based research within AETI and throughout ISGS, other Surveys, and University related to energy issues; develop, implement, and administer research and service programs of the AETI; and facilitate coordination, communication, and teamwork throughout the PRI and the University. As the Director of AETI, the individual will promote AETI services and capabilities to a variety of stakeholders including government funding agencies, corporations, and legislative representatives. The individual will continue to maintain AETI's domestic and international reputation as a global leader in addressing energy issues.

Ph.D. in geological science, engineering, or related discipline with career emphasis related to energy resources and 15 years of combined research and managerial experience beyond the completion of master's degree. Demonstrated vision, capability, and experience to address challenges facing society related to the advanced energy fields, such as carbon capture and storage, mitigation of fossil fuel emissions, water for energy resource development and power generation, public engagement and education on energy issues, unconventional oil and natural gas resource assessment, natural gas geologic storage, and enhanced oil recovery.

Applications must be received by May 15, 2015. Applicants may be interviewed before the closing date; however, no hiring decision will be made until after that date. To apply, please visit https://jobs.illinois.edu/academic-job-board to complete an

online profile and to upload a 1) cover letter, 2) résumé/CV, 3) the names and contact information (including e-mail addresses) of three professional references. All requested information/documentation must be submitted for your application to be considered. An incomplete application will not be reviewed.

For further information please contact Lori Walston-Vonderharr, Human Resources, Illinois State Geological Survey, at lwalston@illinois.edu or 217-244-2401.

The University of Illinois is an EEO Employer/Vet/Disabled http://inclusiveillinois.illinois.edu/

Thermochronology or Cosmogenic Isotopes Research Scientist and Lecturer Position, Univ. Tüebingen, Germany

The Earth System Dynamics research group at the University of Tübingen, Germany, announces an open position (Assistant) in thermochronology or cosmogenic isotope analytical techniques. The preferred candidate will have demonstrated experience in running a thermochronology ((U-Th)/He, fission track) or cosmogenic isotope laboratory with application to problems in tectonics and surface processes. The candidate is expected to play a leading role in managing the research group and laboratories. Mentoring of students, proposal writing, collaborative research within the group, and teaching (in English and eventually German) a minimum of 4 hours per week are required. Position requirements include: (1) a PhD at the time of appointment, (2) experience in laboratory management, and (3) a collegial personality within a workgroup environment.

Salary is commensurate with experience (A13, 100%). The position is available for 3 years with a possibility for an additional 3-year appointment. The position also has the possibility to become permanent after an initial evaluation period. Interested persons should send a CV with a list of peer review publications, 1 page statement of research interests, past laboratory management experience, and contact information for three references. Application materials (in a single PDF file) and questions concerning this position should be directed to Todd Ehlers at todd.ehlers@uni-tuebingen.de. Applications should be submitted by May 1, 2015. The start date for the position is negotiable, but preferably in the fall of 2015.

The University of Tübingen is committed to increasing the proportion of women in research and teaching positions and therefore encourages qualified candidates to apply. Disabled persons will be given preference if equally qualified. Employment takes place via the Central Administration of the University.

Student Opportunities

MPOWIR (Mentoring Physical Oceanography Women to Increase Retention) will be holding the bi-annual Pattullo Conference in October, 2015. The Pattullo Conference is a mentoring event for early-career female physical oceanographers. Pattullo brings junior women and senior scientists together for an intensive workshop focused on building community networks, professional development sessions, and sharing experiences, advice and concerns. Registration is open until April 17th, 2015. To find out more and register, please visit: http://mpowir.org/get-involved/pattullo/

PhD Student Opportunity at Michigan Technological University.

We are seeking a PhD student with interests in watershed hydrology, chemistry and land use scenario modeling using the Soil and Water Assessment Tool (SWAT). The research will be conducted in a cloud forest region of Mexico, in association with a larger National Science Foundation project assessing the effect of Mexico's Payment for Hydrologic Services program on eco-hydrologic and socio-economic variables and on indicators of watershed sustainability. We anticipate a summer 2015 or fall 2015 start date. Up to three years of funding for stipend and tuition is available. Students could pursue a PhD in either a Forest Science or Environmental Engineering program. Skills in developing and calibrating hydrologic modeling platforms are desired. For more information contact Dr. Alex Mayer (asmayer@mtu.edu). MTU is an equal opportunity employer.

