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EOS

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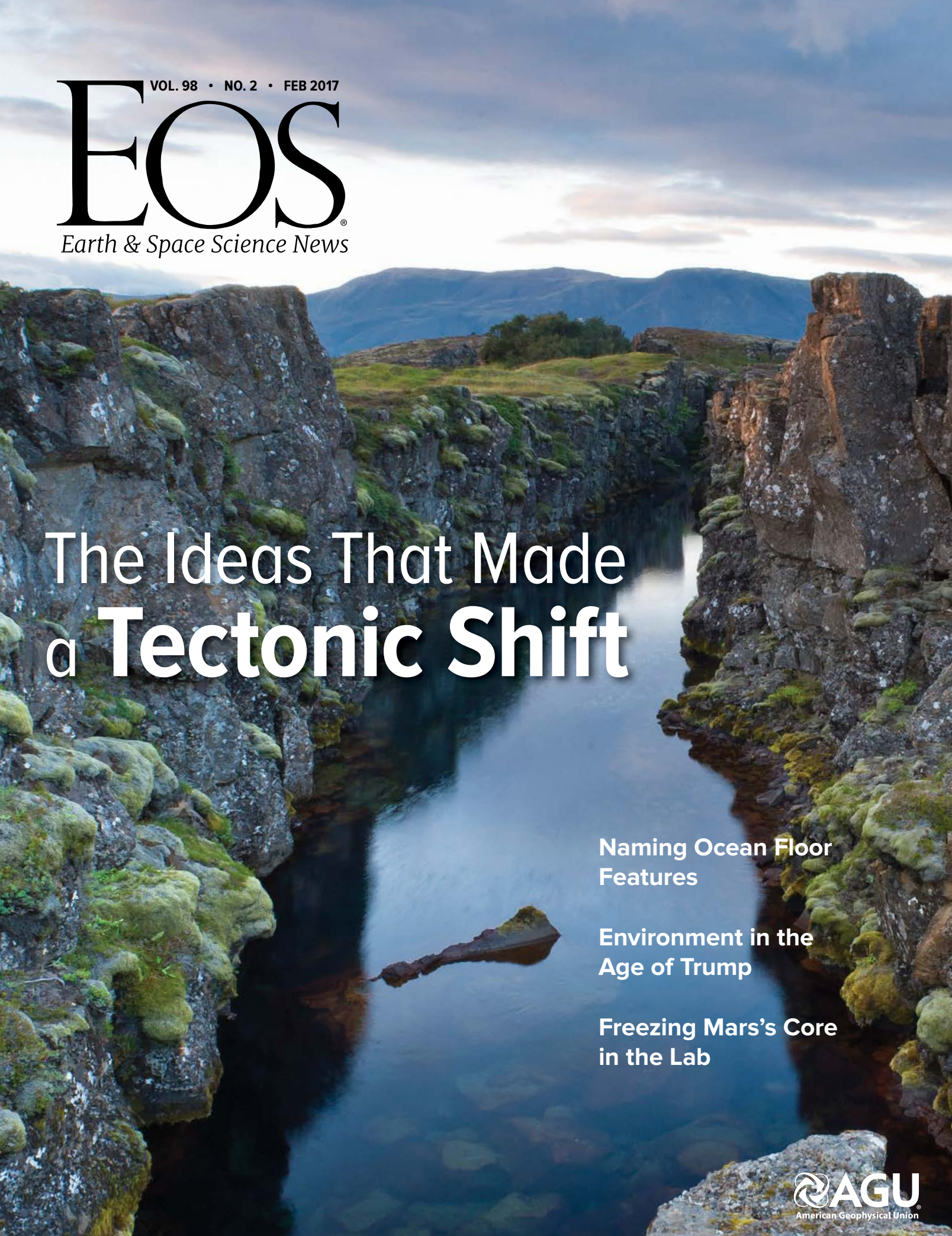

The Ideas That Made a Tectonic Shift

Naming Ocean Floor Features

Environment in the Age of Trump

Freezing Mars's Core in the Lab

AGU American Geophysical Union

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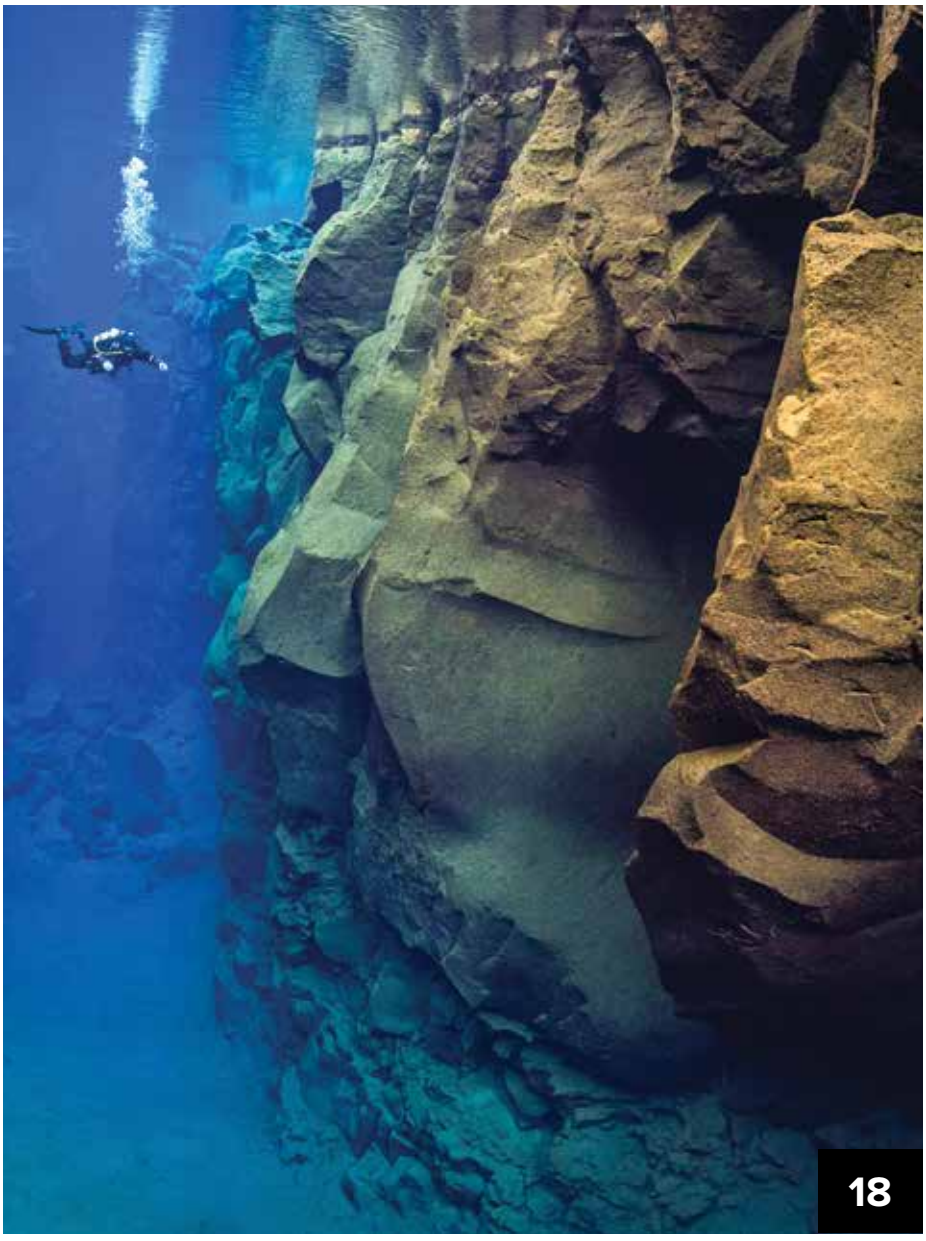
VOLUME 98, ISSUE 2

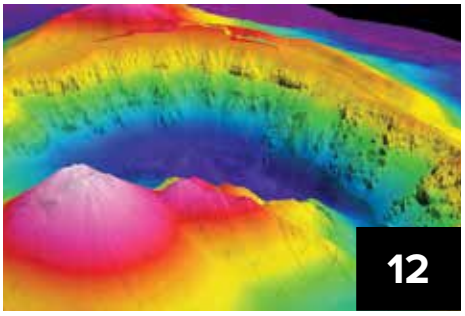


COVER

A Meeting That Helped Foster the Acceptance of Global Tectonics

Fifty years ago, scientists in the United States added their heft to a theory with profound implications: Earth's ocean crust recycles itself on a global scale, and continents move across the face of the planet.

PROJECT UPDATE



A Name Directory for the Ocean Floor

New web resources enable scientists to standardize the naming of seamounts, trenches, and other undersea features, reducing ambiguity in identification and communication.

PROJECT UPDATE

Interviewing 101: Navigating the Four-Step Process

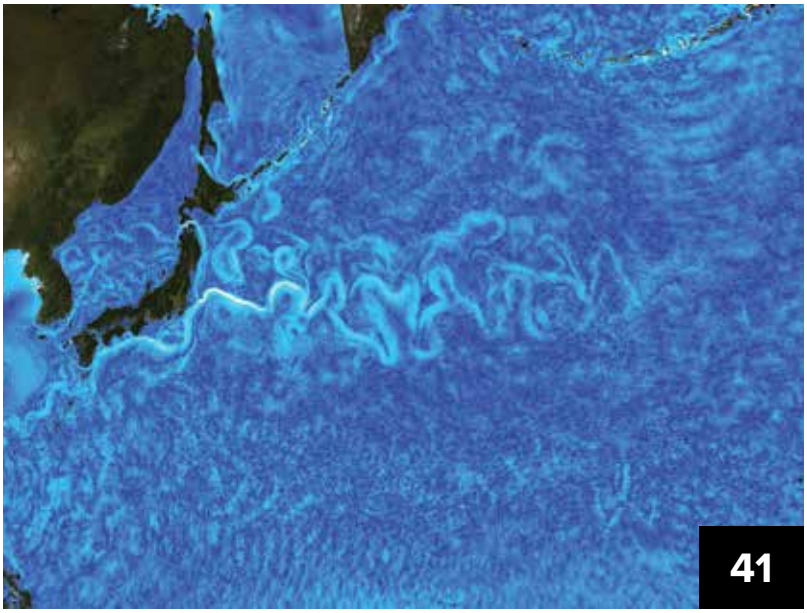
Think of an interview as a dance of words. As in many dances, there are a few patches of tricky footwork.

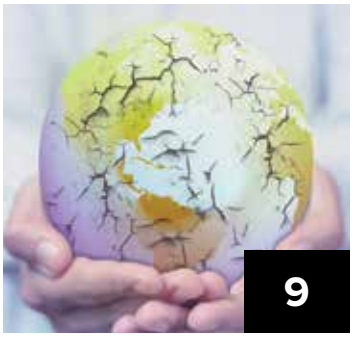
RESEARCH SPOTLIGHT

43 New Insight into Silica Explains Planetary Smashup

A better equation of state for silica will help planetary scientists accurately constrain the giant impacts that have shaped our solar system.

DEPARTMENTS





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Christine W. McEntee, Executive Director/CEO

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It's Not Just Fracking: New Database of Human-Induced Quakes

Design Pics via AP

An oil sand mine in Alberta in Canada. Processes involved in mining, such as removing material from the surface or subsurface, can induce earthquakes. A team of researchers recently cataloged 715 human-induced earthquakes and found that although media attention focuses mainly on induced earthquakes from wastewater injection, most induced quakes are caused by other processes.

How many earthquakes have human processes induced? Probably many more than we think, scientists said in December at the 2016 AGU Fall Meeting in San Francisco, Calif.

Just in the United States, the number of earthquakes per year in the center of the country has jumped dramatically since the early 2000s. According to the U.S. Geological Survey (USGS), the central United States experienced about 21 earthquakes of magnitude 3 or higher each year between 1973 and 2008. This number grew to almost 100 per year between 2009 and 2013. In 2014 alone, the region experienced more than 400 earthquakes.

In the past few years, scientists have begun to better understand the relationship between industrial processes and "induced" earthquakes. Recent media attention has zeroed in on fracking and wastewater injection, but earthquakes are also induced by the load of water impounded behind a dam, mining processes, and extracting groundwater for irrigation, among other causes.

Because repeated small quakes have struck areas around an oil field in the Netherlands for the past few decades, the Dutch oil and gas exploration company NAM commissioned a study by earthquake experts to better understand human-induced earthquakes. The team, led by Gillian Foulger, a geologist at Durham University in the United Kingdom, ended up compiling the most complete database of occurrences to date.

The team also found that induced earthquakes are "tremendously underreported," Foulger said. She presented her team's findings on 13 December (see http://bit.ly/triggered-quakes-abstract).

Hunting for Quakes

Foulger and her colleagues spent a year digging through scientific literature, industry literature, newspaper reports, and accounts from colleagues to create the database of as many previously reported induced earthquakes as they could find. The database, which stretches back through the early 19th century, currently lists 715 earthquake sequences, each consisting of as many as several hundred quakes.

The catalog divides the causes of induced earthquakes into four general triggers: surface operations (such as quarrying, building structures, and impounding water reservoirs), injecting material into the subsurface (such as wastewater disposal in fracking), removing material from the subsurface (such as mining or pumping water for irrigation), and explosions from underground nuclear tests.

Mining-Induced Quakes Dominate

When the researchers looked at the data, one thing was clear: Of the 715 cases of induced earthquake sequences, "mining by far dominated the picture," Foulger said, with about one third of the earthquake sequences tied to mining processes. In fact, "mine quakes account for about 50% of all earthquakes in Britain," she noted.

Mining falls under the category of "removing material from the subsurface." Imagine gradually removing support beams and walls from a tall building, Foulger said. At some point, the building will collapse.

In 2007, for example, more than 100 mines in China reported seismic events larger than magnitude 4, she said. In 1989, an induced magnitude 5 quake in Germany collapsed the surface over 5 square kilometers of a potash mine, killing three.

Not all mining-induced quakes are so large, however. The majority of the mining quakes in the database range between magnitudes 2 and 4, according to the publicly available preliminary report (see http://bit.ly/durham-report).

Earthquake Sources in Groundwater Removal

Another example from the "removing material" column took place in Spain, Foulger said. In 2011, a magnitude 5.1 earthquake razed a small town called Lorca and killed 10 people. Research following the earthquake tied the event to the decades-long removal of water from the ground for irrigation, which drastically lowered the water table. This led to ground subsidence and resulted in the earthquake.

In fact, a 2014 paper in *Nature* found that the increase in small earthquakes recorded in California's San Joaquin Valley could be tied to underground water removal. More than 100 cubic kilometers of water have been removed from the ground in the region over the past 150 years, mostly for irrigation purposes (see http://go.nature.com/2id2utN).

"The removal of any mass from under the ground is going to create voids, and essentially the earth is going to collapse," Foulger said. "There's just so much material you can remove from the earth before it has to subside." And sometimes that subsidence results in an earthquake, she continued.

Dam-Induced Quakes

After mining, the next most common source of induced earthquakes, making up about 20%, is water reservoirs, Foulger said. Huge masses of water piling up on Earth's surface affect the hydrology of the earth below in ways that can alter stress on faults. "If water is forced into fault zones, it reduces the confining stress and squeezes the fault open a little bit. It's lubricating the fault," she said.

A notable example is the Koyna Dam in India, which impounds about 3 cubic kilometers of water. There, a magnitude 5 earthquake occurs about every 5 years, according to the researchers' report.

Other examples in the report include Egypt's Aswan High Dam, which impounds about 132 cubic kilometers of water and has induced earthquakes up to magnitude 5.7. In addition, in 2007, more than 7000 earthquakes were recorded over a 2-month period

in Algeria as water was pumped from one reservoir into another (see http://bit.ly/nat-haz-nov2012).

Database for All

Unfortunately, induced earthquakes are likely underreported, Foulger noted, because documented earthquake sequences tend to come from places where humans felt them. Some projects, such as offshore oil and gas extraction, may be far from people, where earthquakes aren't felt and thus aren't recorded, she explained.

A corollary of this is that as populations move and grow, risk increases. For example, 15 years ago "the residents of Oklahoma would not have suffered from the quakes" because at that time fewer people lived near areas where ongoing industrial processes induced quakes, Foulger explained.

Foulger and her colleagues are building a website, http://inducedearthquakes.org, which starting in the spring will allow anyone to report induced earthquakes. She hopes that by crowdsourcing, researchers will be able to use the database to further catalog induced earthquakes and thus to better understand them.

One caveat, Foulger also noted, is that the current list includes not only confirmed induced quakes but also earthquakes that scientists don't necessarily agree were induced.

This could cause problems, noted Susan Hough, a seismologist at the USGS's Earthquake Science Center in Pasadena, Calif., who wasn't involved with the research. "There will be a danger of people taking the catalog as gospel, not appreciating the fact that some associations remain controversial," she said.

However, it's a "worthy effort to try to compile a catalog," Hough continued. "It will be useful to test hypotheses about induced earthquakes and, fundamentally, to highlight the scale and scope of the problem."

Minimizing Risk

Despite the fears surrounding induced earthquakes, Foulger stressed that concerned parties should work with industry leaders to manage risk rather than attempt to cease industrial activities altogether.

Think of it like building a road, she explained. The future road may be a source of car accidents, but "people don't prevent industrial activity because new roads have to be built. These earthquakes are the same—a potentially dangerous side effect of industrial activity that needs to be managed," she said.

By **JoAnna Wendel** (@JoAnnaScience), Staff Writer

California's Governor Promises to Fight for Science

Gary Wagner

California governor Jerry Brown addresses scientists and policy makers at the AGU Fall Meeting in December.

It's time to stand up, unite, and fight for science. That was the message California governor Jerry Brown delivered on 14 December to a convention hall packed with scientists and press at the 2016 AGU Fall Meeting in San Francisco, Calif.

"Some people need a heart attack to stop smoking. Maybe we just got our heart attack," Brown said, referring to recent threats against Earth and climate science as a new administration was about to gather in Washington. "This is a long-term slog into the future, and [scientists] are there, the foot soldiers of change" and collaboration, he said.

A Friend in California

"California will continue in support of research," Brown said. "We've got the scientists, we've got the lawyers, and we're ready to fight. California is no stranger to this fight."

The Golden State has long been a leader in enacting environmental policy. In 2012, Governor Brown signed into law the nation's strictest vehicle emissions standards, which called for a 75% reduction of smog and a 50% reduction of greenhouse gas emissions by 2025. Shortly after the law was signed, these standards became national. "California drove the United States," Brown said.

In 2014, Governor Brown also signed into law a bill to create a strategy to reduce short-lived climate pollutants such as black carbon (toxic particles that cause respiratory problems), fluorinated gases (which contribute to ozone layer destruction), and methane (a greenhouse gas more powerful than carbon dioxide). The bill calls for a 50% reduction in black carbon emissions, a 40% reduction in fluorinated gases, and a 40% reduction in methane by 2030 (see http://bit.ly/SB605-slcp).

From phasing out plastic bags to promises to clean up California's air, the state plans to remain a beacon for environmental policy based on sound science. "If anyone in Washington starts picking on researchers, you can be sure you'll have a friend in California…and all the legal talent we can bring to bear," Brown said.

Science Is "Not a Joke"

Brown also touched on the role that extremely biased news publications play in muddying scientists' efforts to communicate the dangers of climate change. For example, when he pledged to reduce methane emissions in California, Breitbart, a self-described source for the white nationalist "alt-right" group, "talked about cow farts," Brown said.

"Everything is reduced from seriousness to just a joke. Well, it's not a joke," Governor Brown said. "This is about real life. This is about real people, real science, and [scientists] are the custodians of that aspect of our lives."

The governor also referenced his old moniker, "Governor Moonbeam," from his gubernatorial term in the 1970s, bestowed on him when he proposed that California launch its own Landsat-type satellite. He said that the new administration has threatened to turn off some of the satellites that monitor Earth's atmosphere and surface and lightheartedly joked, "If Trump turns off [the] satellites, California will launch its own damn satellites."

Governor Moonbeam is back, and he's here to ramp up scientific engagement. He told scientists, "It'll be up to you, as truth tellers and truth seekers, to mobilize all your efforts to fight back."

By **JoAnna Wendel** (@JoAnnaScience), Staff Writer

Editor's Note: A full recording of Brown's speech is available on AGU's Facebook page (see http://bit.ly/gov-brown-video)

Rise in Tornadoes per Outbreak Might Not Be Tied to Warming

Early last year, a *Nature Communications* paper reported that although the number of tornadoes per year in the United States remains consistent, the average number of tornadoes per outbreak has increased steadily from 10 per outbreak to 15 since 1954. The authors had no idea why.

The researchers also found that outbreaks with extraordinarily large numbers of tornadoes—like an outbreak in 2011 that included a tornado that razed neighborhoods and killed more than 100 people just in Joplin, Mo.—have become more common as well.

The same research team, plus another colleague, set out to investigate possible causes for the swelling of outbreaks. They found something unexpected: Effects from global warming may not be the cause of this increasing number. Their findings appeared recently in *Science* (see http://bit.ly/Tippett-etal).

Phillip Jones/Moment/Getty Images

A house destroyed by a large, powerful tornado that struck Joplin, Mo., in 2011. Scientists have suspected that climate change is causing a recently discovered decades-long rise in the average number of tornadoes per outbreak in the United States. However, new research on that trend has found that the expected signature of global warming in tornado-spawning storms is surprisingly absent.

Tornado Ingredients

Every year, about 1200 tornadoes hit the United States, concentrated disproportionately in a region called "Tornado Alley," which spans the south central United States. (Meteorologists note that tornadoes can strike anywhere that environmental conditions are right.) Tornadoes form out of thunderstorms because humid, warm, buoyant air meets relatively dry, cold air and winds moving at different speeds interact to form a vortex.

A tornado "outbreak" is defined many ways but generally refers to six or more tornadoes rated 1 or greater on the Fujita or enhanced Fujita intensity scale forming from the same weather system.

Led by climate and weather expert Michael Tippett (who was also the lead author on the *Nature Communications* paper (http://go.nature.com/2ig9IiO)) of Columbia University in New York, the team homed in on two key meteorological ingredients for tornado formation to explore what may be causing the increase in the average number of tornadoes per outbreak.

One of these ingredients is vertical wind shear, which refers to differences in wind speed and direction as altitude changes, Tippett told *Eos*. Another key ingredient in tornado formation is convective available potential energy (CAPE). This refers to the potential for the upward rush of warm air that invigorates a thunderstorm. Higher CAPE values mean higher chances that tornadoes will spawn.

Chasing the Cause

The researchers wanted to know to what degree the increasing number of tornadoes per outbreak was connected to climate change. Models of climate change show that "in a warmer climate, there tends to be generally more moisture in the atmosphere, which would allow values of CAPE to increase," Tippett said. Prior studies have indicated that increases in CAPE are a signature effect of climate change on severe thunderstorms, he added.

The researchers dug into two data sets: one that compiled observations of actual tornadoes between 1951 and 2015 and one that compiled meteorological observations surrounding the tornadoes starting in 1979. The researchers specifically looked at the changes in the daily averages of CAPE and vertical wind shear and how they changed over the years compared with tornado occurrence.

The results surprised them: Instead of an increase in CAPE, which would tie the rise in the number of tornadoes per outbreak to climate change, they found an increase in vertical wind shear, Tippett said. This increase in wind shear may be what's driving the increasing number of tornadoes per outbreak, the authors speculate.

Climate Variations

"The study is important because it addresses one of the hypotheses that has been raised to explain the observed change in number of tornadoes in outbreaks," Harold Brooks, senior scientist at the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory, said in a statement. "Changes in CAPE can't explain the change. It seems that changes in shear are more important."

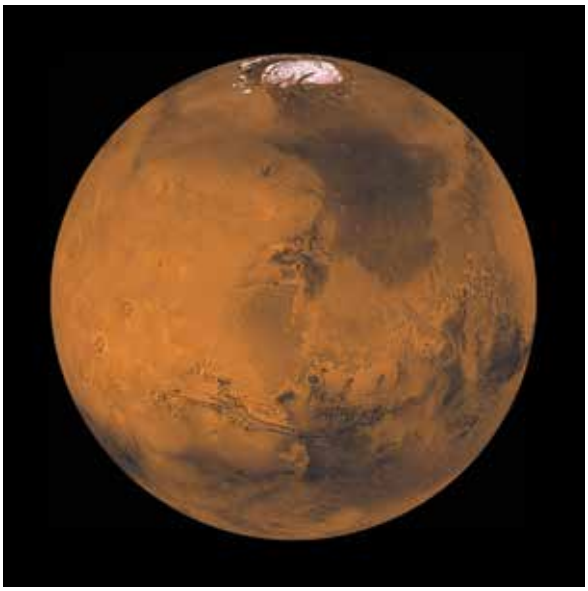
However, the causes of the greater wind shear—and the accompanying weather patterns—remain unknown and are an area for future research, Tippett said.

Although no signature of global warming emerged from the new analysis, the new findings don't rule out warming as a cause. If climate change is contributing to the greater number of tornadoes in each outbreak, "then we might expect to see either continued increases in the number of tornadoes per outbreak or at least no return to earlier levels," the 1 December *Science* paper notes.

Another possibility is that the outbreak trend results from shorter-term fluctuations in climate on timescales of several years or decades. In that case, the researchers write, "a return toward earlier levels [of the number of tornadoes per outbreak] might be possible in the future."

By **JoAnna Wendel** (@JoAnnaScience), Staff Writer

Freezing Mars's Core—in the Lab



NASA

Mars with polar ice.

Scientists know that it snows on Mars. Researchers years ago detected evidence of frozen carbon dioxide sprinkling from Martian skies. Now a group of researchers are conducting experiments to learn which conditions may make "snow" of a different sort fall someday inside the Red Planet—in this case, flakes of either iron or an iron-sulfur compound tumbling through molten regions of Mars's core.

Most Mars interior experts suspect that much of the planet's core remains molten. However, they are unsure to what degree; some argue that it is fully molten. "Right now, there's a lot of speculation about the state of Mars's core," said Forrest Gilfoy, a graduate student in Earth sciences at University of Michigan in Ann Arbor and lead researcher on the experiments.

Mars researchers agree, however, that the planet's core will eventually solidify as the planet cools, and some researchers have been investigating what kinds of freezing processes the molten core will undergo at that time.

A study published in 2007 by Swiss researchers proposed two scenarios for this core solidification in Mars: one in which flakes of "iron snow" form in the outer reaches of the core and descend toward the center and another in which a wave of crystallization begins in the liquid core near the center of the planet and propagates outward (see http://bit.ly/Science6-1-07). Earth researchers suspect that outward growing crystallization is taking place in our own planet's deep interior.

Bringing Mars into the Lab

Gilfoy and his team decided to explore these scenarios by mimicking Mars solidification in the lab. They ground up and melted a mixture of iron, nickel, and sulfur, the main components of Mars's interior. They created different mixtures with varying sulfur concentrations that are all possible representations of Mars's interior. They altered the amount of sulfur in each alloy sample because sulfur is thought to have the most impact on melting temperature.

In an experiment called quenching, the scientists brought the pressure of the molten blend up to that of the outer core of Mars, 20 gigapascals, which is 200 times greater than the pressure of the deepest part of the ocean on Earth. After melting each sample, the researchers rapidly dropped its temperature. Multiple quenching experiments revealed the melting points of the range of alloy samples they had created.

The team then compared its melting curve to the calculated temperatures of the Martian core—with the hottest being near the center of the core and the coldest being near the core-mantle boundary—to determine the depth at which different alloys would solidify. Alloys that solidify at lesser depths become snow, whereas those that solidify at greater depths become part of the bottom-up crystal formation, Gilfoy explained. He presented the experimental results on 13 December at the 2016 AGU Fall Meeting in San Francisco, Calif.

They created different mixtures with varying sulfur concentrations that are all possible representations of Mars's interior.

Sulfur Scenarios

The experiments revealed that if the core contained 10%–12% sulfur, snowfall would dominate the core's freezing process, Gilfoy told *Eos.* During cooling, alloys would crystallize in the outer reaches of the core and then sink toward the planet's center, displacing lighter elements. This is what scientists think is happening within Mercury.

The team's second scenario is an Earth analogue. Our own planet's core is slowly solidifying in a process called bottom-up crystallization. "Imagine [that] iron forms at the center and slowly grows outward, like a growing apple," said Gilfoy. According to him, this occurred in melts with a large range of higher sulfur concentrations, above 13%. Because such a wide range of possible mixtures led to bottom-up crystallization, it's the most likely process to occur when Mars's core eventually does firm up, he said.

On the basis of their experiments, the researchers propose a third scenario that had not been previously discussed, Gilfoy added. If the sulfur concentration stands at exactly 13%, bottom-up growth and sulfur-rich iron alloy snowfall processes would take place simultaneously, he said.

Mars's Interior Still Hot Liquid

Past studies determined only a few melting temperatures associated with different concentrations of sulfur, according to Gilfoy, which was not enough to predict solidifying behavior (see http://bit.ly/Breuer-et-al-2015).

From the new experimental results involving many more samples, he computed the temperatures at which alloys would melt at various pressures. Given that these temperatures were all below the most widely accepted interior temperatures of Mars, the results add further evidence that Mars's core is not solidifying yet, Gilfoy said.

"Sulfur changes the melting temperatures, so solidification will depend on how much sulfur there is," said Christian Liebske, a mineralogist at the Swiss Federal Institute of Technology in Zurich, who was not part of the study. "There is evidence that Mars's core is molten, but to what extent, we still don't know."

In 2018, NASA plans to install a measurement station on the surface of Mars to better understand Mars's interior.

By **Yasemin Saplakoglu** (email: ysaplako@ucsc.edu; @yasemin_sap), Science Communication Program Graduate Student, University of California, Santa Cruz

A Quest to Put Sea Level Rise Data in Your Pocket

Polar Explorer Team, MGDS, LDEO/Columbia University

The Polar Explorer: Sea Level app shows sea level fluctuations at tide stations around the globe. The user can select a specific location, and the app generates a brief report with the name of the station and the sea level trend. This example shows Grand Isle, La., on the Gulf Coast, where sea levels are rising at a rate of nearly 3 feet (around 1 meter) per century.

Want to know where sea level is changing right now, or what places around the world are at risk from storm surge? Don't worry; there's an app for that.

Polar Explorer: Sea Level is a new climate change education app that focuses on sea level rise and its consequences (see http://bit.ly/polar-explorer-sea-lvl). It aims to remove barriers between the public and often inaccessible climate data. Developed by researchers at Columbia University's Lamont-Doherty Earth Observatory, this novel app allows iPhone and iPad users to navigate clickable, data-based map layers to explore questions about climate change.

In the graphics regularly displayed by news media or elsewhere on the Internet, "people see data visualizations all day long, but they don't realize it's data—they think it's a picture somebody made," said Margie Turrin, an education coordinator at Lamont-Doherty and the project lead for the app. Turrin presented the findings at the 2016 AGU Fall Meeting in San Francisco, Calif.

"Just getting people to go and interact with it and realize, 'Oh! It's actually data,' is a pretty important thing," Turrin told *Eos* on 13 December.

Asking Big Questions

Polar Explorer: Sea Level is structured around seven "big question" categories, including "What is sea level?" and "What are future predictions for the U.S. coast?" Each category functions like a book chapter, and upon delving into the chapter, users can choose from a selection of map layers that will help them better understand their topic.

> The app aims to remove barriers between the public and often inaccessible climate data.

For example, a user who wants to know where sea level is changing right now can choose to display a map showing tide stations around the world, regional trends in sea level, or regions vulnerable to future coastal flooding.

In response to a selection, the app presents data at three levels: a brief introduction box, an audio recording that tells a short story, and an interactive map showing the data around the world. At every stage, the app offers an option to redirect to a summary of the data and their source.

Bruce Moravchik, an education specialist at the National Oceanic and Atmospheric Administration (NOAA), believes that the Polar Explorer: Sea Level app is a powerful tool. Moravchik was not part of the app's development but has collaborated with Turrin on using the app for educational events.

"The problem is that a lot of climate data sets are not accessible to educators and students in a manner they can easily query and understand," said Moravchik. This app "has a tremendous interface that pulls on real data from NOAA and NASA and puts it in a framework of telling a story; it is really compelling."

Explorer Quests

Turrin and her team developed a series of parallel "quests" to accompany the app. These quests prompt users to use the app to answer questions like "You move to the Swedish coast and are puzzled to find the people there are not worried about sea level rise. … Why not?"

Although the app was originally developed for a general adult population, Turrin suspects that undergraduate students may be the perfect audience for it and its quests.

"In a college class…you could put the app in their hands and let them pull up a data set and have them try and generate questions around what they are seeing," Turrin said.

Positive Responses

So far, the response to the app has been overwhelmingly positive, although Turrin would like future updates to simplify some of the app's scientific language that may be overly complex.

With an eye toward future improvements, Turrin's team is investigating users' responses to Polar Explorer: Sea Level. The team completed a pilot study in September with 150 participants and plans this month to start a full study of which features users took advantage of, the questions they explored, and how the interactive app compares to a paper atlas.

By **Aaron Sidder** (email: aaron.sidder@gmail.com; @sidquan), Freelance Science Writer

Flood Response Using Earth Observation Data and Products

NASA Flood Response Workshop
Greenbelt, Maryland, 14–16 June 2016

NOAA

This aerial photograph, taken a few kilometers east of Baton Rouge, La., on 15 August 2016, shows the devastating effects of last summer's floods (the brown areas are under water). Interstate 12 runs through the middle of the image.

Over the past decade, floods all around the world have been of exceptionally high magnitude. Rainfalls have set new records and caused unprecedented damage in many countries, including China, India, Malawi, northern England, Thailand, the Philippines, and the United States. Areas in the United States that have been especially hard hit include the East Coast, the Midwest, the Southwest, Mississippi, Virginia, West Virginia, and Louisiana. These events cover spatial scales well beyond what we have seen in the past, and they frequently surpass traditional regional disaster response capabilities.

Such events have demonstrated the need to develop a rapid global response to enable relief teams, decision makers, local agencies, and international organizations to deal swiftly with successive big events and deliver relevant geospatial data and flood imagery when and where they are needed.

Many organizations, including space agencies such as NASA, already have ongoing missions, programs, initiatives, and research funding to provide flood-monitoring and response services, as well as image and computer simulation products, during an event. But with the proliferation of information, it is difficult to coordinate systems during a single event, let alone multiple simultaneous events or successive large events. In addition, each of those systems provides a unique capability, and so coordination is necessary.

The NASA Applied Sciences Disasters Program held a flood response workshop (http://go.nasa.gov/2gyVxW2) in June 2016 in Greenbelt, Md., that brought together lead people from NASA's flood expert pool and emergency managers from national and international organizations to discuss and formalize a coordinated domestic and global response to flood disasters. The workshop participants—more than 70 total—included people from government agencies, academia, nongovernmental organizations, development and aid organizations, and the private sector who have a common interest in U.S.-wide and global flood response.

The workshop enabled a unique and successful dialogue among Earth observation (EO) mission technology and science experts, capacity-building officials, and the flood response community, with the goals of meeting user needs and fostering better coordination in flood disaster response worldwide.

In a series of invited talks, decision makers from federal agencies, state emergency departments, and the humanitarian aid sector presented the types of EO products, if any, that they currently use in their flood response operations. In many cases, such products are either not easily understood or not specifically designed for the purpose, and often they are not accessible in a timely manner.

The workshop addressed current EO system capabilities and limitations and focused on ways to deliver integrated and operation-tailored solutions for decision making. The various flood response communities involved put together a "wish list" at the end of the workshop (Table 1) that identifies the immediate challenges to be addressed by EO research investigators, scientists, and product developers as a first step.

The outcomes of the workshop will inform a near-term action plan to set up a new "community of practice," which will set out to improve EO data and products over the next 1–3 years for better assisting flood disaster response.

Table 1. Challenges and First Steps for the Flood Response Community

EMERGENCY MANAGEMENT	MONITORING AND OBSERVING	MAPPING AND MODELING	PRODUCT DISSEMINATION AND DISTRIBUTION	CAPACITY BUILDING AND END USER ENGAGEMENT
Push data and products out in 12- to 24-hour intervals, within capabilities (ask for assistance with resources as needed and manage expectations)	One-stop shop (should also include future acquisitions), where communities can pull rather than push data and products	Automated polygon generation of flood disaster location to target Earth observation data acquisition and products, especially at the international level	Single access point (one-stop shop) that allows automated product delivery system	Build trust in the products and report value to community; one-stop shop needs to have products that are tailored to user needs and allow for feedback

By **Guy J.-P. Schumann** (email: gjpschumann@gmail.com), Remote Sensing Solutions, Inc., Monrovia, Calif.; and School of Geographical Sciences, University of Bristol, Bristol, U.K.

Environmental Issues in the Age of Trump: Take the Long View

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Donald Trump is the new president. What does this mean for the environment?

Normally, we rely on a politician's past behavior to frame the future. However, we do not have any record of environmental policy or practice on which to base an analysis of what to expect. Our best information relies on the appointments to his transition team and his nominations for key political positions.

On this basis, I see a strong chance that former president Barack Obama's climate policy will be rapidly disassembled. How do we face this head-on?

The answer is a simple statement: To develop an effective U.S. response to climate change, we must break the politicization of science-based knowledge.

To accomplish this, however, we must embrace the complexities of science and politics and think beyond any matrix or formulaic solution. We know that effective and sustaining climate policy must be bipartisan. Trump's disruption of traditional party positions potentially provides entryways to break decades of stalled efforts to address climate change in the United States.

Focusing on this potential long-term opportunity may be the key to preserving the environment beyond the age of Trump. First, we need to recognize that forces in the new administration will seek to undo not only recent gains in climate policy but also decades of environmental regulations. But with climate change so directly tied to economic and national security, our future societal success will compel us to tackle climate change as part of our political and cultural behavior.

Rollback of the Clean Power Plan

Trump's nominations of Rex Tillerson for secretary of state and Rick Perry as energy secretary place individuals with complex histories on energy and climate policies at the head of key departments. Although neither of these nominees is expected to continue Obama's climate priorities, potential repercussions on renewable energy and climate policies are difficult at this point to decipher.

To develop an effective U.S. response to climate change, we must break the politicization of science-based knowledge.

However, the consequences of some appointments remain quite clear. One of Trump's first actions as president-elect was to announce Myron Ebell as part of the presidential transition team. Ebell is director of the Center for Energy and Environment at the Competitive Enterprise Institute (CEI).

Ebell has a long history of denying the consensus analyses of climate scientists and the economic risks of climate change (see http://nyti.ms/2hr4e1S). CEI holds the position that U.S. environmental regulations are onerous and damaging to the economy. Ebell and CEI oppose regulation of greenhouse gas emissions by the Environmental Protection Agency (EPA).

Trump has nominated Oklahoma's attorney general, Scott Pruitt, to head the EPA. Pruitt is a strong advocate for Oklahoma's fossil fuel. He is anchored in the conservative base that feels that there is federal overreach in environmental regulations, which drags on the economy and costs jobs. He is part of the lawsuit to stop President Obama's Clean Power Plan.

President Obama's Clean Power Plan, which focused on electricity generation, was a fundamental part of his administration's efforts aimed at curbing carbon dioxide emissions. The Clean Power Plan rests on the Clean Air Act along with the Supreme Court's 2007 decision (http://bit.ly/SCOTUS-CO2) that requires the EPA to regulate carbon dioxide emissions as a pollutant if carbon dioxide emissions are found to harm human health.

Pruitt's nomination signals, therefore, an administrative priority to revoke the Clean Power Plan. Likewise, Pruitt will interpret enforcement of existing regulations and advocacy of new regulations far differently than the Obama EPA did.

Good-Bye, Paris Agreement

President Trump has promised to withdraw from the Paris Agreement on Climate Change, which was established within the United Nations Framework Convention on Climate Change (UNFCCC). The U.S. commitment to the Paris Agreement was achieved by executive signature, in contrast to the Kyoto Protocol, which required ratification by the Senate.

The Paris Agreement, therefore, carries the same perceived baggage of executive over-

reach as the Clean Power Plan. This makes the Paris Agreement a clear target.

Although actual withdrawal from the Paris Agreement would be difficult to achieve in the near term, the Trump administration could easily fail to implement any of the commitments the Obama administration made under the agreement. What's more, some of Trump's advisers are already calling for cuts to "politically correct environmental monitoring," including NASA programs that support climate change research (see http://bit.ly/NASA-climate).

These steps would, minimally, establish the United States as an unreliable partner and insert doubt into global climate change policy for many years.

The Bigger Storm to Come: Dissolution of Environmental Laws?

Undoing the Clean Power Plan could be just the beginning. Following Trump's rhetoric, we must be prepared to face efforts aimed at weakening the Clean Air Act itself. Also in the crosshairs are many other environmental statutes passed in the 1970s, such as the National Environmental Policy Act, the Clean Water Act, the Endangered Species Act, and the Safe Drinking Water Act.

In terms of enduring impacts, weakening of these underlying statutes will be more consequential than scuttling the Clean Power Plan. Alterations or repeals of these laws will meet with fierce political resistance and litigation. However, the executive vigor and legislative wherewithal are in position to do considerable damage as well as to appoint and confirm judges sympathetic to the notion that environmental regulation is damaging to business and economic growth.

Preservation of these statutes must not get lost in the potential clamor over the Clean Power Plan. They are the foundation of environmental policy and were responses to dangerous environmental degradation. With hostility toward these regulations at the federal level, vigilant focus on these laws is required at the state and local level as well as by the broader public.

A World Stage

Weakened U.S. involvement in the Paris Agreement has many consequences. Mutsuyoshi Nishimura, former lead Japanese climate change diplomat, points to worldwide backlash, including protests (see http://wapo.st/2gtg5uq). Ceding to China the moral high ground on climate change will also have fallout.

The battle to preserve our end of the Paris Agreement is important and necessary. But we must not lose sight of the need to preserve our commitment to the UNFCCC, which provides the substance that made the Paris Agreement possible.

The UNFCCC is the foundation of international policy, and as a candidate, Trump expressed animosity to "U.N. global warming programs." It was signed and ratified by the United States in 1992 and went into effect in 1994. The treaty specified that countries that sign hold a commitment to reporting greenhouse gas emissions, expressing intent to reduce emissions, avoiding dangerous climate change, and maintaining economic development.

More so than the Paris Agreement, it would be difficult for the United States to withdraw from the UNFCCC. We need, however, to move beyond polls that show that the United States supports international response to climate change. Instead, we must strategically plan ways in which we can ensure that public officials keep their promises to U.S. participation on this foundational treaty.

> Climate change is too compelling an issue to go away.

What Way Forward?

Progress in the face of federal barriers relies on appealing to common causes and individual people rather than to political parties. In this way, we have an advantage compared to where we were at the beginning of the Obama administration. During the past 8 years, we've seen significant changes in how people perceive climate change in the United States.

Notably, concerns and responses to climate change have expanded at state and local levels (see http://bit.ly/mayors-climate). Historic droughts and floods, the occurrence of persistent record-high temperatures, and changes along the coastlines due to sea level rise have revealed unprecedented vulnerabilities.

Emerging observational evidence is that weather-related threats and risk are increasing. When response occurs locally, it is typically bipartisan and has corporate and faith-based participation.

An important policy goal is to advance the many voices of those on the ground responding to climate-related vulnerabilities. Likewise, organizations that seek to affect climate change policy should focus more on action-oriented efforts on local to regional scales, rather than mire their primary resources in the political gamesmanship that will dominate at the federal level.

We need to move away from the situation where the farmer, the Republican, the Evangelical, or even entire cities already coping with climate change are treated as novel examples. We are all part of a constituency responding to weather that is changing from generation to generation.

Nowhere is this mainstream emergence more critical than at the climate and energy intersection.

Countries, including the United States, are growing their use of renewable energy while growing their economies. What's more, the economics of fossil fuel extraction are changing rapidly. ExxonMobil is moving to write down its dirtiest reserves and has stated support for the Paris Agreement (see http://cnb.cx/2hnjXi9 and http://bit.ly/Exxon-Paris). Companies are actively seeking policy stability in the face of compelling political and scientific evidence (see http://n.pr/2gSzDt6). Market-based energy and climate policy, such as that advocated by conservative politician Bob Inglis of South Carolina, is as viable and as robust as any other potential strategy (see http://www.republicen.org).

But challenges lie at every turn. The sound defeat of the state of Washington's carbon tax initiative shows that even in a solidly Democratic state, the public does not easily advance climate change policy or regulation.

Appealing to Security

As countries, including ours, develop increased predictive skill on the effects of climate change, those with access to those forecasts learn to use those predictions. This knowledge provides competitive advantage not only in business but also in anticipation of national security interests.

Drought in the Middle East amplifies political strife. Several nations scramble in the Arctic for territory and resources as the sea ice melts. In business, multinational corporations face supply chain challenges, water availability issues, and customers demanding that sustainability and the cost to the environment be taken into account.

It is reasonable to expect that at some point, future trade deals will penalize those who most damage the climate. So we must place these issues of environmental security and concrete information for real-world applications front and center in climate research.

We must also break the notion that environmental research and prediction are inseparably wed to environmental regulation. Both the absence and the excess of regulation have negative societal and economic consequences. Optimal environmental regulation benefits society, including the viability, sus-

tainability, and security of businesses and their customers.

Focusing on the Long Term

Any effective, sustaining climate and energy policy will have to be bipartisan. To gain this bipartisan support, we must break the link between science-based policy decisions and political and cultural self-identification.

We must take direct measures to reclaim science-based knowledge from partisan interests. Science has been made partisan with political intent; we require similar intent to reclaim it.

To the climate change community, the initial actions of President Trump on climate and climate policy were decentering, disconcerting, and bleak. Grassroots efforts have emerged to protect putative threats to access to climate data and information. Undoubtedly, however, Hillary Clinton's election would have maintained the status quo of climate change as a partisan issue.

President Trump, on the other hand, has proved to be difficult to characterize, resistant to traditional partisan classification, and prone to swift changes of position. Trump will challenge his party and disrupt party norms. With this disruption, political walls become porous.

At that point, it becomes possible that sources of informed influence, anchored in the substantive challenges of those who govern and those who create and sustain jobs, can enter the administration. New coalitions of organizations become likely, which can align on solving problems rather than political warfare.

Trump's administration can disperse President Obama's climate change policies. However, climate change is too compelling an issue to go away. In the event that an opportunity to address climate change does not emerge during Trump's administration, I don't see this lack as placing us at any more of a tipping point than where we already are.

Stewards of the Future

Policy in the United States often emerges from long, difficult negotiations leading to outcomes that balance priorities, share benefits and risks, and provide flexibility for individuals and commerce. Acrimonious politics, particularly during this past election, have left us with little trust of individuals and institutions. The scientific method, objective analysis, and the fundamentals of logic and reason are tainted with political culture and identity.

These practices of investigation, reason, and knowledge generation, however, sit at the growth of civilization, economies, and wealth. Our ability to compete and thrive as a nation requires us to extract science-based knowledge from the realm of political partisanship and to support knowledge-based decision making.

We must have confidence in this future and do all we can to steward the transition from now to then.

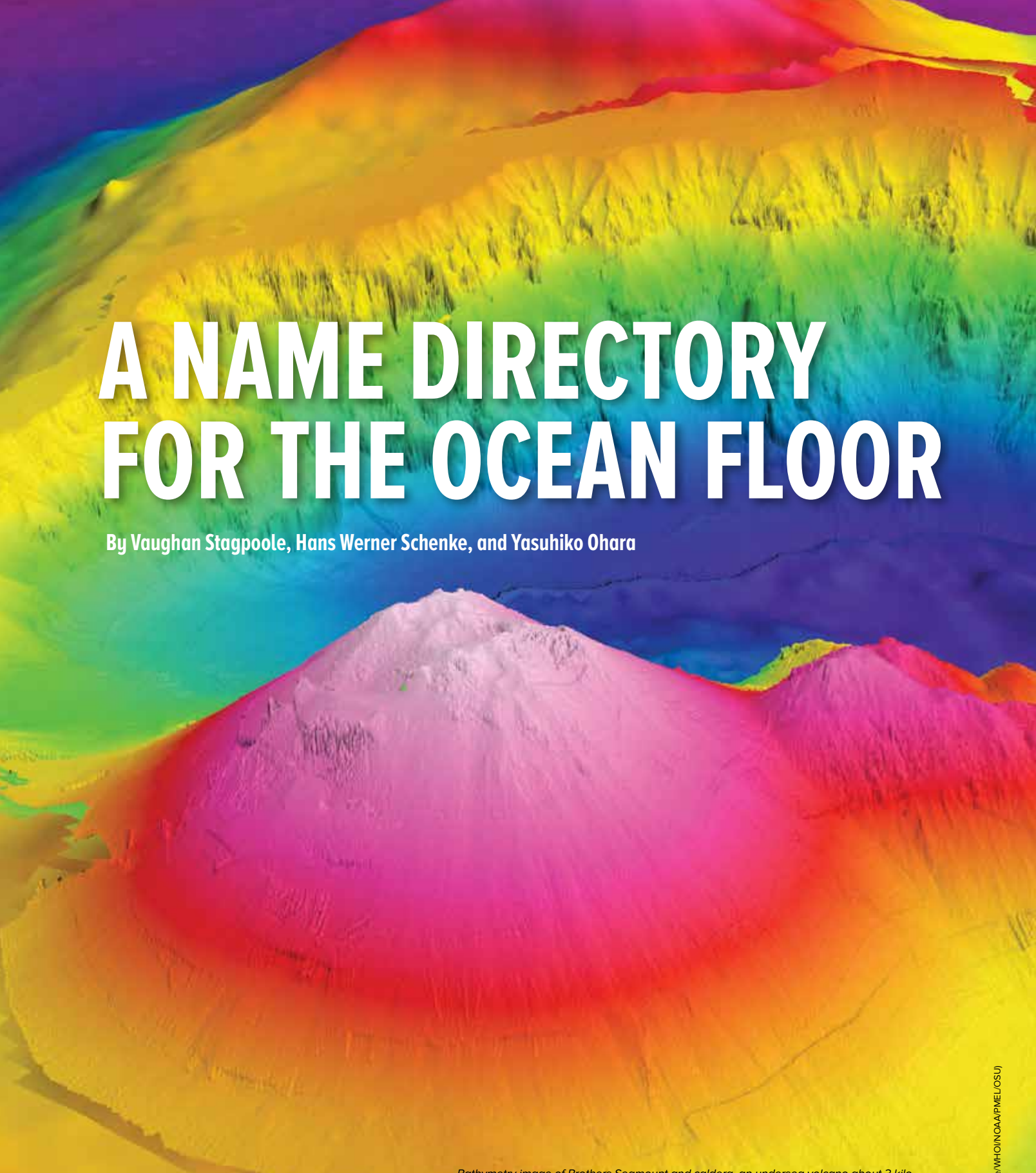
Acknowledgments

I thank Paul Higgins of the American Meteorological Society and Paul Edwards and Matt Irish of the University of Michigan for helpful conversations and comments.