PhD Student Opportunity at Michigan Technological University.

We are seeking a PhD student to contribute to a project on sustainable water management in the Middle Rio Grande basin. The goal of the project is improved management of regional water resources to sustain irrigated agriculture in the face of dwindling supply and competing demands. The PhD student would focus on integrating existing surface and groundwater models into a spatially explicit, dynamic systems model that can inform a stakeholder participatory modeling approach. Up to four years of PhD are available. We anticipate a fall 2015 start date. Students could pursue a PhD in either a Civil or Environmental Engineering program. Experience in surface water and/or groundwater modeling and an interest in participatory modeling are required. Contact Alex Mayer (asmayer@mtu.edu) for more information. MTU is an equal opportunity employer.

U.S. Graduate Student Scholarships for the 2015 Urbino Summer School in Paleoclimatology (USSP)

The 12th Urbino Summer School in Paleoclimatology (15 July – 1 August; http://www.urbinossp.it/) will provide graduate students with an intensive program on reconstructing the history and dynamics of paleoclimate through an integrated series of lectures, investigations, case studies, and field and laboratory analyses. To promote U.S. graduate student participation in this international experience, the National Science Foundation is funding ten scholarships to cover U.S. carrier airfare, stipend, and course expenses (including lodging). Interested students in U.S. graduate programs should email a pdf file comprised of a one-page CV and one-page statement on how the USSP would benefit their professional development as a researcher and educator to nsfusspscholarship@gmail.com. In addition, students should request their primary adviser to email a recommendation letter directly to the above email address. Members of historically underrepresented groups are encouraged to apply. Deadline for receipt of application materials, including recommendation letters, is 30 April 2015.

Postcards from the Field

Installing sapfllow sensors at 7 m in height of a >200 cm in diameter tree in a premontane tropical rainforest at the TAMU Soltis Center in Costa Rica. The information provided from this research is helping us understand and quantify how much water is being uptaken and released back to the atmosphere. This tree (and others from this site) is just one component of the global water budget, but it is already a small step in introducing the importance of tropical (wet) forest studies on global climate modeling and forest hydrology science.

Luiza Maria T. Aparecido
Ph.D. student at Texas A&M University (Department of Ecosystem Science and Management)

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

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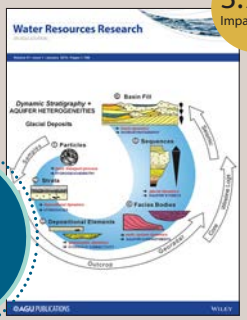

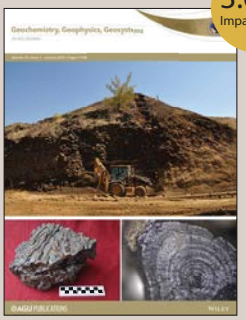

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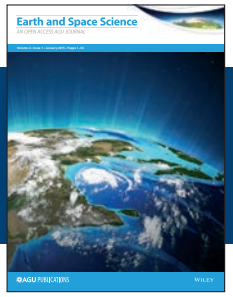

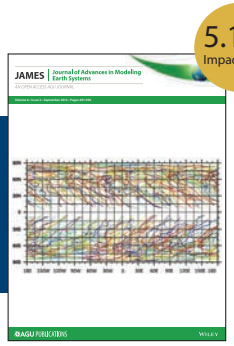

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Call for Session Proposals and Tutorial Presentations

Submission Deadline: 29 April, 11:59 P.M. EDT

About the Meeting

The theme for the 2016 Ocean Sciences Meeting is Ocean Sciences at the Interface. Complex interactions often occur at interfaces. The meeting will highlight processes at interfaces and how the work at such interfaces advances the study of ocean sciences and shapes the impact of our research on society.

Session Proposals

Proposals can span a broad array of marine science topics, and strong interdisciplinary themes that address new and emerging areas of research are strongly encouraged.

Tutorial Presentations

Back by popular demand, tutorials are 30-minute talks where presenters have the opportunity to discuss their research with time for a brief Q&A.

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