By **Richard B. Rood** (email: rbrood@umich.edu), Department of Climate and Space Sciences and Engineering and School of Natural Resources and the Environment, University of Michigan, Ann Arbor

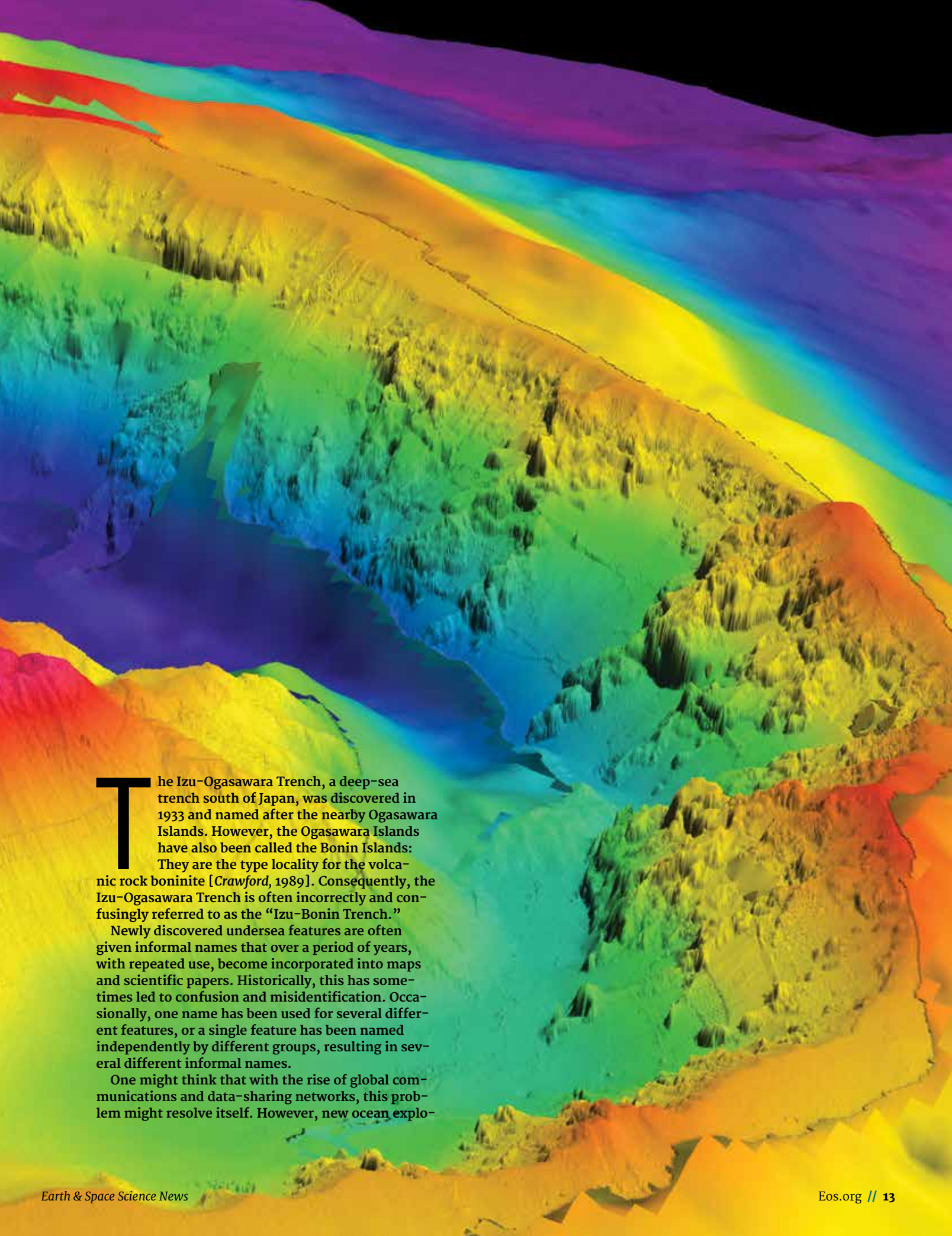
A NAME DIRECTORY FOR THE OCEAN FLOOR

By Vaughan Stagpoole, Hans Werner Schenke, and Yasuhiko Ohara



Bathymetry image of Brothers Seamount and caldera, an undersea volcano about 3 kilometers in diameter off the coast of New Zealand. Woods Hole Oceanographic Institution's autonomous underwater vehicle ABE acquired high-resolution (2-meter) bathymetry data inside the caldera. Surface ships mapped the lower-resolution (25- to 30-meter) bathymetry data on the surrounding volcano flanks. This feature was formally named using tools provided by the General Bathymetric Chart of the Oceans (GEBCO).

S.G. Merle (GNS Science/WHOI/NOAA/PMEL/OSU)



The Izu-Ogasawara Trench, a deep-sea trench south of Japan, was discovered in 1933 and named after the nearby Ogasawara Islands. However, the Ogasawara Islands have also been called the Bonin Islands: They are the type locality for the volcanic rock boninite [*Crawford,* 1989]. Consequently, the Izu-Ogasawara Trench is often incorrectly and confusingly referred to as the "Izu-Bonin Trench."

Newly discovered undersea features are often given informal names that over a period of years, with repeated use, become incorporated into maps and scientific papers. Historically, this has sometimes led to confusion and misidentification. Occasionally, one name has been used for several different features, or a single feature has been named independently by different groups, resulting in several different informal names.

One might think that with the rise of global communications and data-sharing networks, this problem might resolve itself. However, new ocean explo-

GNS Science

The Woods Hole Oceanographic Institution's autonomous underwater vehicle Sentry, which can map the seafloor with a resolution of 1–2 meters, is launched from a surface ship.

ration technologies are exacerbating this old problem by adding to the inflow of new information.

An increasing number of ships now routinely survey our oceans, and we are learning more about the seafloor and its features. The rapid developments in multibeam sonar technology and the deployment of these instruments on remotely operated vehicles (ROV) and autonomous underwater vehicles (AUV) mean that some features only tens of meters in relief are now being mapped and named.

To ensure that these features don't get renamed on subsequent cruises, scientists turn to a reliable tool: the General Bathymetric Chart of the Oceans (GEBCO) Undersea Feature Names Gazetteer (http://bit.ly/GEBCO-Gazetteer), an online interactive map. This map is supplemented with other online resources, including naming guidelines, links to proposal forms, and a glossary.

GEBCO's Sub-Committee on Undersea Feature Names (SCUFN) is also developing new web applications to facilitate collaboration and coordination for naming undersea features within the world's oceans. These future applications, plus the new web supplemental resources, will assist users in completing name proposals and should help speed up the review and approval process.

The GEBCO Gazetteer

GEBCO, an international group of experts in ocean surveying and mapping, established SCUFN in 1975 when the need became apparent for a uniform policy for the handling and standardization of undersea feature names. GEBCO's aim is to provide the most authoritative publicly available bathymetry of the world's oceans, including undersea feature names.

SCUFN reviews name proposals for undersea features that lie entirely or mainly (more than 50%) outside the external limits of territorial waters. The subcommittee comprises a multinational group of hydrographers and Earth scientists. SCUFN is supported by a secretariat based at the International Hydrographic Organization in Monaco, which coordinates its activities and maintains the GEBCO gazetteer.

This gazetteer contains a list of more than 3800 named features throughout the oceans. Several national naming authorities and geographic naming boards also maintain separate gazetteers that include names of undersea features outside territorial waters, and SCUFN endeavors to harmonize the GEBCO gazetteer with these names.

The gazetteer enables users to search and view features quickly. It also provides further metainformation (where it is available) about feature dimensions, the discoverer, and the origin of the name. Proposers of new undersea feature names or journal reviewers can use this resource to ensure that names are not duplicated or features are not already named.

The need became apparent for a uniform policy for the handling and standardization of undersea feature names.

Proposing Undersea Feature Names

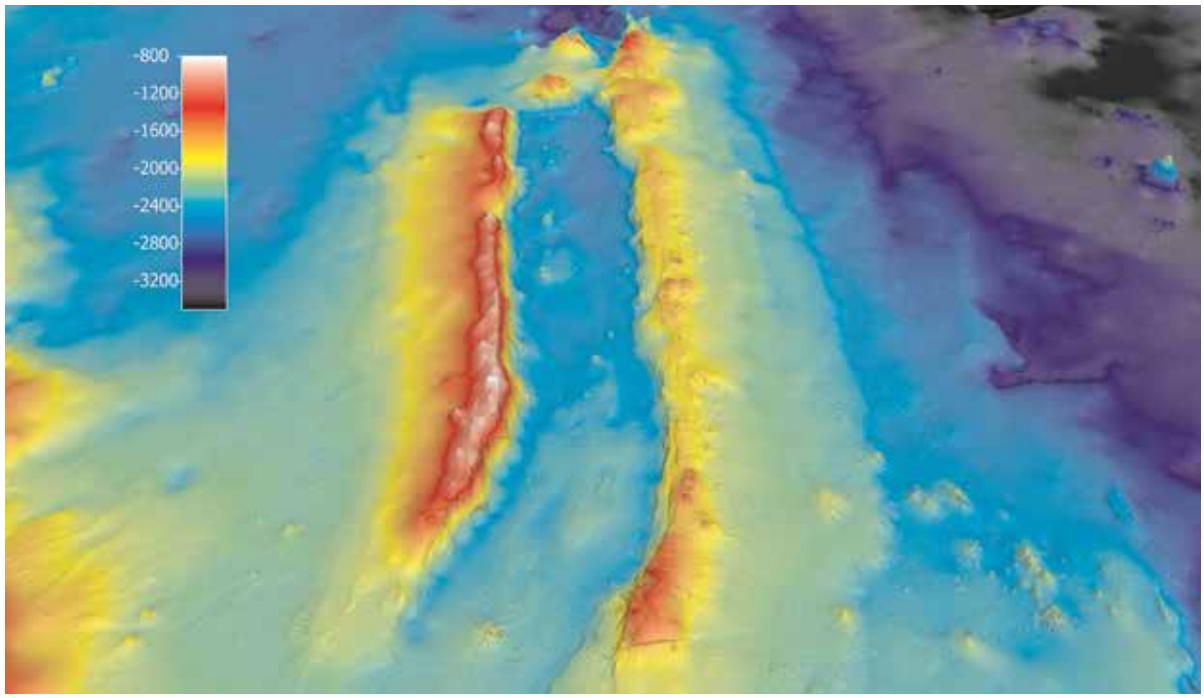
People who want to propose names for new features should use the GEBCO undersea feature names website (http://bit.ly/GEBCO-SCUFN). This site describes the role of SCUFN and has useful links to proposal forms, naming guidelines, and meeting reports. The SCUFN guidelines for naming features are given in the "Standardization of Undersea Feature Names," International Hydrographic Organization Publication B-6 (http://bit.ly/standard-undersea-names), which is available in six languages. This publication includes information about proposals along with examples of supporting documentation, including maps and images depicting the features.

Undersea feature names have two parts: a specific term and a generic term. The specific term should primarily relate to nearby onshore or offshore features, the discovery ship, or an eminent maritime figure, explorer, or scientific researcher. Other specific terms may be given to recognize cultural icons or traditions.

The generic term relates to the geometrical form of the feature (escarpment, seamount, trench, etc.) or, in special cases, the genesis of the feature. SCUFN regularly reviews generic terms, adding new terms as they become established in scientific usage and abandoning older terms that have fallen out of use.

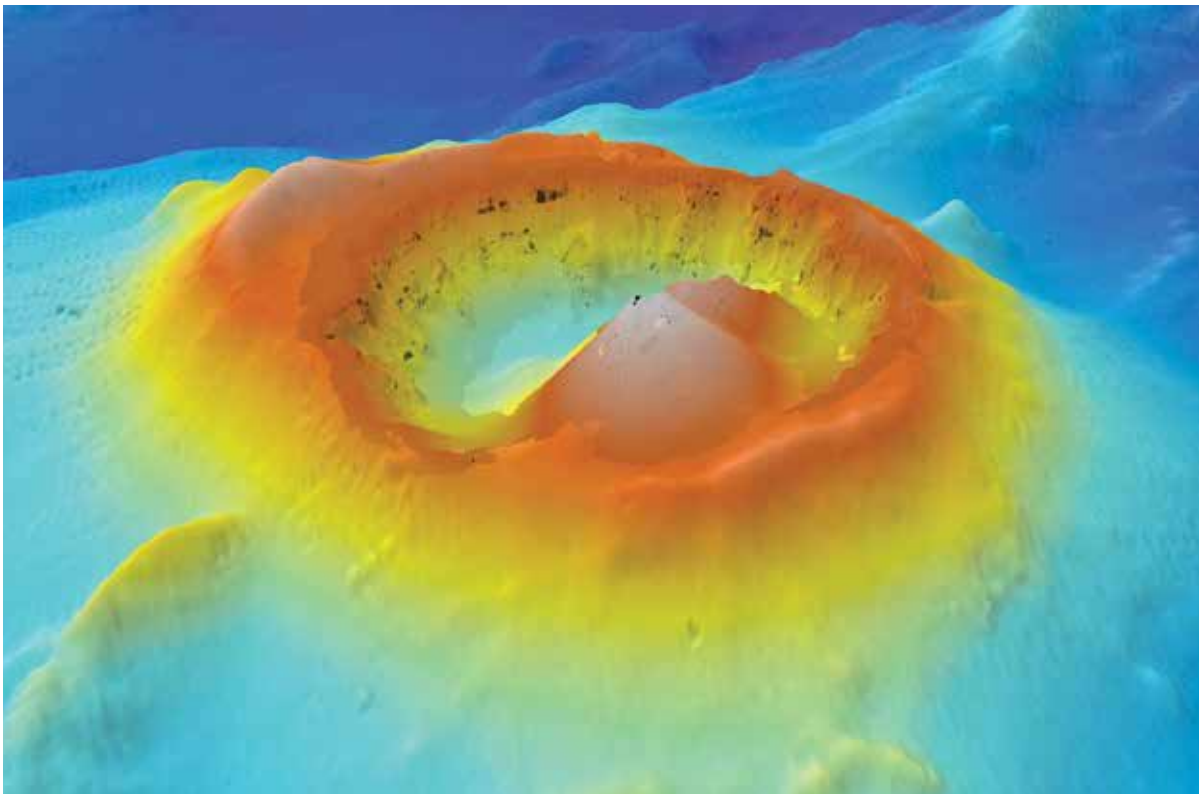
For example, the Adare Trough, located in the Ross Sea off the coast of Oates Land, Antarctica, is a flat-bottomed depression with symmetrical, parallel sides that is more than 100 kilometers long. The specific term "Adare" is from the nearby Cape Adare, and the generic term "trough" describes the morphology of the feature.

Several features in the GEBCO gazetteer have generic terms that are no longer recommended but are maintained to harmonize names with other gazetteers. Definitions for generic terms, including example images of feature types, are now readily available on a new website (http://bit.ly/undersea-terms). This resource allows those proposing new undersea feature names to identify the correct generic term for the features they find.



GNS Science

The Adare Trough, located in the Ross Sea off the coast of Oates Land, Antarctica, has the specific name "Adare" that refers to nearby Cape Adare and the generic name "trough" that describes the morphology of the feature. The color scale gives the elevation in meters.



V. Stagpoole (GNS Science/WHOI/NOAA/PMEL/OSU)

A 3-D image of Brothers Seamount, showing the top of the volcano. This image is a combination of ship-based multibeam sonar and AUV multibeam sonar inside the caldera and over the summit cone. The summit is about 1200 meters below the sea surface.

Currently, proposals are emailed directly to the SCUFN secretariat (info@iho.int), where they are uploaded onto a web application and shared with subcommittee members for review. Final approval of proposed names is made at the annual SCUFN plenary meeting. SCUFN members consider proposals in chronological order of submission: Late proposals will be considered last if there is sufficient time at the plenary meeting. For each of the past 5 years, SCUFN has reviewed between 70 and 200 names. In 2016, the subcommittee reviewed 206 feature names, and 144 of these will be added to the GEBCO Gazetteer.

Future Goals

We plan to enable users to submit undersea feature name proposals to SCUFN via a new web application using an online form or by uploading a completed proposal document with accompanying images. SCUFN members can then immediately access these submissions to assess feature names and share comments about each proposal. In this way, the new interface will help speed up SCUFN review and approval processes.

We expect to unveil this new web tool in 2017. The online submission tool will include a facility for submitting geographic information system files (GIS shapefiles) that can be used to help evaluate the proposal and can be incorporated into the Web map application.

Until that tool launches, we encourage users of undersea feature names in scientific literature and on bathymetric maps to access the current iteration of the gazetteer as well as resources connecting them to generic feature terms and naming guidelines.

Once proposals become more streamlined, we will be well positioned to meet our goal: to increase the number of feature names in the GEBCO Gazetteer and to make them readily available to the scientific community for publications and web map services.

Acknowledgments

We thank the International Hydrographic Organization and the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC-UNESCO) for maintaining the activities of SCUFN. We also acknowledge the support of the U.S. National Oceanic and Atmospheric Administration (NOAA) and the Korea Hydrographic and Oceanographic Agency (KHOA) for the development of the new web applications for undersea feature names.

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GeoHealth

AN OPEN ACCESS AGU JOURNAL

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AGU PUBLICATIONS

A MEETING THAT HELPED FOSTER THE ACCEPTANCE OF GLOBAL TECTONICS

By Michael R. Rampino

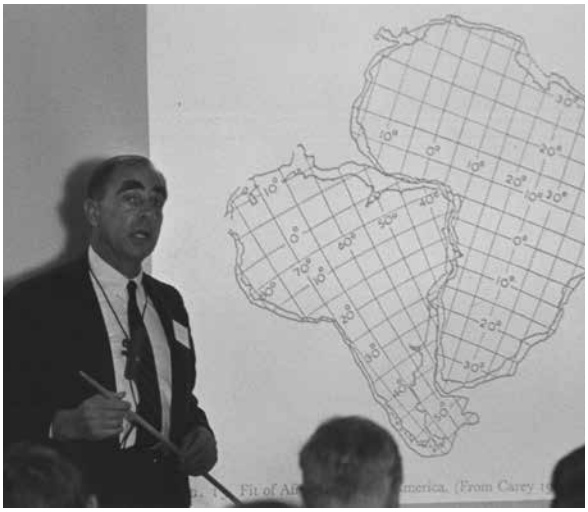
Nature Picture Library / Alamy Stock Photo

Barrett Gallagher

In December, scientists from across the world gathered at the AGU Fall Meeting in San Francisco, Calif. They attended to be a part of history—at such meetings, those who convene present new results, build collaborations, refine ideas, and engage in discussions that could change the very course of our science.

For those involved with seismology, paleomagnetism, and global tectonics, last year's event marked an important anniversary of another meeting 50 years ago. On 11–12 November 1966, a crucial private meeting took place in New York at the NASA Goddard Institute for Space Studies. Called the History of the Earth's Crust Symposium, the gathering brought together geologists and geophysicists interested in the evolution of continents and oceans, especially in new ideas pertain-

A diver explores a deep fault filled with freshwater in the rift valley between the (left) North American Plate and (right) Eurasian Plate in Iceland's Thingvellir National Park.



Barrett Gallagher

Patrick Hurley of the Massachusetts Institute of Technology shows the fit of the continents around the present Atlantic Ocean. His was one of several talks at the History of the Earth's Crust Symposium, held in New York in 1966 at the NASA Goddard Institute for Space Studies.

ing to continental drift and the origins and history of the ocean floors.

At the time of the meeting, geologists, who generally fell into two theoretical camps—the fixists and the mobilists—had been pondering a variety of hypotheses that explained the features on Earth's surface. Since World War II, additional observational data had come to light that offered clues to the physical mechanisms underlying those features. Might it be possible that the continents were moving across the face of the planet, and could the emerging field of paleomagnetics explain past movement?

An Auspicious Time

The History of the Earth's Crust Symposium occurred at an auspicious time in the geological sciences. While the idea of continental drift was not new, evidence pointing to the mechanism of drifting was under much debate. New evidence bearing on the evolution of Earth's crust was just coming to light, from magnetic analysis of surface rocks, sediment cores, and shipboard magnetics data and from seismic data from the world's oceans. Much of this new information was still unpublished at the time of the meeting.

The meeting was organized by geochemist Paul Gast of the Department of Geology at Columbia University and astronomer Robert Jastrow, director of the Goddard Institute. These organizers realized that new research on geomagnetic reversals, earthquake activity, the nature of the oceanic crust, and the causes of tectonic episodes was coming together in ways that presaged a revolution in the study of Earth's evolution.

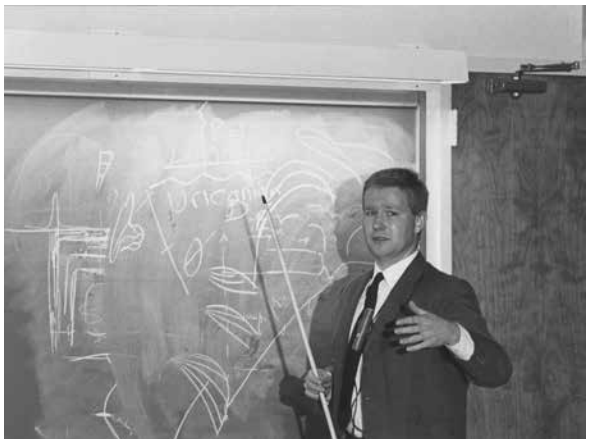
The guest list was impressive and included Harry Hess and Fred Vine of Princeton University; Maurice Ewing, Lynn Sykes, James Heirtzler, Xavier Le Pichon, Neil Opdyke, and Walter Pitman from the nearby Lamont Geological Observatory; Henry Menard of the University of California, San Diego; Edward Bullard, John Dewey, and Dan McKenzie from Cambridge University; Patrick Hurley of the Massachusetts Institute of Technology; Marshall Kay of Columbia University ; and other geological luminaries.

It marked the first time that geologists and geophysicists came together to focus on what became the new global tectonics [*Phinney,* 1968]. This is significant, because many of the last holdouts against the idea of continental drift—spurred by what they felt was a lack of scientific evidence—were from the United States [*Oreskes,* 1999]. But this meeting provided intellectual and disciplinary credibility that helped nudge the community to accept the basic ideas behind continental drift.

A Focus on Geomagnetic Reversals

The attendees were particularly interested in new results related to Earth's magnetism and the subject of geomagnetic reversals. Meeting attendees knew that Earth experienced episodes when the geomagnetic poles flipped, when geomagnetic north became south and south became north. Prior to the meeting, Allan Cox of Stanford and Richard Doell and Brent Dalrymple of the U.S. Geological Survey in Menlo Park, Calif., had established the timescale of reversals of Earth's magnetic field for the past few million years [*Cox et al.,* 1964]. They had accomplished this by measuring the magnetic polarities and ages of volcanic rocks from many different oceanic islands and some continental areas.

Their methods will be familiar to anyone who's worked on paleomagnetism since then: They carefully drilled oriented samples from volcanic lava flows and



Barrett Gallagher

John Dewey of Cambridge University discusses the origins of the Appalachian-Caledonian mountain range at the History of the Earth's Crust Symposium.

measured their direction of magnetization in the lab. At the same time, they performed radiometric dating of their samples to provide a time history for the magnetic flips they detected. They found that during specific time intervals, paleomagnetic signatures followed the same pattern worldwide.

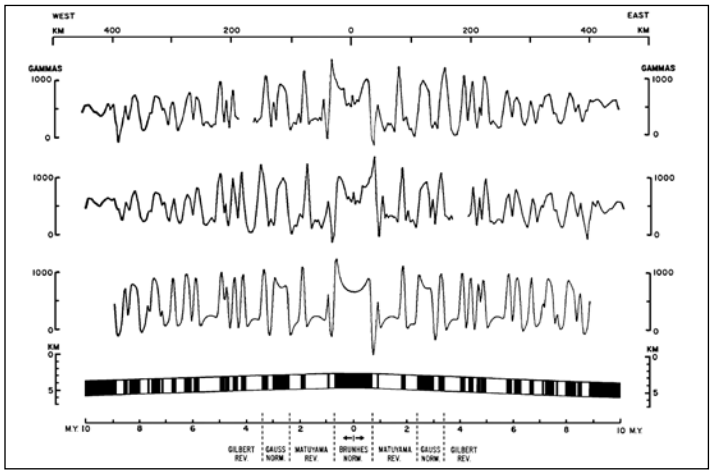
The internal consistency of the worldwide paleomagnetic and radiometric results established that the polarity events were the result of a rapid switching of the geomagnetic poles and could be correlated from one place to

another. Cox, Doell, and Dalrymple brought this new insight to the History of the Earth's Crust Symposium.

Signatures in Ocean Sediment

At the same time, Neil Opdyke and his students at the Lamont Geological Observatory were studying sediment cores from the ocean floor. These sediments, the researchers found, contain grains of magnetite that align themselves in the direction of the magnetic field at the time they were deposited. In this way, the scientists were able to determine the direction of the Earth's magnetic field as a function of time downward through the cores [*Opdyke et al.*, 1966].

Opdyke's team presented these new results at the symposium. Together, the researchers verified a remarkable result: Ocean sediment cores vertically showed in detail the same sequence of reversals found in the volcanic rocks dated by Cox, Doell, and Dalrymple. The field of magnetostratigraphy was born.



Pitman and Heirtzler [1966]/AAAS

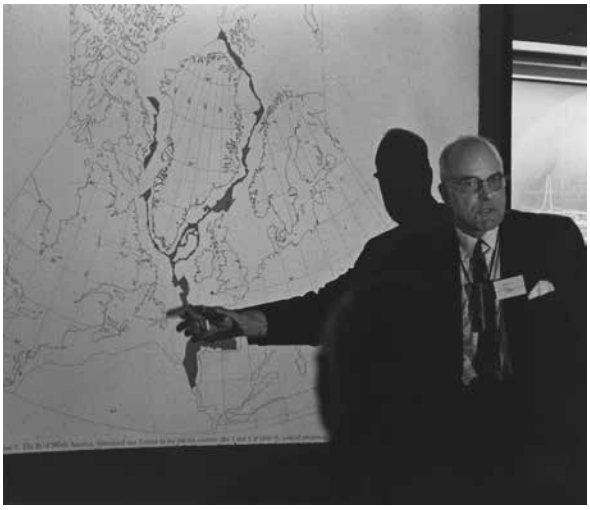
(Top) Magnetic anomalies, imaged while traveling across a mid-ocean ridge near Antarctica. (middle) A mirror image of the top profile, reflected across the ridge axis. Note the symmetry in the two profiles. (bottom) A model generated by assuming normal and reversed ocean crust as shown as black and white banded chrons.

Seafloor Stripes

Also remarkable was the prediction by Fred Vine and Drummond Matthews of Cambridge that because of ongoing seafloor spreading and the reversals of Earth's magnetic field, the magnetism of the ocean floor rocks should be arranged as a series of stripes of normally and reversely magnetized crust. They proposed that these stripes run parallel to and symmetrical with the mid-ocean ridges [*Vine and Matthews*, 1963].

Studies of the magnetic pattern on the Reykjanes Ridge south of Iceland reported at the meeting showed exactly this configuration of reversed and normally magnetized crust. By towing a magnetometer (an instrument that records the strength of Earth's magnetic field) behind a ship, researchers discovered that when a magnetometer passes over normally magnetized ocean floor, the recorded signal is enhanced, whereas over reversely magnetized ocean crust, the signal is weakened.

The pattern of normal and reversed stripes of ocean floor matched the pattern of geomagnetic reversals found by dating the rocks from continents and oceanic islands and also matched that discovered by Opdyke in his deep-sea cores.



Barrett Gallagher

Marshall Kay of Columbia University points out the positions of the continents during the Appalachian-Caledonian orogeny, an event that occurred prior to the opening of the present Atlantic Ocean. Kay's talk was one of several at the History of the Earth's Crust Symposium.

Magic Magnetic Profiles

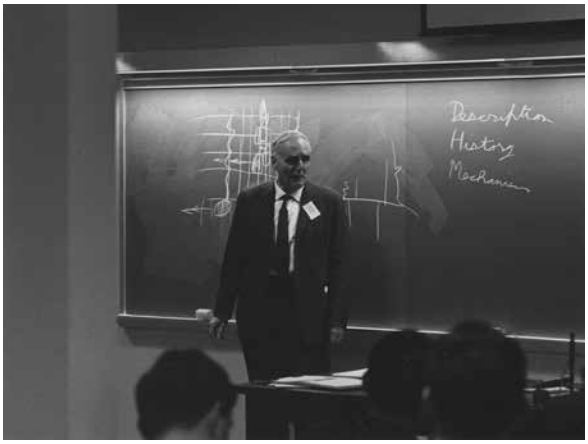
Probably the most astounding discovery was the first report of the R/V *Eltanin*'s "magic" magnetic profile, taken as the ship traveled across the Pacific Antarctic sector of the mid-ocean ridge on its 19th cruise. The discovery, presented by Walter Pitman and Jim Heirtzler from Lamont, showed the same symmetrical magnetic anomalies occurring in the ocean basins far from the axes of the ocean ridges, going back more than 10 million years in geologic time [*Pitman and Heirtzler*, 1966].

What's more, Pitman and Heirtzler demonstrated that the patterns of magnetic anomalies could be reproduced by models in which the seafloor was spreading at rates from 1 to a few centimeters per year. They shared their findings at the symposium, and within a few years, scientists were able to use the same techniques to extend the magnetic timescale back more than 70 million years.

Confirmation from Around the World

The confluence of those three lines of research—tracing the Earth's magnetic reversals in volcanic rocks, in cores of sediment, and on the oceanic crust—transformed geology and geophysics from a collection of unrelated data to a new and dynamic subject. These discoveries would ultimately contribute to a paradigm shift in the geosciences.

Independent evidence of seafloor spreading came from measurements of oceanic heat flow by Xavier Le Pichon, who showed excess heating over the ocean ridges, with the crust cooling and subsiding as one

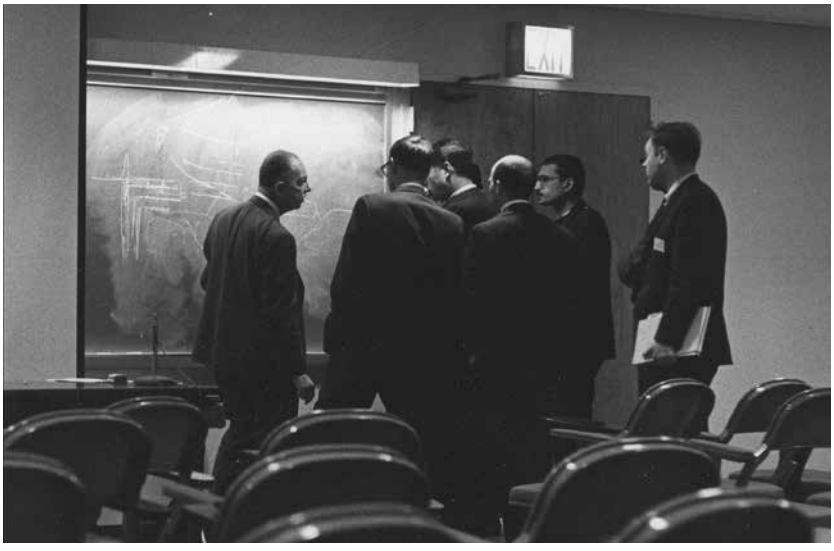


Barrett Gallagher

Edward Bullard of Cambridge University discusses the distribution of heat flow from the oceanic crust at the History of the Earth's Crust Symposium.

moved farther from the ridge crest [*Langseth et al.*, 1966]. Seismological evidence developed by Lynn Sykes at Lamont showed that earthquakes were occurring along the axis of the mid-ocean ridge and on sectors of transverse offsetting faults between the ridge segments [*Sykes*, 1967]. Using first-motion studies of the earthquakes, Sykes showed that the movement along the faults was not in the direction of the offsets, as might be expected, but the reverse. They were not transcurrent faults but "transform faults" as hypothesized by *Wilson* [1965] just a year earlier.

Independent geologic evidence of continental drift was also presented at the symposium in the form of Edward Bullard's computer fit of the continents around the Atlantic Ocean [*Bullard et al.*, 1965], Pat Hurley's compilation of ancient radiometric age data of the continents from West Africa and South America showing that the patterns matched [*Hurley et al.*, 1967], John Dewey and Marshall Kay's reconstruction of the Appalachians and Caledonides prior to the origin of the present Atlantic Ocean [*Dewey and Kay*, 1968], and the presentation of polar wander (now seen as mostly the result of continental drift) by Ted Irving of the University of Leeds [*Irving*, 1964] and others.



Barrett Gallagher

Harry Hess of Princeton University (at left) discusses seafloor spreading with attendees at the History of the Earth's Crust Symposium. Paul Gast of Columbia University is at right.

Edging Toward a Paradigm Shift

After the meeting, a number of conference attendees returned to their respective institutions convinced that global tectonics provided the best explanation for the magnetic signatures they had observed.

This was but one piece of the puzzle. Over the next year, scientists took these paleomagnetic data and combined them with observations of the seafloor, with the mechanics of ridges, and with maps of global earthquakes and known volcanoes to create a unified theory of plate tectonics [*McKenzie and Parker*, 1967; *Morgan*, 1968].

The work presented at the meeting, and the work of many others, contributed to the resolution of a key revolution in geophysical thought. Now, as we prepare our talks and format our posters for future meetings, we can find inspiration in this gathering of scientists half a century ago. We are still feeling the repercussions of that disciplinary paradigm shift today.

What new fields of research might be born as the year unfolds? We'll have to wait and see.

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Interviewing 101
Navigating the Four-Step Process

By David Harwell

Think of an interview as a dance of words. As in many dances, there are a few patches of tricky footwork.

Torturing job candidates is not the only purpose for interviewing.

In fact, there are multiple purposes. For the employer, the purpose is to identify the best candidate for a job and convince that person to accept an offer. For the job seeker, the interview is an opportunity to show off his or her skills and expertise and to see how well the potential job and employing organization fit his or her current professional needs.

At its core, an interview is a conversation in which both parties want something. It is part marketing, part negotia-

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tion, and part research. Think of it as a dance of words. As in many dances, there are a few tricky steps.

To navigate these steps, you must understand where your conversation falls in the interview process. Typically, recruiters engage in four stages.

1. Exploratory Interviews. Exploratory interviews are simply informal conversations. They could happen at a party, after a research talk, at the gym, or at any other place where people meet.

Many companies send employees to technical events to scout for potential job candidates. In the scouting role, they attend research talks at conferences and start conversations with students and other researchers who appear promising for a particular job or research area.

A real job may or may not actually exist at this point. Sometimes companies just want to know who is available as they size up new markets.

2. Screening Interviews. Screening interviews are usually done over the phone by a recruiter or by someone in the human resources office. They serve to help narrow the pool of applicants for a specific position down to a manageable number.

During the screening interview, the recruiter will be actively trying to eliminate candidates by assessing their eligibility. Eligibility will be based on predefined qualifications, skill sets, and experiences. It is unlikely that the recruiter will have detailed technical knowledge about your field, so prepare your answers accordingly.

There are often hundreds of candidates for a single posted job listing. By phone screening candidates, the recruiter will narrow that list to no more than three to five people.

Screening interviews happen only after you have applied for a position, so recruiters will make a few assumptions. They will assume that you are familiar with the hiring organization and that you know what you are getting into.

Screeners will also assume that you will remember that you applied for the position and that you believe that you are a good fit for the job as advertised. Therefore, you should prepare by building an application file for each position to which you apply. The file should include a copy of the job listing, a copy of the resume or CV that you used in the application, and any other materials submitted, including your cover letter, reference list, etc. The file can be a manila folder that you keep in your backpack or a digital file that you store in the cloud; just make sure that you have one and can find it readily when the recruiter calls.

Be prepared to ask the recruiter about both the organization and the position. Your questions should probe deeper than just the job listing. Rather, you want to indicate that you cared enough about the organization to do some research. Look at its website to read about strategic plans, and examine its stance on issues important to you.

You can also look up its employees on LinkedIn and other employment-related sites to see whether the organization has a high turnover rate or whether employees tend to stay and progress through a series of positions. Write a set of questions for the recruiter and have them ready for when you get the call.

3. Preliminary Interview. Once the field has been narrowed by the screening interview, the surviving candidates are referred to the hiring manager for a more detailed review.

The hiring manager will usually call high-potential candidates for further screening. You should regard this as a preliminary interview.

The hiring manager will be technically literate and is likely an expert in the field. You can expect this person to dig more deeply into your technical competencies.

This manager is also looking to see whether you would be a good cultural fit with the team and organization where you would work. Cultural fit refers to the degree to which you would conform with the behavioral norms and values of a team or an organization. Be prepared for questions that probe your problem-solving skills.

At its core, an interview is a conversation in which both parties want something.

4. On-Site Interview. After preliminary interviews, no more than two to three candidates will be invited for an on-site interview.

If you've made it this far, take a moment to breathe a sigh of relief. It takes a lot of money and time to usher candidates through the on-site process, so the privilege is reserved for a very small number of the most promising candidates. More specifically, *they like you*!

Depending on the type and level of the job, the on-site interview could have any (or all) of the following components: introductions, you giving an oral presentation, a meal (lunch or dinner), a series of interviews that probe your behavior (e.g., your ability to problem solve and how you act under stress), a facilities tour, project discussions, a meeting with human resources, and a debrief and wrap-up.

The length of an on-site interview depends on the importance and responsibilities of the position. The higher the position is, the greater the amount of time dedicated to the interview process will be. The interview time for an entry-level position may be only an hour or so, whereas an

For more career advice or to see listings of jobs available in the Earth and space sciences, visit the AGU Career Center (http://careers.agu.org).

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There are often hundreds of candidates for a single posted job listing. By phone screening candidates, the recruiter will narrow that list to no more than three to five people.

interview for a senior research position could last a couple of days.

Every interaction you have with the company is part of the interview. This bears repeating and special type treatment: *Every interaction you have with the company is part of the interview.*

Don't be too informal, even at events meant to help you relax and feel comfortable during the process. Everyone involved, from the person picking you up at the airport to the people in the audience at your oral presentation, is part of the evaluation team. They will look at the way you dress, consider the way you interact with others, probe your technical knowledge, and contemplate your communication skills.

You are their potential colleague, and they want to make sure that you can do what you say you can do, will be a valuable member of the team, and won't be a jerk to work with. No one likes to work with a jerk!

It sounds oppressive, but you have to realize that they have a lot at stake. If you are hired, the future of the organization will be dependent upon what you and your new colleagues can do, and their individual happiness on a daily basis will depend on whether you are able to work cheerfully with them or will rain on their parade.

At this stage, it is no longer your interview; it is theirs. They are shopping for a colleague, and it is up to you to show them how well you will fit in and contribute.

Preparing for the On-Site Interview

Before your interview, you will likely receive a call from the hiring manager to agree on a date and to make necessary logistical arrangements. During the call, he or she should provide information about his or her expectations of you in each stage of the process. If the expectations are not made clear, you need to do the following:

- Ask for the names and titles of anyone who will be included on your interview schedule and look up their online profiles before you arrive on site.
- Get detailed information about the logistics of your presentation if you are making one. Who will be there? What is their level of knowledge? How long should you plan to talk, and does that include time for questions? Should you bring your own computer or just bring your presentation on a memory stick?

Then, on your own time, you should perform the following tasks:

- Review the job description, and be prepared with brief stories that illustrate ways you have successfully demon-

strated the skills and competencies required for this position.

- Practice giving your presentation to *real people*, not just the theoretical ones in your head. This is extremely important. For your practice audience, choose people brave enough to give you constructive feedback. The process may hurt a little, but it will make you stronger in the end.
- Practice answering behavioral questions out loud (search online for sample questions). Again, this process will be most effective if you practice in front of real people.

What Exactly Are Behavioral Questions?

Behavioral questions are asked because hiring managers assume that the best indication of your future performance is your past performance. Therefore, a question to probe your interactions with others might take the form "Tell me about a time when you had a difficult interaction with a colleague. How did you resolve the situation, and what did you learn from it?"

Your answer will reveal your level of self-awareness, your ability to deal with difficult situations, and your openness to learning new skills. If you say that you have never had a difficult situation, the interviewer knows that you are likely lying or not very self-aware. If you were not able to find a way to resolve the situation and/or you did not learn from it, then it is likely that you still have issues dealing with conflict.

Answering behavior-based questions requires a story about a specific time that illustrates your ability to resolve the issue and learn from it. Your probability for successfully answering the questions will increase as you spend time practicing answers.

During the Interview

Be sure that you are prompt and dressed properly. If you have doubts about what is proper to wear, check with a trusted family member or mentor. I'm sure that he or she will have something constructive to add on this subject. If you're interested in more about interview dress attire, you can read my advice at the AGU Career Center's *On the Job* blog (http://bit.ly/interview-attire-advice).

As you meet with people, listen for clues about what is important to them, and make a note for yourself so that you can follow up later. Tailor your answers to their interests where possible.

In addition, remember to ask for their business card, or write down their name, title, and contact information. You are going to need their info after the interview to follow up.

It is also good to leave them with a reminder of your time together. Give them a printed copy of your resume, a business card, and/or a research summary. They will likely see several candidates, so a souvenir from you will help them remember that you were the best candidate for the job.

After the Interview

After the interview, remember to write thank-you notes to everyone involved in the interview process. It's not just a nice thing to do. It's essential. Neglecting this step sends a signal to your potential employer that you aren't that interested. Your competition—the other candidates for the job—will likely remember this step, even if you don't.

In each note, refer to what the interviewer expressed as his or her interest during the interview. Most important, reinforce why you are a good fit for the position, and restate your interest.

If the interview went poorly or you decide that you are less than enthusiastic about the position, follow through anyway. It's the right thing to do. Besides, you can't turn down an offer that you never received.

Regardless of how the interview went, congratulations! The ball is in their court now. We hope that they hit it back to you.

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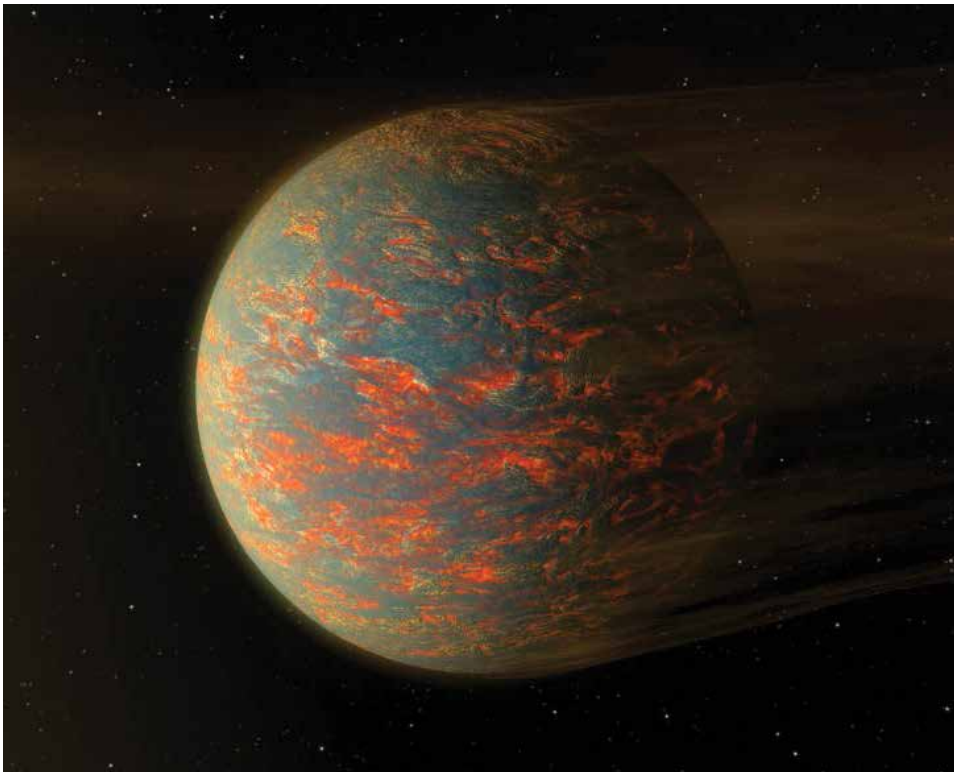
JGR: Planets Celebrated 25 Years

In 1991, AGU launched a new journal to document the research of planetary scientists. Although planetary geology, geophysics, and remote sensing were represented in the old *Journal of Geophysical Research (JGR): Solid Earth and Planets*, "papers on other aspects of planetary science were scattered among *JGR: Space Physics, JGR: Atmospheres,* and several non-AGU journals," said Clark Chapman, senior scientist at the Southwest Research Institute in Boulder, Colo., and the new journal's first editor in chief. "The then current division of topics among AGU journals resulted in fragmentation of the field of planetary science, [and] this had compounding negative effects on AGU serving as a major organization with a focus on planetary science."

The goal of establishing a planetary science–focused journal, *JGR: Planets*, "was both to broaden the range of planetary disciplines being handled by AGU and to unify planetary papers in a single place," Chapman added.

In 2016, *JGR: Planets* editors released a special issue that showcases the journal's role in the prior 25 years of shepherding some of the most prominent discoveries in planetary science (see http://bit.ly/JGR-planets-special-issue). Among many major findings, the issue revisits evidence of Mercury's dynamic past full of geological activity, telling signs that ancient Mars hosted water on its surface and in its subsurface, and the discovery that ocean-bearing worlds are more common than astronomers thought. "Ultimately, we developed a list of topics that highlights fundamental questions and discoveries across the broad scope of topics we publish," said the *JGR: Planets* current editor in chief, planetary scientist Steven Hauck of Case Western University in Ohio.

In interviews with *Eos,* Chapman and Hauck reflected upon the first quarter century of the journal and contemplated the future of the journal and the field it covers. Responses have been edited for length and clarity.



NASA/JPL-Caltech

An artist's representation of the rocky extrasolar planet 55 Cancri e, which is nearly twice the diameter of Earth. NASA's Spitzer Space Telescope recently discovered that the planet may host vast pools of lava.

Eos: *What are the most important contributions* JGR: Planets *has made to planetary science since its founding?*

Chapman: While immediate results of planetary spacecraft missions usually appear in *Science* or *Nature*, *JGR: Planets* is one of several venues for publishing special issues on the more mature research results. During the first year of *JGR: Planets,* we published a joint issue with *JGR: Space Physics* on the major results of Voyager's once-in-a-lifetime encounter with Neptune. In 1992, the *JGR: Planets* special issue on the Magellan mission won an award [from] the Association of American Publishers as "Best Single Issue of a Journal."

Hauck: The papers from the Magellan at Venus special issue inspired me toward my career and remain among some of the most cited that *JGR: Planets* has published. Similarly, special issues from the Pathfinder Spirit, Opportunity, and Curiosity rovers document the beginning of the era of in situ exploration of Mars. Papers not associated with special issues are also quite notable. A great example is a seminal paper on the importance of methane as an additional greenhouse gas in warming Earth's atmosphere (http://bit.ly/methane-paper).

Eos: *When* JGR: Planets *began, no one knew whether there were planets around other stars. Now we've spotted thousands. Was there any hesitation to include planets from beyond our solar system as part of the journal's purview, and why or why not?*

Chapman: I know that in my own head, I had ambivalent attitudes about the degree to which research on exoplanets should be married to planetary science or, alternatively, remain a branch of stellar astronomy (as it mainly was in its earliest years). I now clearly see the intimate linkages between that topic and planetary science.

Hauck: While I wasn't there at the start, *JGR: Planets* published its first special issue on the detection of extrasolar planets in 1996. Exoplanets are planets. Indeed, it is crucial for planetary science for exoplanets and systems of exoplanets to be considered side by side with our own solar system.

Eos: *How have the discoveries of exoplanets affected the journal?*

Hauck: The identification of extrasolar planets is one of the most exciting and important discoveries of our age. *JGR: Planets* start[ed] publishing papers about detecting extrasolar planets over 20 years ago. Today, discussion of exoplanets is increasingly common in papers about objects and processes in our own solar system. Furthermore, we publish papers that consider exoplanets individually or groups of exoplanets in a context of comparison with our own solar system.

NASA/JPL-Caltech/MSSS

NASA's Curiosity rover combined 60 images to create a self-portrait at the "Murray Buttes" location on lower Mount Sharp. Curiosity landed on Mars in August 2012 and has since provided important data about Mars's surface, including composition, atmospheric interactions, and habitability.

Eos: *How does* JGR: Planets *help further AGU's mission and inspire the next generation of scientists?*

Hauck: I think *JGR: Planets* works to inspire the next generation of scientists by publishing excellent science that is communicated clearly. Further, by opening the journal's archives to the public, by promoting plain language summaries, and by disseminating work through a variety of online networks, we are expanding the reach of our science.

Eos: *What's your advice for any young scientist studying planetary science—or wanting to submit to* JGR: Planets*?*

Chapman: If you are bright, well educated, and fascinated by the cosmos, planetary science is potentially a great scientific field to consider. It can have rewards almost unique among the sciences, such as the almost instantaneous new perspectives gleaned when a spacecraft flies by a planet (think of Pluto in the summer of 2015).

But there are risks and downsides. Much, if not most, of your time will be spent writing or contributing to (or reviewing) excellent proposals that are rarely funded. Nevertheless, if you do excellent research and you publish it in highly regarded journals like *JGR: Planets*, you stand a chance of thriving in an exceptional field of human inquiry.

Hauck: Take the communication of your science at least as seriously as performing the research. How we as scientists communicate with each other and with the broader world community is crucial for our work both to have an impact and to endure. This advice extends to every avenue for communicating science, including scientific papers such as in *JGR: Planets*, in talks and poster presentations at conferences such as Fall [Meeting], and in one-on-one interactions with anyone who might be interested, including journalists and the general public. At the end of the day, we need to make the results and implications of our research clearly understandable.

Eos: *What excites you about the future of* JGR: Planets*?*

Hauck: First, the science *JGR: Planets* will publish. This is a great time to be in planetary science. I always look forward to reading papers in *JGR: Planets*. Second, I am excited about how we are expanding [the ways] we spread the news about the science. Part of this is opening up our science more with greater open access to data, to new papers, and [to] our archive of papers, which are open after 24 months. The other part is by supporting broader communication through implementing plain language summaries. Plain language summaries make our content more accessible both to scientists around the world and [to] the public at large.

Chapman: I am reasonably optimistic about the future of planetary science, although one must be concerned about the depth of commitment of our society to science in these troubling times. But it is unclear to me how the future of scientific journals will evolve. Certainly, the Internet has drastically changed the publishing business. I certainly hope that *JGR: Planets*, in the good hands of Steve Hauck and subsequent editors, will have a good future in disseminating excellent planetary research.

Eos: *On that note…what are some potential planetary headlines of the future? For example, "Humans land on Mars!" or "Probe drills into Europa's icy shell!"*

Chapman: Occasionally, nature itself surprises us, as when an asteroid exploded a few years ago in the skies above a Russian city of a million people. And maybe a space alien will suddenly appear, though I doubt it. Eventually, an astronaut from NASA or some other country, or maybe even Elon Musk himself, will land on Mars.

Hauck: I think that those are some good headlines. I also expect to see something like "Humans bring pieces of Mars to Earth" and "Boat sails the frigid seas of Titan."

Eos: *In November, the United States had a presidential election. What are your thoughts, hopes, and fears for planetary science under the new administration?*

Hauck: My hope is that the [new] administration and Congress will work together to fund a robust Earth and space science program. Our planet faces a host of challenges, from the effects of climate change to natural disasters and their consequences for human health in their aftermath. Others range from clean drinking water to the need to move toward renewable energy sources. It is incumbent upon Congress and the president to ensure [that] they and the general public continue to receive the best and most objective science to serve the nation and prepare it for the future.

We must continue to build a deeper understanding of how all planets operate to better understand our own. Whether it is the space weather at Mercury; the weather and climate on Venus, Mars, and Titan; earthquakes or asteroid impacts on the Moon; or oceans on Europa and Pluto—all are subject to [the] same laws of physics as Earth. As with human health, studying a broad population leads to better understanding of how individuals work, so we better keep exploring the solar system if we want to be able to understand and solve Earth's problems too.

By **JoAnna Wendel** (@JoAnnaScience), Staff Writer

Awardees and Prize Winners Honored at 2016 AGU Fall Meeting

Johnson, Lozier, Meltzer, and Oreskes Receive 2016 Ambassador Awards

Ashanti Johnson, M. Susan Lozier, Anne S. Meltzer, and Naomi Oreskes were awarded the 2016 Ambassador Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award is in recognition for "outstanding contributions to one or more of the following area(s): societal impact, service to the Earth and space community, scientific leadership, and promotion of talent/career pool."

Ashanti Johnson

Citation for Ashanti Johnson

Dr. Ashanti Johnson has devoted substantial effort to mentoring underrepresented minority (URM) Earth system science (ESS) undergraduate and graduate students, as well as URM early-career professionals. She recognizes the importance of effectively encouraging URM students to pursue careers within ESS, despite the fact that professional rewards for academic scientists often come not for being good mentors but primarily through their scientific research activities. Although, initially, Ashanti utilized the normal mentoring channels available to faculty by mentoring students who enrolled in her classes or had research interests similar to hers, she quickly recognized a need for a broader, more proactive approach that would reach larger numbers of students, particularly URMs.

I recognized her rare ability to balance and sustain creative and visionary ideas with the necessary detailed research and technical applications. She is one of those individuals who can see the big picture while still managing a complexity of details. It is these attributes along with her dedicated leadership that have led to the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S®) Professional Development Program.

I believe the results of the MS PHD'S Professional Development Program alone would make Ashanti worthy of AGU's Ambassador Award. However, Ashanti also actively engages in a number of other professional development and diversity-focused scholarly activities designed to facilitate research and professional development experiences for URM students and early-career faculty. Recognizing the crucial need for collaborative leadership within the scientific community for continuing to foster the development of a globally diverse ESS community, Ashanti also engages in key service activities with scientific communities whose missions include a commitment to broadening participation. In 2002, AGU established a Diversity Plan recommending a policy of education, engagement, outreach, facilitation, partnership, and collaboration in order to increase the diversity and representation of minorities in ESS. The plan recognized that such increased representation would provide the global scientific community with an expanded means of communicating the science behind ecological and economic practices that affect natural resources. Scientists like Ashanti serve to inspire URM students to pursue the goals of AGU's Diversity Plan. I believe there is no one more deserving of the AGU Ambassador Award than Dr. Ashanti Johnson.

—Warren M. Washington, *National Center for Atmospheric Research, Boulder, Colo.*

Response

It is indeed a great honor to receive an AGU 2016 Ambassador Award. I am even more honored to have been nominated for this award by Warren Washington, an amazing role model. This award is a testimony of our scientific community's acknowledgment of the need for targeted efforts to increase participation of underrepresented minorities (URMs).

I was able to attend my first AGU Fall Meeting in the mid 1990s utilizing funds from my Ford Foundation Minority Doctoral Fellowship award. Before the meeting, I was excited to be able to present my research on radionuclides in the Laptev Sea and looked forward to interacting with other researchers. During the actual meeting two things stood out to me: (1) there were thousands of attendees, and (2) I did not see any other attendees who were identifiably African American. Although I was surrounded by many individuals who were pursuing geoscience careers, I felt absolutely alone. In fact, during my debriefing with Martha Scott, my graduate advisor at Texas A&M University, I expressed how I felt and my hesitation to attend future AGU meetings.

In 2003, as a Georgia Tech research scientist working on an aquatic geochemistry project, I coordinated the university's Alliance for Graduate Education and the Professoriate (AGEP) program. AGEP's main objective was to improve URM doctoral students' pathways to the professoriate. In addition, during the same year, I launched the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S®) pilot project in conjunction with the final Joint Global Ocean Flux Study (JGOFS) Open Science Conference. These activities served as my first formal programmatic opportunities to facilitate the advancement of STEM URM students and strengthened my commitment to provide professional development, mentoring, and funding opportunities for URM students throughout my career.

I am blessed to have been supported by many individuals, including Claudia Alexander, Peter Betzer, LaTanya Turner-Braxton, Jacquelyn Bolman, Robert Duce, Art Hicks, Warner Ithier-Guzman, Ambrose Jearld Jr., Roosevelt Johnson, Jill Karsten, Margaret Leinen, Gary May, Lois Ricciardi, Marilyn Suiter, Ming-Ying Wei, Warren Washington, Vivian Williamson Whitney, and Thomas Windham. Unfortunately, text limitations do not allow me to acknowledge all of those who have positively impacted the efforts for which I am being recognized, but please know there were many. It is because of these individuals and our professional community, coupled with the tremendous talent and dedication of so many URM students that I humbly accept this award.

—Ashanti Johnson, *Mercer University and Cirrus Academy Charter School, Macon, Ga.*

M. Susan Lozier

Citation for M. Susan Lozier

Susan Lozier is widely recognized as a true intellectual achiever and as an awesome role model in physical oceanography. Susan is a Fellow of AGU, a Fellow of the American Meteorological Society, and the 2010 recipient of the Association of Women Geoscientists Outstanding Educator Award. She is the current president of the Oceanography Society.

Susan is unquestionably among the foremost physical oceanographers of her generation, making significant contributions to both theoretical and observational physical oceanography, as well as being a pioneer in understanding the physical controls of biological productivity. Susan's key contributions to physical oceanography have transformed the way we think about the North Atlantic circulation. She currently leads the international Overturning in the Subpolar North Atlantic Program (OSNAP) initiative, designed to enhance our understanding and ability to model the Atlantic Meridional Overturning Circulation—an important component of the Earth's climate system.

While Dr. Lozier's scientific achievements are clearly exceptional, the contribution she has made to geosciences in creating and leading Mentoring Physical Oceanography Women to Increase Retention (MPOWIR) is what makes her uniquely deserving of this Ambassador Award. MPOWIR was established in 2005 in response to her concerns regarding the declining participation of women in the physical oceanography workforce going up the career ladder from Ph.D. to postdoctoral to faculty levels. Entraining both senior and junior scientists, Susan created a community-based structure that allows for the mentoring of a larger number of young women scientists than any one person could do alone. Junior women and senior scientists share experiences and are able to provide and receive frank advice and voice concerns, all the while building community networks to help raise confidence and skills for promoting science and recognizing that there are many differ-

ent pathways to career advancement and success. The MPOWIR approach acts to strengthen the whole community through our commitment to one another. Now, a decade after its implementation, MPOWIR is having a positive impact on the retention of junior women in physical oceanography, ensuring diversity for future generations. As such, MPOWIR also serves as a model program that could surely enrich and diversify the entire geophysical community.

In summary, Susan Lozier is a natural leader whose efforts have benefited the oceanographic community as a whole, not simply the individuals who have personally participated in the science or mentoring programs she has led. Susan Lozier is an excellent and worthy recipient of the AGU Ambassador Award.

—Janet Sprintall, *Scripps Institution of Oceanography, University of California, San Diego, La Jolla*

Response

The truth of the matter is that this AGU Ambassador Award is for the physical oceanography community. I am happy to accept the award on the community's behalf but prefer not to pretend that it is mine alone. MPOWIR got its start in May of 2004, when I invited several colleagues to join me in Washington, D. C., for a meeting with representatives from ONR and NSF to discuss retention issues for women in physical oceanography. Though I admit to bending a few ears, I never had to twist a single arm. From the beginning, my colleagues understood the need for a community-led mentoring program and, importantly, understood that the retention of female scientists was a community issue, not a women's issue. Thus, men in the physical oceanography community joined the effort, wholeheartedly so. NSF, ONR, NASA, NOAA, and DOE lent needed financial support along the way, and, perhaps most important, early-career female physical oceanographers responded with enthusiasm. And now, 12 years down the road, MPOWIR is moving the needle on retention, a point of pride for all members in the physical oceanography community.

Though I am loath to take personal credit for this award, I have no qualms about giving personal thanks. I'll start by expressing deep gratitude to oceanographer extraordinaire Janet Sprintall for heading this nomination; to Mark Cane and Rana Fine for providing shining examples of mentorship; to Sonya Legg and Colleen Mouw for so ably continuing the leadership of MPOWIR; to Eric Itsweire, Terri Paluszkiewicz, and Eric Lindstrom for their longstanding support of MPOWIR; and to Victoria Coles, Amy Bower, and LuAnne Thompson for sticking with me and MPOWIR from the start. Also, a thousand thanks go to my current and former graduate students who taught me how to mentor and forgave me my stumbles.

My engagement with MPOWIR and my own graduate students through these many years has been nothing short of a pleasure. When I think of my role as a mentor, I am reminded of an Edwin Markham quote that my mother taught me long ago: "All that we send into the lives of others, comes back into our own." It has been a privilege and honor to be part of MPOWIR, to be part of so many students' lives, and to be part of the physical oceanography community. Thank you.

—M. Susan Lozier, *Duke University, Durham, N.C.*

Anne S. Meltzer

Citation for Anne S. Meltzer

For 2 decades, Anne S. Meltzer has been a leader in developing community-driven science initiatives and in ensuring that community priorities guide organizations such as the Incorporated Research Institutions for Seismology (IRIS).

Dr. Meltzer's leadership was key in shaping a groundswell of community interest into the National Science Foundation (NSF) EarthScope facility and science program. She helped to develop the concept for the USArray—a rolling transportable array of broadband seismic stations that spanned the contiguous United States and is now in Alaska, plus permanent stations and targeted temporary arrays—and she played an important role in building consensus and crafting the plan for the EarthScope facility (funded by Congress at $200 million) that also included the Plate Boundary Observatory and the San Andreas Fault Observatory at Depth (SAFOD) San Andreas drilling project. Dr. Meltzer coordinated the USArray Steering Committee (1999–2002), was a key member of the EarthScope Executive Committee, and chaired the IRIS Board of Directors during this critical period.

Dr. Meltzer has continued as a leader within EarthScope and IRIS on the EarthScope Science and Education Committee (2002–2005) and as chair of the EarthScope Program Committee (2005–2008), chair of the EarthScope Facility Management Review (2011), chair of the IRIS USArray Advisory Committee (2012–2013), and chair (since 2014) of the IRIS Board of Directors. She was an early proponent of EarthScope-related education and outreach, which, through vibrant programs and the work of many people, has carried this science to thousands of students, teachers, and members of the public. Scores of undergraduates were recruited to help locate sites for transportable array stations, and Dr. Meltzer herself coordinated the student siting effort in Pennsylvania, New Jersey, Maryland, and Delaware.

Dr. Meltzer has worked to expand seismological expertise in developing countries, through research collaborations in Pakistan, Tibet, Mongolia, and Chile and as white paper author and founding chair of the IRIS Committee for International Development Seismology (2008–2011). One highlight was the 2011 NSF Pan-American Advanced Studies Institute in Ecuador, a 2-week immersion in seismology for over 30 students and young faculty. Dr. Meltzer also played a pivotal role in a May 2015 workshop in Chile that gathered more than 100 researchers to discuss best practices for modern geophysical networks and led a 2016 IRIS seismometer deployment to record aftershocks of a damaging earthquake in Ecuador.

In summary, Dr. Meltzer's work has enabled hundreds of researchers worldwide to excel scientifically and thousands of students and members of the public to be inspired by the Earth sciences.

—Karen M. Fischer, *Brown University, Providence, R.I.*

Response

I am honored to receive an AGU Ambassador Award and am grateful to Karen Fischer and other colleagues for nominating me. It is rewarding to have been in a position to help advance community initiatives at various points in my career.

Science is first and foremost a human endeavor, and academic consortia like IRIS have demonstrated that working together, we can achieve remarkable scientific advances. What started as a vision for shared facilities for collection and curation of seismic and other geophysical data, built on principles of open access to data and engagement of individuals across a spectrum of institutions in the United States and abroad, has built a community of scientists with global reach and impact.

The community of scientists who first conceived of USArray, PBO, and SAFOD, in partnership with funding agencies like the NSF and USGS, brought EarthScope from spark to ignition and transformed the Earth sciences. As a multidecadal infrastructure and science program, EarthScope has provided insights into Earth structure and dynamics on a continental scale, engaged a new generation of Earth scientists who easily work with big data and as part of interdisciplinary teams, and sparked the imagination of the next generation of scientists by directly engaging the public in the largest Earth science experiment conducted to date. New community initiatives like subduction zone observatories have the potential to do the same while contributing to the science behind hazards related to earthquakes, volcanoes, and landslides around the Pacific Rim and the Caribbean.

I have benefited from being a member of a diverse scientific community and the shared resources managed by IRIS. Community resources and collaborations with colleagues have allowed me and my students to pursue research in some of the most phenomenal places in the world in terms of Earth processes and sheer beauty, and to meet and get to know the most remarkable and culturally diverse people. We have been welcomed and received support everywhere we have worked and in turn have tried to give back in kind by supporting the communities who supported us and by collaborating with our colleagues abroad to build capacity in their countries. Many geoscientists working internationally, in ways both small and large, do the same. By building capacity at home and abroad, we extend the community of scientists studying our planet, how it works, and our relationship to it.

—Anne S. Meltzer, *Lehigh University, Bethlehem, Pa.*

Naomi Oreskes

Citation for Naomi Oreskes

Naomi Oreskes is truly an ambassador for our community. Her unique expertise, spanning the disciplines of history and geoscience, has allowed her to fulfill a particularly valuable niche in the academic and societal discourse over human-caused climate change.

As a scientist, Naomi has authored or coauthored several fundamentally important articles that have significant implications both for our understanding of the science of climate change and for our appreciation of the larger societal issues involved, including the challenge of communicating science in a hostile environment and the role of scientists as advocates for an informed public discourse. In 2012, Naomi coauthored a study providing a retrospective evaluation of climate science and introducing into the lexicon the phrase "erring on the side of least drama" in describing how and why scientists in our field have tended to err on the side of conservatism/reticence

when it comes to predictions and projections of climate change and its impacts. Naomi's groundbreaking 2004 study in *Science,* "The Scientific Consensus on Climate Change," is one of the most cited studies in our field (more than 1000 citations), which exposed the fallacy that there is still debate within the scientific community as to whether or not climate change is real and substantially due to human activity. It is this article, and the attacks she was subjected to by those looking to discredit this finding, that led Naomi into the center of the public sphere. We are all better off for that development.

Naomi went on to coauthor, in 2010, *Merchants of Doubt,* which explores the historical context for modern-day climate change denial, demonstrating how it grew out of previous disinformation campaigns like that behind tobacco industry efforts to deny the negative health impacts of its product. The book has sold over 50,000 copies, has been translated into six languages, has won several prizes, and was made into an award-winning documentary film that came out in 2014.

Naomi has provided testimony for numerous governmental and scientific panel assessments, has written dozens of commentaries and op-eds in leading newspapers, including the *New York Times, Washington Post,* and *LA Times.* She is a leading force for furthering an appreciation of the historical development of geophysical knowledge, for communicating our science and its implications to the public, and for combating antiscientific attacks in our field, particularly in the arena of climate change. Nobody could be more deserving of the AGU Ambassador Award.

—Michael Mann, *Pennsylvania State University, University Park*

Response

Thirty years ago, Lady Bertha Jeffreys advised me not to become a historian of science. I was making a grave mistake in throwing my scientific career away, she told me, particularly in light of my hard-earned first-class honors degree from Imperial College.

At the time, there were precious few women in geophysics. If asked to name one, most people could only mention Inge Lehmann. It had required extraordinary dedication and grace for Lehmann to earn her place; the same was true for Lady Jeffreys, and no doubt she wanted to keep me "in the fold." Had I been quicker, I would have explained that I was not leaving science; I was simply going to contribute in another way. I would have explained that my goal was to understand science as an enterprise: to study how scientists gather evidence about the natural world and come to conclusions about it. Above all, I wanted to answer the question, Given what we know about the fallibility of all human enterprises, what is the basis for our trust in science?

Today we live in a world where many people do not trust science, which puts our enterprise at risk. As Michael Mann and Ben Santer know, it is not easy to do your scientific work while you are under subpoena or being harassed. It is not a joke when a congressman threatens to hold you in contempt, or put you in jail.

As individuals, the continuance of our work depends upon our capacity to persuade others of its value; as a community, it depends upon our capacity to maintain public trust and resist those who seek to undermine it. The success of science as an enterprise rests on our capacity to persuade others that our work has integrity because we have integrity.

I am extremely privileged to have had the opportunity to stand up for the integrity of science and am grateful to be called an ambassador of the Earth science community. I would like to thank all the scientists with whom I have worked, in particular, Michael Mann and Benjamin Santer, who nominated me for this award; my teachers at Imperial College, particularly Rick Sibson, who taught me how to be a keen observer; my professors and fellow students at Stanford, who encouraged my hybrid career path; and my diverse colleagues at the University of California, San Diego, the Scripps Institution of Oceanography, and Harvard University. I am particularly indebted to the late Charles Drake, and the still-vital Charles Kennel, who supported me at crucial junctures. But above all, I am grateful to the climate scientists whose work I have had the honor to communicate, represent, and stand up for.

—Naomi Oreskes, *Harvard University, Cambridge, Mass.*

Pavel Groisman Receives 2016 Edward A. Flinn III Award

Pavel Groisman received the 2016 Edward A. Flinn III Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an "individual or small group who personifies the Union's motto 'unselfish cooperation in research' through their facilitating, coordinating, and implementing activities."

Pavel Groisman

Citation

Over the past 10 years Dr. Pavel "Pasha" Groisman, an AGU Fellow since 2010 and the leading U.S. climate expert on northern Eurasia, has made an outstanding contribution to the scientific community through his leadership and coordination of the Northern Eurasia Earth Science Partnership Initiative (NEESPI). Pasha's dedication and commitment have contributed to NEESPI's growth into a major international, multi-institutional program with close to 200 projects involving about 800 scientists from 30 countries. Most notably, under Pasha's leadership, NEESPI has facilitated very close interactions between U.S. and regional scientists, particularly in Russia, during the past decade's "window of opportunity" when U.S.-Russia scientific relations developed considerably in comparison to the past and present situation.

Pasha's commitment to education fostered cultivating a new generation of early-career scientists, with several dozens of graduate and postgraduate students engaged in quantifying mechanisms regarding how this carbon-rich, cold region component of the Earth system functions as a regional entity with interaction and feedback to the greater global system. Despite an initial lack of a remote sensing background, Pasha became a proponent of incorporating space observations in NEESPI science. Early in the program, he recognized the value of remote sensing tools for studying ecosystem processes across the vast, often inaccessible territory of northern Eurasia.

Pasha's extraordinary efforts in conducting NEESPI activities have been instrumental in promoting NEESPI's visibility at scientific assemblies of AGU, the European Geosciences Union, and the Japan Geoscience Union. Consequently, Pasha edited five special journal issues (four in *Environmental Research Letters* and one in *Global and Planetary Change*) that comprised over 130 selected papers. Much of the progress that our community has made over the past decade would not have been possible without Pasha's dedication, leadership, and unselfish coordinating efforts.

In summary, Pasha Groisman's scientific coordination and facilitation of numerous activities, along with his strong connections to the regional science community, have made NEESPI a real success story. The AGU Edward A. Flinn III Award is given for "unselfish cooperation in research." Through his dedicated commitment to community service, his motivation, and his leadership, Pasha has clearly earned this recognition from the AGU community.

—Garik Gutman, *NASA, Washington, D. C.*

Response

I am very grateful for this award. It is my understanding that it is related to my work during the past 15 years on organizing and functioning of the Northern Eurasia Earth Science Partnership Initiative (NEESPI). NEESPI began as a joint endeavor of NASA and the Russian Academy of Sciences. However, very quickly (in a few years), the initiative included several hundred scientists from 30 countries having their funded projects that addressed various aspects of functioning of the northern Eurasia environment and its societies. To some extent, we were "lucky" with our subject of study, northern Eurasia. The changes here have been and probably will be among the largest on the Earth. Some aspects of these changes (in the carbon and water cycles, cryosphere, and air pollution) have near-global impact. Socioeconomic experiments here in land use and water management, and in societal life itself, provided us harsh lessons of what to do and, alas, what never should be done to the Earth system. Therefore, it was relatively easy to argue that the studies in northern Eurasia should be done ASAP and that the local scientific communities have to be empowered enough to be ready for new challenges.

This award is given for "unselfish cooperation in research." But all these years, I have been selfish serving as a NEESPI project scientist. Bringing people from different continents together; organizing special NEESPI journal issues, overview books, and dedicated science sessions around the world; and promoting early-career scientists (more than 80 of them have grown from the NEESPI cradle) gave me a feeling of purpose and actual joy. That's all. Thank you!

—Pavel Groisman, *Hydrology Science and Services Corporation, Asheville, N.C.; and P. P. Shirshov Institute for Oceanology of the Russian Academy of Sciences, Moscow*

Louis J. Lanzerotti Receives 2016 William Kaula Award

Louis J. Lanzerotti received the 2016 William Kaula Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an individual for "unselfish service to the scientific community through extraordinary dedication to, and exceptional efforts on behalf of, the Union's publications program."

Louis J. Lanzerotti

Citation

There are few who have given more of their time, talents, and energies to AGU publications than Louis "Lou" Lanzerotti. His service as founding editor of AGU's *Space Weather: The International Journal of Research and Applications* spanned more than an 11-year solar cycle. Lou shaped a publication that became AGU's flagship journal for societal relevance. In the very first issue, the journal's primary goal was front and center: "Promote communication among scientists, engineers, technicians, science administrators, and space weather policy makers in a way that leads to continuous improvement in the nation's ability to mitigate space environment hazards to technical systems on the ground and in space."

In 2001 Lou developed a strategic vision for an AGU publication that captured and archived the rapid advances in space weather science and invited community input to policies related to the developing science of space weather. He saw a need for technical articles that reported peer-reviewed scientific advances and feature articles that suggested new paths for exploring space weather observations and forecasting capabilities. Lou actively sought opinion and commentary that informed a broad community of space weather stakeholders. He encouraged submission of news articles and meeting reports that promoted national and international engagement. As editor in chief, Dr. Lanzerotti wrote more than 50 editorials on a broad range of topics, a clear demonstration of his breadth of knowledge across the full extent of space weather. He did this as a labor of love for the discipline of space weather and for the success of the journal.

Perhaps the most significant accomplishment of all is that *Space Weather* set the stage for a most far-reaching government action: the rolling out of the National Space Weather Strategy and Action Plan by the U.S. president's Office of Science and Technology Policy in October 2015. So not only has the science been served by this journal, but also it has led to political action that will have an impact on the future of the country for years to come. There can be no higher accomplishment for a scientific and technical journal that aspires to affect public policy. And it was all done under the inspirational leadership of Prof. Louis Lanzerotti.

Dr. Louis Lanzerotti is fully deserving of the William Kaula Award recognizing "unselfish service to the scientific community through extraordinary dedication to, and exceptional efforts on behalf of, the Union's publications program."

—Delores J. Knipp, *University of Colorado Boulder*

Response

It was such a great surprise to receive the letter from AGU president Margaret Leinen in July announcing the AGU William Kaula Award. I sincerely thank Dr. Delores Knipp for her most generous words in the nomination, and I thank my colleagues Dr. Tom Krimigis, Dr. Mike Liemohn, and Dr. Howard Singer for their support. I knew Bill Kaula and always admired his strong support for scientific publishing by AGU and by nonprofit scientific professional societies. I also have been privileged to know several past recipients of the Kaula Award. I am honored to join their ranks.

I came to the editorship of *Space Weather* from a nearly 40-year background in the communications industry. Contrary to the occasional impression of an ivory tower environment, the research at Bell Laboratories had an underlying mission focus: communications in all of its forms. That is what attracted me to Bell Labs after my Ph.D. and following the launch of the first active telecommunications satellite, Telstar 1. This focus guided the basic as well as the more applied research. Space-weather-related research, while never a large or central activity, was seen to span both the basic and the applied areas and was of importance to communications. Fundamental knowledge of Earth's space environment was needed (and all the more so following the discovery of the trapped radiation environment where communications satellites were to fly). And this included comparisons of Earth's environment with that of solar system planets with magnetospheres to gain more fundamental knowledge. At the same time, the fundamental knowledge that was acquired needed to be used to advise and improve and advance communications, whether by cable, by wireless, or by satellites. My colleagues and I thrived in this environment that posed everyday challenges in basic research and in engineering-related applications.

I brought my science and engineering background experiences to *Space Weather* when we began the journal. I was pleased that AGU, especially under the Publications Committee, Executive Director Fred Spilhaus, and Publications Director Judy Holoviak, was enthusiastic about the new AGU publications directions that this applications-oriented journal would take. We all agreed that *Space Weather* would incorporate new publishing elements such as editorials on applied topics of the day, commentaries, and feature articles. The result after more than a solar cycle is the dynamic journal today, setting international standards under the capable editorship of Dr. Delores Knipp.

—Louis J. Lanzerotti, *New Jersey Institute of Technology, Newark*

Mark B. Moldwin Receives 2016 Waldo E. Smith Award

Mark B. Moldwin received the 2016 Waldo E. Smith Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an individual for "extraordinary service to geophysics."

Mark B. Moldwin

Citation

It is a great pleasure to nominate Prof. Mark Moldwin for the AGU Waldo E. Smith Award. I can think of a no more deserving recipient for this accolade.

The AGU Waldo E. Smith Award honors individuals who have played unique leadership roles in such diverse areas as scientific associations, education, legislation, research, public understanding of science, management, and philanthropy and whose accomplishments have greatly strengthened and helped advance the geophysical sciences. Mark has excelled in all.

With over 150 scientific publications with impressive citation indices, his research has covered the development of magnetometers and small satellites, understanding the structure of the inner heliosphere and its impact on the magnetosphere, propagation of ultralow-frequency waves, and magnetosphere-ionosphere coupling. Mark's scientific expertise is second to none, and he has a natural ability to communicate that science to others.

His mastery of teaching is manifest in several prestigious awards; he has been recognized by the Florida Institute of Technology (Florida Tech), the University of California, Los Angeles (UCLA), and the University of Michigan and was rated Top 10 Professor at UCLA. He went beyond the traditional teaching methods and developed science courses for students of nonscience disciplines to actively participate in the process of collecting and interpreting data for deeper understanding. He received the Copenhaver Award for the innovative strides made by the Dorm-room Labs.

He has devoted himself to improving public understanding of science through some 24 essays published in the *Culver City News,* which have eradicated misconceptions. His essay on the fallacy of "clean coal" sets the record straight, just as his clear and concise description of the political and scientific debate on global warming leaves little room for the reader to doubt its reality.

He encourages students, teachers, and the public to think critically, understand what science is and is not, and convey the excitement of science. He has promoted space science internationally through programs in Africa and organizing Geophysical Information for Teachers (GIFT) workshops, particularly at the International Heliophysical Year meetings in Ethiopia and Zambia.

Mark has contributed tremendously to service activities as editor in chief for *Reviews of Geophysics,* chair of the Space Physics and Aeronomy (SPA) Education and Public Outreach Committee, a member of the AGU Publications Committee and the AGU SPA Executive Committee, and cochair of the National Research Council Solar and Space Physics Decadal Survey Education and Workforce Working Group on the Space Studies Board.

It is a pleasure to nominate Mark for his accomplishments in scientific research, teaching excellence, and innovative educational methods and for improving public understanding

of science. His accomplishments have greatly strengthened and significantly advanced the geophysical sciences.

—Tim Fuller-Rowell, *University of Colorado Boulder*

Response

Thank you very much, Tim, for your support in nominating me for the 2016 Waldo E. Smith Award. I'd also like to thank the awards committee and my friends and colleagues who provided letters for the nomination package. A special treat for me in winning the award was the opportunity to learn about Waldo Smith, the first executive director of AGU. I especially resonate with the quote associated with him, "There is more to doing science than doing science."

My early advisors and mentors instilled in me the importance of service (editing, refereeing, organizing meetings, contributing to education and public outreach efforts, teaching, mentoring, leading groups, and advocating for science). I'd like to mention and thank a few of them here. One is my undergraduate research advisor, Syun-Ichi Akasofu, who while I was working with him as a research assistant (digitizing analogue Russian magnetograms) became the director of the Geophysical Institute at the University of Alaska–Fairbanks. I watched as he continued an active research program, directing the institute, and traveling the world in various service roles. My Ph.D. advisor, Jeff Hughes, also took on a leadership role as the inaugural director of the Center for Space Physics while I was his Ph.D. student at Boston University. I was able to observe his role in bringing faculty, staff, and students together to make an environment conducive for learning and research. Finally, I'd like to thank a few program managers and colleagues who gave me early opportunities to contribute to the geosciences: Bob Carovillano (who passed away a year ago) and Mary Mellot at NASA invited me to participate in my first NASA review panels and MOWGs; Sunanda Basu and Kile Baker at NSF provided opportunities to contribute to a number of research and education efforts. Janet Kozrya in her role on the AGU Publication Committee's *GRL* Editor Search Committee in 2004 and Jim Burch in his role on the AGU *Reviews of Geophysics* Editor-in-Chief Search Committee in 2009 set me on the path of nearly a decade of editorial service. I'd also like to thank Lou Lanzerotti and Chris Russell, who in their leadership roles in the first Solar and Space Physics Decadal Survey invited me to participate.

Finally, I'd like to thank my parents (Bill and Sally Moldwin) who were the original role models for me in community service and my wife (Patty Hogan) for her support, encouragement, and love.

—Mark B. Moldwin, *University of Michigan, Ann Arbor*

Kevin Murphy Receives 2016 Charles S. Falkenberg Award

Kevin Murphy received the 2016 Charles S. Falkenberg Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an "early- to mid-career scientist who has contributed to the quality of life, economic opportunities, and stewardship of the planet through the use of Earth science information and to the public awareness of the importance of understanding our planet."

Kevin Murphy

Citation

Kevin Murphy is receiving the Falkenberg Award because of his extraordinary accomplishments as the system architect for NASA's Earth Observing System Data and Information System (EOSDIS). In this role, Kevin Murphy has greatly expanded the utilization and exploitation of NASA's vast Earth science data holdings. With ~15 petabytes of remote sensing data hosted at a dozen Distributed Active Archive Centers (DAACs), EOSDIS is one of the largest Earth science information systems in the world. Mr. Murphy heartily embraced the EOSDIS primary goal of making those data accessible, understandable, reliable, and usable by a wide range of science and applications users.

EOSDIS today serves a worldwide community of users. In 2015 alone, EOSDIS distributed over 1.4 billion files of scientific data. EOSDIS has had a significant impact on Earth science, as evidenced by the growth in the number of publications utilizing the data and their citations. The data products managed by EOSDIS are used for answering fundamental questions about the Earth system, which are of global interest. Answers to these questions will have a profound impact on policy and will have political and economic consequences.

EOSDIS must evolve and keep up with advances in technology, which fundamentally change user community expectations every few years. Mr. Murphy's visionary ideas, as well as technical leadership, have had the most impact in this area. A few among his numerous contributions are the following: (1) an integrated but flexible architecture for the "front door" to NASA's data holdings and services (https://earthdata.nasa.gov/), which provides an active and immersive user experience, leveraging current and emerging web services, (2) the Land, Atmosphere Near real-time Capability for EOS (LANCE), which provides access to data from several EOS instruments within less than 3 hours of observation, and (3) Global Image Browse Services (GIBS), a full-resolution, interactive browse capability, and the associated client, Worldview, opening up the data holdings to geographic information system users.

In summary, Kevin Murphy has made very significant contributions to science through his technical innovation and leadership in data systems development and Earth science informatics. His system development activities have greatly contributed to the vitality of NASA's data and information systems and ensured ready access to a large body of Earth science data from NASA's missions for the scientific and operational user community.

—Hampapuram K. Ramapriyan, *Science Systems and Applications, Inc., Lanham, Md.*

Response

I am honored and humbled to receive the Charles S. Falkenberg Award from AGU and the Earth Science Information Partnership (ESIP). Both AGU and ESIP serve critical roles in the advancement of Earth science and communication of science results for societal benefit. Like all human endeavors, accomplishments in Earth science are built on the achievements of those who precede us; our progress is supported by the incremental advancements made in the past. My achievements would not have been possible without the support of a large community, so I would like to thank everyone at NASA's Earth Science Data and Information System project, NASA's Distributed Active Archive Centers, User Working Groups, and the ESIP community for supporting and helping to steer these activities.

My deep appreciation goes to Dawn Lowe, Hampapuram Ramapriyan, and Martha Maiden for embracing the ideas and resulting projects that led to this award. Thanks to Andrew Mitchell for being a patient and thoughtful sounding board from conceptualization to implementation and everyone else along the way. I also want to thank my family, particularly my wife, Tasnima, and our son, Marik, for their endless support, especially through the many weeks away and nights and weekends worked.

Back in the early 2000s, when I was a graduate student trying to access the open data being collected by NASA's EOS instruments, I was frustrated by how difficult it was to find the data I needed, and how long it took to get those data. This experience created my first understanding of the need for improving access to NASA's measurements for scientific use. At that point I did not realize how complicated it is to produce systematic global products and provide them to millions of users across the world day in and day out. The dedication and efforts of many people have created today's more interoperable, accessible, and usable data systems; users around the world owe thanks to the many scientists, operators, and managers for this decades-long effort.

There is still a lot of work to be done. The way to improve is through continued work across the U.S. government, with international partners, and collaboration with industry today and in the future. Only by working together can we continue to improve our understanding of Earth's environment and make this information available to a wide range of scientists and for global societal benefit.

—Kevin Murphy, *Program Executive of Earth Science Data Systems, NASA, Washington, D. C.*

Visit https://eos.org/agu-news to read citations for and responses from 2016 medalists.

Roberta Marie Johnson Receives 2016 Athelstan Spilhaus Award

Roberta Marie Johnson received the 2016 Athelstan Spilhaus Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an individual "for their enhancement of the public engagement with Earth and space sciences."

Roberta Marie Johnson

Citation

It gives me great pleasure to cite Roberta Johnson for the Athelstan Spilhaus Award. Through her career Roberta has worked to share the excitement and beauty of Earth and space through Windows to the Universe and programs for the public. This started in the early 1990s when she understood the potential power of the Internet to support scientific research and inform and excite large and diverse audiences about the wonders of the geosciences.

Roberta began her career as a research geophysicist studying upper atmospheric dynamics. While involved in this research, she also became involved in efforts to develop educational extensions to NASA missions. This effort resulted in her receiving initial funding in 1994 for the award-winning Windows to the Universe website, focused on bringing the beauty and wonder of Earth and space science to the public, students, and teachers. Shortly thereafter, as director of the Michigan Space Grant Consortium, she expanded her efforts to include public outreach events. Later, as director of education and outreach at the University Corporation for Atmospheric Research and at the University of Albany, she continued her focus on Internet-based outreach through Windows to the Universe in addition to working with colleagues to develop new museum exhibits and organizing large public events.

Roberta served as the executive director of the National Earth Science Teachers Association (NESTA). Under her leadership, NESTA has become revitalized, with new partnerships, projects, and opportunities and a membership that grew significantly above previous levels.

Her most significant and enduring accomplishment is the creation, development, growth, and continuity of Windows to the Universe (http://windows2universe.org), which includes an extensive multilevel website and associated teacher professional development program. Roberta and her team have maintained and grown this resource in service to the geoscience community, the public, students, and teachers. The website, now translated into Spanish and hosted by NESTA, is one of the most popular Earth and space science websites in the world, with ~12 million visitors per year.

Since she began working in geoscience education efforts, she has continued to be motivated by a desire to share the wonder, beauty, and relevance of the geosciences with students, teachers, and the public. For her commitment and her ceaseless efforts to bring the excitement, significance, and beauty of the Earth and space sciences to the public, students, and educators, Dr. Roberta Johnson clearly deserves the AGU Athelstan Spilhaus Award.

—Tamara Shapiro Ledley, *TERC, Cambridge, Mass.*

Response

I am deeply honored to receive this recognition from AGU for my work in sharing the geosciences with the public. I would like to thank AGU; Tamara Ledley, my citationist; and colleagues Sandra Henderson, Geoffrey Haines-Stiles, and Michael Passow, who supported my nomination. I'd also like to thank the dozens of educators, scientists, and other specialists who worked on the Windows to the Universe project over the past 22 years, including in particular my fellow graduate student, dear friend, and colleague, Claudia Joan Alexander, whom we tragically lost in 2015.

My passion for sharing the geosciences with the public began in the early 1990s while I was doing upper atmospheric research at the University of Michigan. I had become deeply motivated to help the public appreciate the awesome beauty of our planet and the wonders of the universe so that we could become better stewards of our environment. I've always had a passion for the humanities as well. For me, connecting the geosciences to other disciplines might provide the "hooks" needed to reach others not already in the scientific "frame of mind."

In 1994, I submitted a successful proposal to NASA to develop Internet-based resources for the public spanning geoscience and the humanities, which led to the Windows to the Universe website. Shortly thereafter, I was asked to lead the Michigan Space Grant Consortium. This led to expansion of my activities to include organizing large public events, professional and workforce development, and later public exhibits. Windows to the Universe quickly rose in popularity. I recall, while still at the University of Michigan, being amazed to have reached the milestone of a Michigan football stadium's worth of unique users in a month. Today the website is used by a Michigan stadium's worth of users in 2 days! Since its inception, the website has been used by over 300 million users worldwide.

A critical part of our success was our effort to make the website useful to K–12 educators by providing resources appropriate for classroom use, and by creating multilevel bilingual content. Our team worked hard to get these resources to teachers—looking back, I've calculated that during my time working on the website and as executive director of the National Earth Science Teachers Association, we offered over 400 professional development workshops, reaching over 20,000 teachers and thereby millions of students, in addition to our website outreach. Thanks again, AGU!

—Roberta Marie Johnson, *University of Illinois at Urbana-Champaign, Urbana*

Tom Beer Receives 2016 International Award

Tom Beer received the 2016 International Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors "an individual scientist, group, or a small team for making an outstanding contribution to furthering the Earth and space sciences and using science for the benefit of society in developing nations."

Tom Beer

Citation

Tom Beer has a long and distinguished international career culminating with his election in 2007 as president of the International Union of Geodesy and Geophysics (IUGG) for a 4-year term. He has made major contributions to the development of international science and the societal impacts of natural hazards and climate change.

He studied in Australia, New Zealand, and Canada, then went to the University of Ghana to work on atmospheric waves. Later, as science adviser, he introduced risk assessment methods to the Australian Environment Protection Authority and helped produce the generic risk management standard that has become the international standard known as ISO 31000. Tom helped to organize the workshop at the Hungarian Academy of Sciences in Budapest that issued the "Budapest Manifesto on Risk Science and Sustainability." This work led to the theoretical risk assessment and management underpinnings of two international research programs—the Natural Hazards Theme of the International Year of Planet Earth and the International Council for Science (ICSU) program Integrated Research on Disaster Risk—as well as the underpinnings of the IUGG Commission on Geophysical Risk and Sustainability, of which he was the founding chair.

In addition to his scientific degrees, he holds a diploma in Asian studies, undertaken to help when he was an adviser to the Mekong River Commission Secretariat. As a member of an Intergovernmental Panel on Climate Change (IPCC) expert group and as lead author for the IPCC Special Report on Technology Transfer, he shared in the recognition of IPCC for the 2007 Nobel Peace Prize. Tom also received the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Chairman's Medal in 2000 for his work on greenhouse gas emissions from alternative fuels and in 2013 was the Axford Lecturer for the Asia Oceania Geosciences Society. He is presently chair of the IUGG Commission on Climatic and Environmental Change and a member of the Committee for Scientific Planning and Review of ICSU and during 2016 has taken part in two international review committees.

Tom has been editor in chief of the journal *Natural Hazards.* He has authored or edited 28 books, of which *Atmospheric Waves* won the Adam Hilger Prize and *Environmental Oceanography* (now in its second edition) has been translated into Chinese. He has also published over 200 peer-reviewed papers, book chapters, and technical reports.

Congratulations to Tom for his distinguished career and outstanding contributions to the development of international science and innovative cross-disciplinary research on natural hazards, risks, and climate change.

—Jaime Urrutia Fucugauchi, *Mexican Academy of Sciences, Mexico City*

Response

I was recently asked to provide advice for my younger self; it was "Never forget that your parents were refugees, neither of whom had been inside a university. Remember to help those from less developed countries, and never forget that a university education is a privilege, not a right" (see http://sydney.edu.au/alumni/awards/2016/tom-beer.shtml). I should extend this to say that scientific research is a privilege, not a right, as demonstrated by the actions of governments that are opposed to the idea of climate change, most recently in Australia (see http://bit.ly/csiro-church and http://bit.ly/article-CSIRO).

I applaud AGU for its motto of "Unselfish cooperation in research," and for emphasizing in 2007 that geophysics is truly international in character by establishing the International Award. I thank Jaime Urrutia Fucugauchi for his citation and thank international luminaries such as Gordon McBean, Le Huu Ti, Harsh Gupta, Keith Alverson, Ian Allison, Guoxiong Wu, Uri Shamir, Mike MacCracken, Alik Ismail-Zadeh, and Ian Galbally for their support over the years.

Acknowledgment must also go to the research scientists in the 69 countries that make up the International Union of Geodesy and Geophysics (IUGG). AGU started as the U.S. National Committee of the IUGG, and as the United States is a member of IUGG it means that all AGU members are also members of IUGG. I encourage them to cooperate internationally and globally as well as nationally and locally.

Last year's International Award response stated that "…without due deference to different social norms, international projects often wither in the 'Valley of Death.' We are still learning how to become more effective." Indeed, we are. As natural hazards and disasters become an ever more important part of the societal background, the work of the International Council for Science (ICSU) and its program on Integrated Research on Disaster Risk (IRDR) becomes ever more important, as does the work of IUGG commissions such as the Commission on Climatic and Environmental Change.

Finally, let me acknowledge my family and my wife, Jane, who bears the brunt of my frequent international absences, and once again remember and honor my parents. They represent the quintessence of George Eliot's quotation from *Middlemarch*, that "…the growing good of the world is partly dependent on unhistoric acts; and that things are not so ill with you and me as they might have been, is half owing to the number who lived faithfully a hidden life…."

—Tom Beer, *Safe System Solutions Pty Ltd; Chair, IUGG Commission on Climatic and Environmental Change*

Ashanti Johnson Receives 2016 Excellence in Geophysical Education Award

Ashanti Johnson received the 2016 Excellence in Geophysical Education Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors "a sustained commitment to excellence in geophysical education by a team, individual, or group."

Ashanti Johnson

Citation

Over the past 15 years, Ashanti has worked tirelessly to bridge the inherent gaps that exist for groups historically underrepresented in science, technology, engineering, and math (STEM) fields through developing successful programs such as the Minorities Striving and Pursuing Higher Degrees of Success in Earth System Science (MS PHD'S®), the Classroom and Community Engagement and Mentoring Program, and the new MS PHD'S-GEO Research Experience for Undergraduates Professional Development Program. All three programs were born out of the critical need for professional development, research, and networking opportunities for underrepresented minority students, and they have effectively catalyzed an ever growing community of support and encouragement that was previously lacking for nonmajority students in STEM.

During her service in these noteworthy roles, Ashanti has been a stalwart advocate for supporting underrepresented youth who reflect talent in STEM professions, especially in the geosciences. She has been a stellar role model, continuing her research in marine science while pursuing the professional development of students and building diversity initiatives in STEM through the integration of research and education.

Ashanti also served as the president of the Institute for Broadening Participation (IBP), which has the mission of increasing diversity in the STEM workforce. IBP Pathways to Science has worked to help talented, underrepresented people at many different levels—K–12 education, higher education/college, and professional—find suitable STEM programs, funding, mentors, and other resources.

Ashanti has also made significant contributions to broadening participation for hundreds of (diverse) young scientists. Ashanti has served as assistant vice provost for faculty recruitment for the University of Texas at Arlington's Division of Faculty, extending her support of diversity yet another step forward in the ranks of geoscience faculty.

Ashanti is the current CEO and superintendent of Cirrus Academy Charter School, which uses an integrated, hands-on curriculum based on science, technology, engineering, arts, and math (STEAM) for kindergarten through twelfth grade. As the CEO, her goal is to ensure that every student has access to the tools needed to exceed world-class standards and to compete for college admissions and jobs in an increasingly globalized economy.

Ashanti's outstanding educational contributions and sustained commitment to excellence in geophysical education and advancing groups historically underrepresented in STEM to serve the geophysical profession and society make her an excellent recipient of this award.

—Melanie Harrison Okoro, *NOAA Fisheries, Sacramento, Calif.*

Response

First, I would like to thank Dr. Melanie Harrison Okoro for her kind and thoughtful words. I am truly honored to receive the 2016 AGU Excellence in Geophysical Education Award.

After taking a moment to reflect on my past educational experiences and activities, I am extremely grateful for opportunities and resources to assist so many talented and committed geoscience students and young professionals from underserved and underrepresented minority (URM) populations.

In 1993, I became the first African American to receive a marine science B.S. degree from Texas A&M University at Galveston. Six years later, I became the first African American to receive a doctoral degree in chemical oceanography from Texas A&M.

While some who learn of these achievements may immediately celebrate, others might ponder what I experienced on the road to receiving these recognitions. I quickly recall the fact that the last time I attended a class with another African American student or was taught by an African American was in high school. In third grade I decided to pursue an oceanography career. As a student in talented and gifted programs in Dallas, Texas, public schools from the third to the twelfth grade, I conducted annual ocean science research projects. It was not until twelfth grade that I learned of Dr. Ernest Everett Just, an African American marine scientist who died in 1941. Despite the absence of contemporary African American role models, I was determined to make positive contributions to the geosciences.

It was my grandmother, Clemateen Williamson; my mother, Dr. Vivian Williamson Whitney; and my father, Don Johnson, who instilled in me the belief that I was capable of achieving my goals and was responsible for helping others to do likewise. This belief and sense of responsibility remain and influence my actions in each URM mentoring, professional development, and funding program that I participate in, coordinate, and/or direct.

In reflecting on the many accomplishments of the amazing URM geoscience students with whom I have interacted, I am excited to report that with sustained community-supported efforts, we are now poised to be able to celebrate URM geoscience students who, instead of being "firsts," are achieving their goals in substantial numbers.

In accepting this award, I celebrate our community's efforts to facilitate increased diversity and the accomplishments of young geoscientists from underserved and underrepresented populations.

—Ashanti Johnson, *Mercer University and Cirrus Academy Charter School, Macon, Ga.*

John Bosco Habarulema Receives 2016 Africa Award for Research Excellence in Space Science

John Bosco Habarulema received the 2016 Africa Award for Research Excellence in Space Science at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an early-career scientist from the African continent for "completing significant work that shows the focus and promise of making outstanding contributions to research in Earth and space sciences."

John Bosco Habarulema

Citation

Dr. John Bosco Habarulema from the South African National Space Agency (SANSA) in Hermanus, South Africa, receives the 2016 AGU Africa Award for Research Excellence in Space Science for his important contributions to the monitoring and modeling of the ionosphere over Africa. John received his B.S. from Mbarara University of Science and Technology in Mbarara, Uganda, and his Ph.D. from Rhodes University in Grahamstown, South Africa, in 2011. John's research is concentrated on the understanding and modeling of the temporal and spatial variations of the electron density and the total electron content (TEC) over the African continent with special emphasis on the South African region. Existing ionospheric models were badly lacking in this region of the globe because of limited data availability and the lack of research infrastructure. John supplemented the existing regional GPS data with proxy data based on ionosonde measurements and theoretical considerations and used the neural network technique to develop more accurate TEC models for this part of the world. TEC models of high accuracy are urgently needed by the many applications that use radio waves traveling through the ionosphere. John has also started to use radio occultation data and other Global Navigation Satellite Systems (GNSS) data for his research studies. Recent studies include investigations of storm effects and traveling ionospheric disturbances, both areas of high interest and great applicability. Since 2007, he has published papers of high quality at an astonishing rate, over 35 publications in highly regarded refereed science journals.

John plays an essential role in helping to build up the science infrastructure in Africa. He has several master's and Ph.D. students under his guidance from South Africa and other African countries. He runs the South African ionosonde network and is actively involved with other ionosonde stations and groups on the African continent. He is the vice-chair of the international body in charge of coordinating ionosonde activities (Union Radio Scientifique Internationale (URSI)/Ionosonde Network Advisory Group), and he is a member of the Committee on Space Research/URSI Working Group on the International Reference Ionosphere.

Since he completed his Ph.D. in 2011, his research has resulted in a better understanding of TEC variations over Africa and in a more accurate representation of these variations in his newly developed models. He is a role model for young African scientists and is very actively involved in supporting young scientists and improving the science infrastructure across the African continent.

—Dieter Bilitza, *George Mason University, Fairfax, Va.*

Response

It is my utmost pleasure and honor to receive the 2016 AGU Africa Award for Research Excellence in Space Science, established in honor of Sunanda Basu. I am privileged to have first met Sunanda and Santimay Basu during the 2007 International Heliophysical Year (IHY 2007) conference in Addis Ababa, Ethiopia, which was also my first attendance of an international conference. Seven years later, I received the 2014 International Sunanda and Santimay Early Career Award in Sun-Earth Systems Science Research from the Space Physics and Aeronomy section of AGU. Thanks, Sunanda and the late Santimay Basu, for your dedication to science and your tremendous support of emerging scientists, especially from developing nations, of which I have become a big beneficiary.

Understanding and modeling spatial and temporal variations of ionospheric electron density in a region devoid of relevant infrastructure is challenging but also presents opportunities to develop innovative techniques of inferring important ionospheric parameters from available instrumentation, especially those that are space based. I am glad that space science research continues to grow on the African continent, thanks partly to the partnership with many international research groups and organizations such as AGU.

Having become a scientist by sheer luck (owing to my humble background), I am grateful for the support from many people along my science journey. From walking over 28 kilometers every day to and from school in pursuit of education, the journey that led me here is a long one! My consistently late arrival at school caught the attention of my then head teacher (the late David Rwarinda) of Kabindi Secondary School, Uganda, who inquired where I walked to school from. The answer of a 14-year-old trekking 14 kilometers every morning to school led him to welcome me into his home so that I could access school from a short distance. He (and his family) would later support me along with my family in all ways possible to acquire a university education. I wish he were able to witness the fruits of his efforts. I will forever be immensely grateful to him and his family.

I'm very thankful to my Ph.D. mentor, Lee-Anne McKinnell, who provided the support and guidance toward my starting a career in space science research. She availed me with opportunities to meet and work with many scientists all over the world, an avenue that caused me to know my nominator, Dieter Bilitza. Special thanks to Dieter for the nomination and to Ivan Galkin, Michael Pezzopane, and Michael Kosch for supporting it. Finally, I am fortunate to work with very supportive friends, colleagues, and students at the South African National Space Agency.

—John Bosco Habarulema, *South African National Space Agency, Hermanus, South Africa*

Musa Siphiwe Doctor Manzi Receives 2016 Africa Award for Research Excellence in Earth Science

Musa Siphiwe Doctor Manzi received the 2016 Africa Award for Research Excellence in Earth Science at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award honors an early-career scientist from the African continent for "completing significant work that shows the focus and promise of making outstanding contributions to research in Earth and space sciences."

Musa Siphiwe Doctor Manzi

Citation

Dr. Musa Manzi is richly deserving of the AGU Africa Award for Research Excellence in Earth Science. A close reading of Dr. Manzi's published work in international journals reveals an original problem solver and interpretive thinker, and the strength of his academic curriculum vitae, together with his ongoing work, paints a clear picture of an emerging leader in the field of exploration geophysics. While conducting research on three-dimensional seismic imaging of the South African crust, Musa has also thrown himself with committed enthusiasm and great skill into teaching not only seismological theory and applications but also field-based geophysical research to a growing group of international students.

Musa's life story, seemingly insurmountable obstacles overcome and subsequent achievements, makes him effectively peerless as an African scientist. However, one does not need to be aware of these aspects of his life and times to fully appreciate his scientific work.

Dr. Manzi advances techniques for resource identification and extraction while furthering the science of being able to do so safely, with the interest of the human workers in mind. As an example, we may cite a pair of papers published by Musa in 2012 in the journal *Geophysics* about seismic attributes, properties of the seismic wavefield that are measured as proxies for properties of the subsurface. In the first paper, new attributes are designed to evaluate ore resources (finding gold), and in the second, these are used to map conduits for water and methane (protecting miners). Sophisticated techniques of three-dimensional wavefield processing are developed and deployed to produce some truly stunning interpreted images of the shallow subsurface. In each case, the skill of the processing routines is responsible for the remarkable quality of the images. In these papers, we see a master of exploration-seismic imaging at play. Beyond seismology, they have been influencing other research endeavors, for example, into the deep subsurface microbiology of the Witwatersrand Basin. Joining these interdisciplinary studies with intellectual audacity and

engaging leadership, Musa has now ventured into correlating three-dimensional fracture networks with (a)biogenic gas compositions, microbiology, and subsurface-fracture fluid flow.

Although his rise from student to lecturer to senior researcher and director of the Seismic Research Centre at the University of the Witwatersrand has been meteoric, Musa continues to find time for teaching science and mentoring: undergraduates and graduates, disadvantaged youth, precollege students (on Saturdays), and the beneficiaries of a number of charities that he founded and in which he maintains an active involvement.

—Frederik Simons, *Princeton University, Princeton, N.J.*

Response

I am very grateful to AGU and the members of the selection committee for this unexpected honor, which I receive with heartfelt gratitude and humility. Being a first recipient of the prestigious 2016 Africa Award for Research Excellence in Earth Science at this stage of my academic career is indeed great motivation and a tremendous honor. I will never forget the hour when I received that email from AGU informing me of the astounding news and how I literally burst into tears of joy and remained speechless at my office desk.

I have always been intrigued by science, involving a combination of physics, math, and geology ever since my undergraduate studies at the University of the Witwatersrand. During my undergraduate years, I had the privilege of working as an assistant researcher for 3 years in physics research laboratories, including the High Pressure and Mossbauer laboratories, which provided me with an opportunity to explore and appreciate the beauty of science. Furthermore, assisting Susan Webb during my vacation periods with many geophysical projects introduced me to the application of physics principles in Earth science, a crucial route that moved me from the physics department to the School of Geosciences for my fourth year in geophysics and then postgraduate studies. My most sincere thanks go to my geophysics lecturers, Susan Webb and Raymond Durrheim. Since my very first footsteps into geophysics, they have been inspiring and nourishing me.

I would also like to express my gratitude to my Ph.D. advisor and mentors, Kim Hein, Lewis Ashwal, and Roger Gibson, who were key personalities for my academic life. I was fortunate to be given by them the liberty to pursue my own interests and conduct independent research on various components of geophysics. I am truly grateful to Frederik Simons and Tullis Onstott for being kind enough to nominate me for this award. For one who grew up under extreme poverty in a rural village in South Africa, and who taught himself and his classmates physics and math because there were no teachers, such an honor is far from self-evident and encourages me to continue on in developing the next generation of inspired and enthusiastic young African scientists. Without the love and support of my family and friends, the emotional toil of teaching and supervising postgraduate students while running many nonprofit organizations would have been unbearably onerous.

—Musa S. D. Manzi, *School of Geosciences, University of the Witwatersrand, Johannesburg, South Africa*

David A. Seekell Receives 2016 Science for Solutions Award

David A. Seekell received the 2016 Science for Solutions Award at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award is for "significant contributions in the application and use of the Earth and space sciences to solve societal problems."

David A. Seekell

Citation

One of the major goals for modern societies is to secure access to enough resources that can be used to produce a sufficient amount of food to feed the growing and increasingly demanding human population while eradicating undernourishment and limiting the impact on the environment. Two of the main challenges in doing so are as follows: (1) In many countries the population has grown so much that the land and water resources locally available are not sufficient to produce all the food they need. Therefore, these countries depend on trade. (2) The environmental response to increasing human pressure may be nonlinear. Ecosystems may be susceptible to abrupt and highly irreversible changes to unwanted alternative states. It is still unclear how the resilience of global food systems is affected by the globalization of food through trade and the presence of alternative stable environmental states. Research in these areas is crucially important to the future of the global society. David Seekell's scholarly work has contributed to major advances in both directions.

His research on early warning signs of state change in lakes has moved ecological theories forward while providing new tools for ecosystem management. David focused on transitions between alternative stable states in bistable ecosystem dynamics and developed methods that can be used to recognize incipient conditions of regime shift. His work has developed some "leading indicators" based on the use of conditional variance as a precursor of transitions between eutrophic and oligotrophic conditions. Through theory, numerical simulations, observations, and experimental manipulations, his work has advanced our current understanding of regime shift in ecosystems and identified early warning signs that "work" even when the other leading indicators either fail or are ineffective.

David Seekell is addressing research questions relevant to social-environmental systems with a focus on food security, inequality, and globalization. His work is connecting the dots between water use and inequality theories. His research on the global inequality of water use has investigated the major biophysical factors contributing to inequality in access to water and clarified the extent to which it is affected by trade. His recent work has also highlighted how the resilience of the global food system strongly depends on the presence of redundancies (e.g., yield gaps, uncultivated land, and grain reserves), the structure of the trade network, and the degree of trade dependency. Collectively, these areas of activities connect fundamental research questions with issues of immediate societal relevance.

—Paolo D'Odorico, *University of Virginia, Charlottesville*

Response

I am honored and humbled to receive the Science for Solutions Award. I would like to thank Paolo D'Odorico for organizing the nomination and AGU for recognizing and supporting the efforts of early-career researchers.

I consider myself first and foremost a limnologist and aquatic ecologist with a focus on lakes. Few features of the Earth system are untouched by human activities, and lakes reflect human activities particularly strongly. The human–ecosystem connection is strong to the extent that even the most fundamental questions are not fully evaluated without considering them within the human context. Increasingly, this includes international teleconnections such as climate change and international trade. Patterns of international trade, for example, can be strongly related to changes in ecosystem mass balances but are rarely evaluated because limnological studies tend to have a more local focus. I expect that developing an understanding of these types of connections will be an active area of research for my generation, and I am encouraged that AGU supports this through both the Science for Solutions Award and the development of the journal *Earth's Future*.

The Earth science community comprises smart, kind, and supportive individuals. Collaborating with members of this community has made my career in research a worthwhile and enjoyable endeavor. The group of researchers I have had the pleasure of working with is too large to list in this response, but I am particularly grateful for the support and encouragement of Michael Pace and Jan Karlsson, who were my doctoral and postdoctoral advisors. I am also grateful for mentoring and opportunities provided by Paolo D'Odorico, Stephen Carpenter, and Jon Cole. Finally, I would like to thank the Knut and Alice Wallenberg Foundation for its support through the Wallenberg Academy Fellows program.

Thank you for this award. This recognition is motivation to continue my efforts in addressing these fundamental questions.

—David A. Seekell, *Umeå University, Umeå, Sweden*

Lizzie Wade Receives 2016 Walter Sullivan Award for Excellence in Science Journalism–Features

Lizzie Wade received the 2016 Walter Sullivan Award for Excellence in Science Journalism–Features at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award recognizes "a journalist for a feature story or series in any medium except books that makes information about the Earth and space sciences accessible and interesting to the general public."

Lizzie Wade

Citation

In her *Science* feature "Cradle of Life," Lizzie Wade delves into the fascinating question of how life in the Amazon became so rich and diverse. It's an edgy topic as well: Two research camps hold irreconcilable views on how rising mountains and shifting rivers transformed habitats over millions of years.

Lizzie could have written the article as a straightforward explanation laying out the arguments of the opposing scientists. Instead, she brings alternative histories to life by taking us on a journey from the foothills of the Andes Mountains on the western edge of the Amazon basin down deep into the rain forest. Her vivid on-the-ground reporting resulted in what the Walter Sullivan Award Committee called "a majestic piece, successful in its efforts to sketch the history, or possible histories, of an enormous and important part of our planet."

Lizzie's story had a long gestation. The question of Amazonian biodiversity first entranced her 4 years ago, when she was an intern at *Science*. After she completed her internship, we posted her to Mexico City as our first Latin America correspondent. Still a cub reporter, Lizzie suddenly found herself responsible for reporting on the disparate scientific communities of Central and South America.

Speaking from experience, I can say that it's daunting to singlehandedly cover such an expansive territory, and being a one-person bureau can get lonely at times. But Lizzie, a fluent Spanish speaker, has proven that she's up to the challenge, and in her short tenure so far, she has produced several memorable and high-impact stories.

I enjoy working with Lizzie both because she finds exclusive stories for us and because she's a wordsmith who pays close attention to every detail of a story. Her love of language shines through in "Cradle of Life," resulting in a narrative that traverses vast passages of time while weaving in telling details of the scientists whose work is illuminating the Amazon's origins.

—Richard Stone, Science *Magazine, Washington, D. C.*

Response

I'm very honored to receive this year's Walter Sullivan Award. I'm particularly delighted because both of the editors who worked on this story, Richard Stone and Tim Appenzeller, are past Sullivan recipients. Weaving together the details of a scientific debate with a journey through disparate landscapes was an incredible writing challenge, and I sincerely thank Rich and Tim for helping me find a path through the weeds.

One of the great joys of science reporting is interviewing such intelligent, generous, and patient sources. I'd like to thank all the scientists who were kind enough to include me on this once-in-a-lifetime trip, especially Sherilyn Fritz of the University of Nebraska–Lincoln and Paul Baker of Duke University, and Yachay Tech for organizing it. They had help from Marianne van Vlaardingen and her team at Pantiacolla Tours, who did a phenomenal job managing the logistics and making sure we ate delicious food at every stop along the way. Earth scientists can be hard to keep up with, especially for a reporter who is more at home in urban jungles than natural ones. Thank you all for making sure I made it out of the cloud forest alive, especially Lauren Gonzalez, who pulled me to safety after I tumbled off the trail (and nearly off a cliff).

My story wouldn't have been the same without the photographs taken by Jason Houston. His images of the landscapes and portraits of the researchers made my words come to life. His nightly slide shows of the pictures he had taken that day were a highlight of the trip for everyone, and his generosity and curiosity should be a model for all journalists.

And, of course, thank you to *Science*. After merely 6 months as a news intern, the magazine sent me to Mexico City to be its Latin America correspondent. It is a great privilege and responsibility to cover this often overlooked region for one of the world's best science publications. But I don't want to do it alone. We need more science reporters in Latin America, not to mention scientists. And they shouldn't all be foreigners like me. I humbly encourage AGU and all its members to think about how they can support science and science communication in Latin America, so more stories like this one can be told.

—Lizzie Wade, Science *Magazine, Mexico City, Mexico*

Alexandra Witze Receives 2016 David Perlman Award for Excellence in Science Journalism–News

Alexandra Witze received the 2016 David Perlman Award for Excellence in Science Journalism–News at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The award recognizes "a journalist for a news story or series in any medium except books that makes information about the Earth and space sciences accessible and interesting to the general public."

Alexandra Witze

Citation

It's not exactly a secret that Alex Witze has a thing for the most restless parts of the planet. She and her husband, Jeff Kanipe, toiled for several years and spent part of their savings to trek around Iceland to research their book *Island on Fire*, which describes the great Laki eruption of 1783. For *Nature*, Alex has reported from the site of the devastating Wenchuan earthquake in China, headed into the Pacific on a ship to learn about undersea volcanoes, and shadowed the seismologists who track earthquakes across the world.

In early 2015, Alex decided she wanted to write about a different kind of instability: earthquakes triggered by humans. Oklahoma and Texas had been hit by increasing numbers of earthquake swarms, and seismologists had accumulating evidence that this activity was caused by the injection of wastewater into deep rock formations, typically as a by-product of oil and gas production. Seismologists were set to explore this issue at a Seismological Society of America meeting in April, and Alex decided the time was right for a story.

But unlike many reporters, who might focus on the latest study, Alex decided to write a broader story by touring Oklahoma, the epicenter of this seismic activity. She drove 10 hours from her home to visit with some of the Oklahoma researchers who would soon present their data to the seismological meeting. She went to a town hall gathering, where residents, scientists, and state regulators talked about the issue that was threatening their livelihoods and lives. She explored the brick architecture and gas pipelines that were not built to withstand strong quakes. She also took care to show how important the oil and gas industry has been to Oklahoma and how everybody has struggled to manage a risk associated with a key source of revenue.

Then, after a marathon drive back home, Alex quickly wrote a beautiful story with her trademark efficiency. What makes this story stand out is that Alex used the opportunity of the scientific meeting to investigate how the results of research fit into a complex public discussion that is roiling a state. Her superb instincts were prescient. In September, Oklahoma suffered one of the strongest quakes in state history, forcing regulators to shut down fluid injection wells in the region. For anyone wanting to understand the issue, Alex's award-winning story would be an excellent place to start.

—Rich Monastersky, Nature *Magazine, Washington, D. C.*

Response

I'm honored to receive AGU's award for news reporting, which is named after David Perlman, the science editor of the *San Francisco Chronicle*, who has been an inspiration throughout my career. Dave's hardworking, hard-nosed journalism, which he has practiced since the 1950s, is a model for any reporter in any decade. Thanks to Lauren Morello for deftly editing the story, to Matt Crenson for commissioning it, and to Rich Monastersky for writing the citation.

I would like to thank my husband, Jeff Kanipe, above all. He did not blink when I said we should go to Oklahoma to report on induced seismicity, and he suggested lines of reporting and places to visit that enhanced the final piece. Both of us, however, missed the moderate earthquake we should have felt on the trip: I was walking across the campus of Oklahoma State University when it happened and he was in the car, both of us insulated from ground movement by our own motions. Jeff's personal and professional support has enabled so much of what I have been able to accomplish, for which I am eternally grateful.

—Alexandra Witze, Nature *Magazine, Boulder, Colo.*

Heiko Pälike Receives 2016 Asahiko Taira International Scientific Ocean Drilling Research Prize

Heiko Pälike was awarded the 2016 Asahiko Taira International Scientific Ocean Drilling Research Prize at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The Taira Prize is a partnership between AGU and the Japan Geoscience Union (JpGU) and is made possible through a generous donation from the Integrated Ocean Drilling Program Management International (IODP-MI). The prize honors an individual for "outstanding transdisciplinary research accomplishment in ocean drilling."

Heiko Pälike

Citation

The centerpiece of Heiko Pälike's work is the development of tuned timescales in critical intervals of the Cenozoic era. He opened up new and unknown regions to precise timescale generation and then applied this timescale to extract properties of Earth and solar system orbital motion and to solve first-order questions about Earth's climate system and Earth system sensitivity. The approach of this work is located at the frontier and intersection of solar system astronomy, geochronology, stratigraphy, Earth system modeling, paleoceanography, and a mathematical analysis of the interaction between the component systems while applying transdisciplinary approaches in novel ways to constrain critical Earth system parameters.

Heiko Pälike's research combines a fundamental mathematical understanding of orbital mechanics and its application to forcing of climate. Since early in his career, he has combined this approach with the active design of drilling expeditions to gather and interpret marine geological data in a paleoclimatic context.

An early paper, written with the late Nick Shackleton in 2000, demonstrates how geological data can be used to extract and calibrate astronomical parameters. In 2006, another paper provided an elegant demonstration of the power of astronomically tuned records to reveal the mechanisms controlling climate change at a whole range of timescales, using quantitative models to marry observations and theory.

One of his major contributions was the design and execution of a research project using the unique capabilities of the R/V *JOIDES Resolution,* applying geological principles developed through ocean drilling (detailed plate tectonic reconstructions and integrated stratigraphies), to locate the best possible drilling locations for a paleodepth transect in the equatorial Pacific, which allowed a major refinement of the understanding of the carbonate system over Cenozoic time. Parts of this work were published in a seminal paper involving all Expedition 320/321 participants in 2012.

Heiko Pälike has also taken up high-level responsibilities in the International Ocean Discovery Program (IODP) scientific strategy by cochairing the Science Evaluation Panel, contributing to the *JOIDES Resolution* Facility Board, and promoting the high-level scientific aims of ocean drilling through his deep involvement in the IODP New Ventures in Exploring Scientific Targets (INVEST) Renewal Meeting and codesigning the current science plan for IODP for 2013–2023.

As recipient of the Taira Prize, Heiko Pälike is honored for his outstanding transdisciplanry contributions to the problem of Earth climate system reconstructions and the extraction of astronomical parameters from geological data.

—Michael Schulz, *Center for Marine Environmental Sciences, Bremen, Germany*

Response

I feel extremely honored to receive the prestigious Taira Prize. First, I would like to thank Michael Schulz for his kind and generous citation and AGU, JpGU, and IODP for establishing the Taira Prize to recognize research enabled by international scientific ocean drilling. I am grateful to my mentors who introduced me to marine research, foremost Paul Wilson and the late Harry Elderfield, who supported me to apply for a Ph.D. in Cambridge. I cannot overemphasize the encouragement I received from the late Sir Nicholas Shackleton, who allowed me to learn so much about how the planet (and science) works, and was always open and excited to apply new methods to hard and exciting problems, and who introduced me to Jim Zachos, who was on sabbatical in Cambridge in 2000. Nick also introduced me to my postdoc advisor Jan Backman, and to participating in my first Ocean Drilling Program Expedition, 199, to the equatorial Pacific in 2001, which was a perfect deadline to finish my Ph.D. project with Nick in time to travel to Honolulu to join the *JOIDES Resolution.* The co–chief scientists Mitch Lyle and Paul Wilson assembled a fantastic international team of scientists, many of whom became my lifelong friends and colleagues and who together represented my first experience of the great "family" of scientific ocean drilling. Nothing can be more exhilarating than awaiting the next "Core on Deck!" call over the intercom, and knowing that no one else has seen the treasure archive of ocean and climate history to be retrieved from several kilometers below. Colleagues and friends from that first cruise were involved in our research on the climate history of the Paleogene, and I would particularly thank Hiroshi Nishi, Ted Moore, Steve Hovan, Tom Janecek, Carrie Lear, and Helen Coxall in addition to the co–chief scientists. After this first cruise, Jan Backman, Ted Moore, and Mitch Lyle encouraged and supported me in writing my first drilling proposal, which later turned into IODP Expeditions 320 and 321 in the equatorial Pacific, and on which I was allowed to sail as co–chief scientist. I particularly thank Nobu Eguchi for moving this proposal through the IODP panels, with a memorable AGU town hall in 2003. I thank my host institutions in Cambridge, Stockholm, Southampton, and Bremen for their incredible support, and finally I thank my wife and family for supporting me throughout this incredible journey.

—Heiko Pälike, *MARUM–Center for Marine Environmental Sciences, University of Bremen, Bremen, Germany*

Richard B. Alley Receives 2016 Climate Communication Prize

Richard B. Alley was awarded the 2016 Climate Communication Prize at the AGU Fall Meeting Honors Ceremony, held on 14 December 2016 in San Francisco, Calif. The Climate Communication Prize is funded by Nature's Own, a purveyor of fossils, minerals, and handcrafted jewelry in Boulder, Colo. The prize honors an AGU member-scientist "for the communication of climate science" and "highlights the importance of promoting scientific literacy, clarity of message, and efforts to foster respect and understanding of science-based values as they relate to the implications of climate change."

Richard B. Alley

Citation

Richard Alley, Evan Pugh Professor of Geosciences, Pennsylvania State University, is a global leader with a phenomenal record of accomplishments in science communication. He is lead author of the Intergovernmental Panel on Climate Change Working Group I report *The Physical Science Basis* (2007) and has also authored public and general education books, including *Two-Mile Time Machine: Ice Cores, Abrupt Climate Change and Our Future,* and *Earth: The Operators' Manual. Publishers Weekly* referred to *Time Machine* as a "brilliant combination of scientific thriller, memoir and environmental science" and recognized *Earth: The Operators' Manual* as a book that "thoroughly explains the dynamics of global warming" with a "lively and positive" approach. He is also author and coauthor of numerous interpretation and overview articles in *Science, Nature, Scientific American, Proceedings of the National Academy of Sciences of the United States of America,* and education journals and supplements.

Richard has also made more than 800 nontechnical presentations to interest groups, the public, industry, and museums and has responded to an estimated 4000 media inquiries and taught a global online course on climate sci-

ence. In addition, he advised the U.S. president's science office, the U.S. vice president, the U.S. Senate, and congressional committees and senators and provided advice and briefings to many levels of government.

He provided text to the National Science Foundation that was incorporated into a speech by the president of the United States. And he is the author of 335 publications, including 241 in peer-reviewed scientific journals!

Tom Wagner of NASA characterized Richard Alley as an "exceptional researcher…an outstanding communicator…a central figure in policy discourse…. His audiences at scientific meetings typically overflow the room, and he is enviably comfortable speaking to eight-year-olds." He has traversed the continent to share the climate message with audiences, often riding those red-eye flights to make tomorrow's lecture and then share a science discussion in a local school. Search YouTube for "Richard Alley scientist," and thousands of videos that feature Richard's congressional testimonies, public and science presentations, and humorous science music videos appear; his presence goes on and on. In the YouTube video "How to talk to an OSTRICH: 'IT'S US,'" Richard makes carbon balance and isotope geology interesting and enjoyable to everyone.

Richard speaks to all audiences, sharing science, impacts, and wonderful discussions of solutions. He leaves people with greater understanding and confidence that we can address the biggest challenges of our time. How does he do all these things so well and remain our kind, humble, and generous colleague? I cannot imagine anyone more deserving of this AGU Climate Communication Prize.

—James M. Byrne, *University of Lethbridge, Lethbridge, Alb., Canada*

Response

This honor is deeply humbling. My thanks to Jim Byrne, himself a brilliant climate communicator, to so many colleagues, and to AGU. I have had the opportunity to work with and learn from the best, and I thank them, especially Geoff Haines-Stiles. Thanks to Kerry Emanuel. Particular thanks to my wife, Cindy, and daughters, Janet and Karen, a wonderful family who all are outstanding science communicators who helped my efforts.

Climate communication is almost always painted as doom and gloom. But, ultimately, our field empowers, using knowledge to make people better off.

Suppose we were forced to summarize the entire Intergovernmental Panel on Climate Change output as a sound bite. That's impossible, but a scholarly attempt might be, in passive voice, "There is a significant social cost of carbon." Humanity gains good from the energy released by burning fossil fuels, and the price reflects that good, but the carbon dioxide released causes net harm that is not in the price. We could rephrase that as "Society subsidizes fossil fuels." But we could also say, "The economy and the environment will be better off if society uses our knowledge of energy and climate wisely."

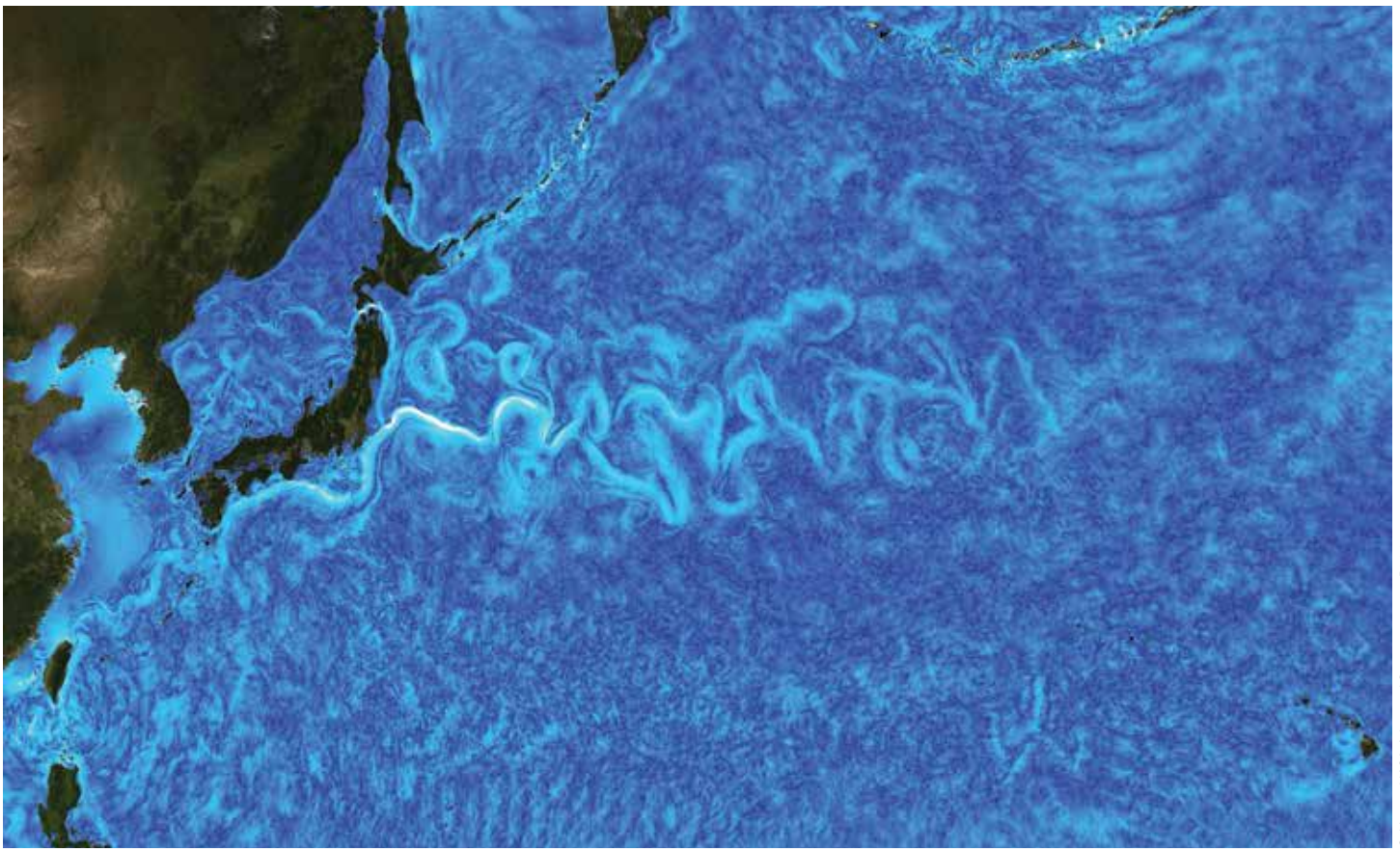
I believe all of us understand that living for today and planning for tomorrow involve trade-offs. But even if we calculate with a typical economic "pure rate of time preference," essentially assuming we are more important than our grandchildren, ignoring climate science is still economically inefficient. In some sense, the social cost of carbon is profit waiting to be made, profit we will throw away if we reject science.

People have a history of burning through energy sources far faster than nature makes more, suffering shortages, and then finding something else to burn. We did it with trees, and whales. Now we're doing it with fossil fuels, burning in a few hundred years what took nature a few hundred million years to accumulate. But we are the first generation that truly knows how to build a sustainable energy system. Delaying that transition will lead to damaging climate changes that persist for millennia and beyond; making the transition smoothly may be one of the greatest material accomplishments of humanity.

Our knowledge on climate and energy, used wisely, really can bring more good to more people. Climate communicators have an unfinished, central role to play in helping people see the good, and to reach it. I thank you for including me in the effort.

—Richard B. Alley, *Department of Geosciences, and Earth and Environmental Systems Institute, Pennsylvania State University, University Park*

East of Japan, Upper Ocean Waves Follow a Seasonal Cycle



C. Henze, NASA Advanced Supercomputing Division

Snapshot of surface speed from a high-resolution computer simulation. The Kuroshio Current hugs the eastern coast of Japan before meandering eastward and farther into the Pacific Ocean. A new study of seasonal, fine-scale upper ocean dynamics in this region raises important considerations for the upcoming Surface Water and Ocean Topography (SWOT) mission.

An upcoming space mission aims to capture high-resolution satellite measurements of Earth's global surface waters. After launching in 2020, the Surface Water and Ocean Topography (SWOT) satellite will measure ocean surface height at a resolution of about 15 kilometers, up to 10 times finer than current altimeters. These data will then be used to infer fine-scale ocean dynamics and improve global ocean circulation models.

To interpret SWOT sea surface height data correctly, a clear understanding of their relationship with fine-scale flow must be established. In a new study, *Rocha et al.* demonstrate that scientists will need to consider seasonal variations in upper ocean internal wave dynamics when working with SWOT data.

The researchers focused on a portion of the Kuroshio Current, which flows northward along the western side of the North Pacific Ocean. After it passes Japan, the Kuroshio Current turns eastward, and its warm waters take a meandering path through the chilly Pacific, forming the Kuroshio Extension. This region is known for its major seasonal changes in upper ocean water stratification.

The authors used two global computer simulations to examine seasonal changes of features known as inertia-gravity waves in the Kuroshio Extension. Inertia-gravity waves are internal waves with wavelengths long enough to be affected by Earth's rotation.

The simulations revealed that fine-scale inertia-gravity waves in the Kuroshio Extension undergo a strong seasonal cycle. Inertia-gravity waves with wavelengths between 10 and 100 kilometers peak in the late summer and early fall when the upper ocean is highly stratified.

An important observation is that the inertia-gravity wave cycle is out of phase with the Kuroshio Extension's seasonal cycle of macroturbulence. Although inertia-gravity waves have a bigger impact on sea surface height variability and horizontal flow in late summer and early fall, macroturbulence dominates in late winter and early spring.

These findings have important implications for the interpretation of SWOT sea surface height data. However, the authors caution that patterns observed in the Kuroshio Extension may not apply to other ocean regions. They plan to explore the variability of fine-scale upper ocean seasonality of different ocean regions in a future study. (*Geophysical Research Letters*, doi:10.1002/2016GL071349, 2016) **—Sarah Stanley, Freelance Writer**

A Wetter Climate Increases Methane Production in Peat

Peatlands like bogs and fens have been in the spotlight for some time for their role in climate change, both as carbon sinks and as methane sources. Methane is produced naturally in the low-oxygen environments of peatlands and Arctic lakes. It is a potent greenhouse gas that traps heat more effectively than carbon dioxide and poses a threat to agriculture.

Despite its importance to climate patterns, the dynamics of methane production in peatlands are not fully understood. Here *Glaser et al.* build upon previous studies to analyze 43 years of peatland data and draw out connections between climate patterns and methane dynamics.

Big Bog State Recreation Area in Minnesota, part of the glacial Lake Agassiz peatlands. Increased precipitation in this area has doubled the methane-producing zone in the peat, which could play a role in further climate change.

The researchers sampled water in pores, or microscopic voids in peat, at numerous sites across the glacial Lake Agassiz peatlands in northwestern Minnesota to see how water moves solutes through the peat. The researchers took advantage of the calcium-rich deposits that lie beneath the peatland, measuring calcium to trace the upward movement of groundwater in the peat. They examined tritium, a radioactive hydrogen isotope that has been present in the atmosphere since nuclear testing began, to trace the downward movement of precipitation. Finally, they tracked radiocarbon, which is also carried downward by precipitation, as a representative of young, easily altered, and mobile forms of carbon that stimulate methane production.

The researchers identified three periods in the climate of the past century: dry (1911–1940), transitional (1941–1986), and moist (1991–2012). They found that during the dry and transitional phases, contemporary precipitation penetrated only 1 meter into the peat, but by the onset of the moist phase it had flushed the top 2 meters. Because the carbon that stimulates methane production is primarily dissolved organic carbon carried downward through the peat by rainwater rather than the solid-phase carbon that forms peat, this change in transport depth doubled the peak production zones for methane. Methane production is accelerated even more in areas dominated by sedges, grasslike plants that exude more easily altered forms of dissolved organic carbon from their roots.

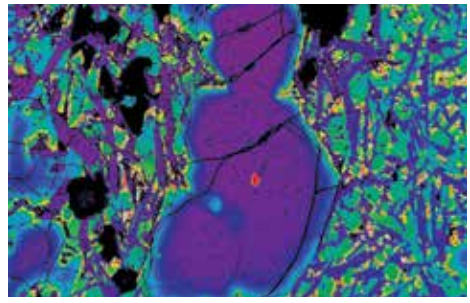
As climate patterns continue to change, it is important to understand how chemical processes in peatlands change along with them. The researchers suggest that other factors, such as changing peat temperatures or water levels, may also play a role in a peatland's greenhouse gas emissions. Because the shift in pore water chemistry that doubled methane production zones happened so suddenly and unexpectedly, the researchers warn that peatlands may be even more sensitive to changes in climate patterns than was originally thought. (*Global Biogeochemical Cycles*, doi:10.1002/2016GB005397, 2016) **—Elizabeth Jacobsen, Staff Writer**

A Significantly Hotter Mantle Beneath Iceland

Variations in the temperature of the mantle drive its convective circulation, a process that links the deep mantle with the atmosphere and oceans through volcanic and tectonic activity. Because of this connection, effective models of Earth's evolution must incorporate the planet's thermal history, for which a crucial constraint is the mantle's current temperature.

Because the mantle's temperature cannot be measured directly, scientists have devised a number of creative methods to derive this information, but these have produced widely varying results. Now *Matthews et al.* offer new constraints on this parameter beneath Iceland, one of the few places on Earth where a divergent plate boundary is subaerially exposed because of an anomalously large amount of melting occurring beneath the island.

Using a recently developed mineral thermometry technique, the researchers found that lava flows from four different eruptions along Iceland's Northern Volcanic Zone crystallized at substantially higher temperatures (maximum, 1399°C) than average mid-ocean ridge samples that have experienced little melting (maximum, 1270°C). Next, the team developed a thermal model of mantle melting and used it, along with other observations such as the local thickness of the crust, to quantify the uncertainties in deriving mantle temperatures from their data.



S. Matthews

A false-color backscatter electron image of an olivine crystal from Borgarhraun, a lava field in northern Iceland. The crystal contains a spinel inclusion, set in a fine-grained crystalline groundmass. The chemistry of these crystals records the temperatures at which they crystallized. The image is approximately 1.5 millimeters wide.

Their results indicate that the mantle below Iceland is at least 140°C hotter than that beneath average mid-ocean ridges. This outcome should shed light on the factors that control the extent of melting beneath Iceland, including the ongoing debate about whether the voluminous melting is due to a deep mantle plume and, if so, whether changes in its magma production reflect variations in the plume's temperature. (*Geochemistry, Geophysics, Geosystems*, doi:10.1002/2016GC006497, 2016) **—Terri Cook, Freelance Writer**

New Insight into Silica Explains Planetary Smashup

NASA/JPL-Caltech

An artist's depiction of a massive object slamming into a planet.

Scientists hypothesize that roughly 4.5 billion years ago, a protoplanet often referred to as Theia struck the newly formed Earth. The impact transferred so much heat to our young planet that a fraction of it melted and vaporized, creating a cloud of debris that quickly coalesced into the Moon.

Such collisions occurred often in the solar system's youth. Impacts likely explain Mercury's large core, Pluto's moons, and the demise of the dinosaurs. Battle wounds can still be easily spotted on the surfaces of Mercury, the Moon, and Mars. Although scientists would like to better characterize the early impacts that literally shaped our solar system, the degree to which rock melts and vaporizes during impacts isn't well understood because of poorly constrained equations of state.

Connolly set out to refine the equation of state for silica, which was chosen because silica is the most abundant oxide in rocky planets and plays a crucial role in impacts. The author then used the equation of state to create a new model of the silica boiling curve, which terminates at a critical point at about 6000 K.

Because there are no direct measurements of silica at extremely high temperatures and pressures, such conditions must be calculated from thermodynamic data that are extrapolated from much lower temperatures. The author found that at high temperatures, silica liquid boils incongruently such that it becomes depleted in oxygen. As a result, atmospheric loss after a giant impact could enrich residual silicate liquid in reduced silicon.

Improving the equations of state for silicate liquids will help researchers to better model impacts and ultimately give us a stronger understanding of the history of our solar system. (*Journal of Geophysical Research: Planets*, doi:10.1002/2016JE005059, 2016) **—Shannon Hall, Freelance Writer**

ATMOSPHERIC SCIENCES

Assistant Research Engineer – Ionospheric Connection Explorer (ICON)–Space Sciences Laboratory, University of California, Berkeley

The Space Sciences Laboratory (SSL) at the University of California, Berkeley, seeks applicants for an Assistant Research Engineer position, specifically in the area of upper atmospheric and space physics, with an emphasis on the science operations and data processing from the Ionospheric Connection Explorer (ICON) mission. ICON is a NASA Explorer mission, developed and managed by the Space Sciences Laboratory at the University of California, Berkeley with key support from several partner institutions. ICON will explore the boundary between Earth and space to understand the physical connection between our atmosphere and our space environment.

The Assistant Research Engineer will assist the ICON PI with the management of the ongoing science operations planning for the ICON mission and continuous development of the data analyses that further the science goals of the ICON mission. A detailed list of responsibilities and qualifications for the position is available at the application link provided below.

To apply:

To apply please go to the following link: https://aprecruit.berkeley.edu/apply/JPF01088.

This position will remain open until filled. If you have any questions please contact Dr. Thomas Immel (immel@ssl.berkeley.edu) or Tamiko George (tamiko@berkeley.edu).

The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability, age or protected veteran status. For the complete University of California nondiscrimination and affirmative action policy see: http://policy.ucop.edu/doc/4000376/NondiscrimAffirmAct

Postdoctoral Research Associate, Purdue University

The Shepson Tropospheric Chemistry Research Group at Purdue University has an opening for a Postdoctoral Research Associate. The position involves an opportunity to lead, and to work on a number of other problems in atmospheric chemistry, including:

1. Aircraft-based methods for quantification of greenhouse gas fluxes
2. Nitrogen cycling in forest environments
3. Aerosol phase photochemistry
4. Arctic halogen chemistry and analytical mass spectrometry

Expertise in atmospheric/analytical chemistry, chemical instrumentation, and good computational skills is essential. The position is for one year, but potentially renewable annually. The

position will be open until filled. Interested candidates should send a CV with a list of 3 references to:

Prof. Paul B. Shepson
Purdue University
560 Oval Dr.
West Lafayette, IN 47907
765-494-7441
pshepson@purdue.edu

Purdue University is an ADVANCE Institution. Purdue University is an EEO/AA employer fully committed to achieving a diverse work force. A background check will be required for employment in this position.

Postdoctoral Research Associate, University of Washington

The Joint Institute for the Study of the Atmosphere and Ocean (JISAO) at the University of Washington is seeking a Postdoctoral Research Associate in the area of atmospheric modeling on the LES or regional modeling scale. JISAO fosters collaborative research and education between the University of Washington and NOAA, as well as with other major organizations throughout the U.S.

Research is currently underway at the University of Washington to explore the feasibility of marine cloud brightening as a means of cooling Earth's climate. Current research topics include techniques to generate fine aerosol salt particles, aerosol–cloud interactions at the LES scale including both models and field experiments, possible links to regional scale circulations, and implications of climate engineering for global-scale climate. We are seeking a post-doc with experience in numerical modeling of atmospheric processes, particularly in the areas of aerosol physics, cloud physics and aerosol-cloud interactions, to engage in modeling in support of this research program. Priority will be given to applicants in the areas of aerosol-cloud interactions at the LES scale or at the scale of regional cloud-resolving models, but applicants interested in the global scale will also be considered. The research will be in collaboration with Professors Tom Ackerman (tpa2@uw.edu) and Rob Wood (robwood2@uw.edu) and Affiliate Professor Phil Rasch (Philip .Rasch@pnnl.gov).

This is a 12-month, full-time (100% FTE) appointment, renewable for a second year, subject to approval, satisfactory performance, and availability of funding. Applicants are asked to submit electronically (in PDF): (1) a curriculum vita; (2) a cover letter including a statement of interest in the climate engineering problem; (3) a description of potential research to be pursued during a two-year tenure at the University of Washington (limited to 4 pages including figures and references), and (4) the names and contact information of three individuals who can serve as references. Manuscripts that have been submitted to peer-reviewed journals but not yet published may be attached if they are relevant to the research topic. Applicants must provide proof of the Ph.D. conferral and be within 6 years of receipt of the PhD. Applicants who expect to receive a Ph.D. in the first quarter of 2017 will be considered. Individuals with disabilities desiring accommodations in the application process should notify Mary Smith, JISAO, 206-543-5216 or mchsmith@uw.edu

Applications should be received by January 31, 2017; applications received after that date may be considered. Applicants are expected to be available to assume the post-doc position no later than May 1, 2017. Applications should be sent to: Collen Marquist, Assistant to the Director, (marquist@uw.edu).

The University of Washington and JISAO promote diversity and inclusivity among our faculty and staff, and seek candidates who are able to fully

Ministry of Earth Sciences (MoES)
Government of India

Call for proposals to work on core samples

The Ministry of Earth Sciences has launched scientific deep drilling investigations to understand the mechanism of Reservoir Triggered Seismicity in the Koyna-Warna region, western India. Under the programme, core drilling has been carried out up to depth of 1522 m, passing through Deccan flood basalt and underlying basement granitoids for the first time in the region. The cores constitute a valuable archive, offering unique opportunities for investigating Deccan volcanism and other geoscience problems. A core repository is under development at the Ministry's research facility, the Borehole Geophysics Research Laboratory (BGRL) located at Karad.

Research proposals are invited for international collaboration with MoES/BGRL to carry out relevant investigations on core samples. The proposals must address outstanding science problems of global importance. Researchers are expected to make their own arrangements for collection of samples from BGRL, Karad.

Application deadlines: March 31, 2017 and Sep 30, 2017

Submission details including proposal format are available at www.moes.gov.in. Proposals may be submitted in a single PDF file to: Project Director, Borehole Geophysics Research Laboratory, Ministry of Earth Sciences, Karad-Patan Road, Karad 415 114, India. Email: projectdirector.bgrl@gov.in

U.S. NAVAL RESEARCH LABORATORY

Senior Scientist for Mesoscale Meteorology
ST-1301/1340, $124,406 to $187,000* per annum
*Rate limited to the rate for level III of the Executive Schedule (5 U.S.C. 5304(g)(2))

Serves as the technical expert in the field of mesoscale meteorology. Performs research and provides leadership to advance mesoscale meteorology scientific understanding, prediction and applications relevant to Navy, DoD, and civilian agencies.

Conducts hands-on, world-class, cutting edge research in basic and applied science, leading research teams to study atmospheric processes, predictability, and develop innovative mesoscale numerical weather prediction (NWP) models. Provides vision and direction to the Division, guides research project planning, and participates in the scientific planning or direction of field measurements that provide opportunities for data collection and hypothesis validation in support of basic and applied research theories.

As a distinguished scientist and recognized leader in his/her field the incumbent will be called upon to brief DoD senior officials regarding Laboratory research efforts in the above areas, to serve as liaison between NRL, the Navy and other national and international organizations, and to consult on important scientific and programmatic issues.

Applicants should be recognized as national/international authorities in the above areas of research, and should have demonstrated the scientific vision and organizational skills necessary to market new research proposals to obtain funding and bring long term, multi-faceted research programs to successful completion. NRL is the Navy's corporate lab and operates under the Navy Working Capital Fund (NWCF).

You must apply online by logging in to USAJOBS at www.usajobs.gov and searching for the vacancy announcement number NW713XX-00-1743284K9437232S. Please carefully read the announcement and follow the instructions when applying. Please contact Tara Bright at tara.bright@nrl.navy.mil for more information. Vacancy announcement closes on 28 February 2017.

Navy is an Equal Opportunity Employer

Federal Job Opportunities in Meteorology. Two Branch Head (GS-14/15) Positions (Salary $116,577-$161,900) at the U.S. Naval Research Laboratory in Monterey, CA

The U.S. Naval Research Laboratory (NRL) Marine Meteorology Division (MMD) is seeking two experienced scientists to fill senior supervisory positions (GS-14/15 equivalent) in our new leadership team: 1) Atmospheric Dynamics and Prediction Branch Head (Code 7530); and 2) Meteorological Application Development Branch Head (Code 7540). The MMD is entering an exciting new era with a broadened emphasis on coupled forecasting of the atmosphere, ocean, land, and cryosphere at short-range to weekly to sub-seasonal time scales. The two Branch Heads are key leaders in developing, planning, executing and maintaining the scientific and technical integrity of the R&D and transition programs; and ensuring that their programs are fully aligned and integrated with DoD, Navy, NRL, MMD, and other funding sponsor short, medium, and long-term research goals.

The MMD is a national and international leader in conducting basic and applied meteorological research; developing new Numerical Weather Prediction (NWP) models, data assimilation systems, and decision support tools; and implementing weather analysis and prediction systems for the DoD. The MMD is one of the very few locations worldwide where scientists can experience the satisfaction of overseeing the progression of their research programs from basic research all the way through to operational transition and implementation Funding from DoD through the Office of Naval Research (ONR), as well as non-DoD sources (NASA, DOE, and NOAA) provides extensive collaborative opportunities with academia, national agencies (NOAA/NWS, NASA/JPL, NCAR, etc.), and international organizations (WMO, UKMO, ECMWF, DLR, JMA, etc.). The MMD also plays leading roles in national and international field campaigns, such as THORPEX, TCS-08, DEEPWAVE, NAWDEX, TCI, SEAC4RS, etc. Outstanding research by our world-class workforce has led to the AMS recognizing 11 MMD employees as Fellows. Find out more at www.nrlmry.navy.mil

1. Atmospheric Dynamics and Prediction Branch Head (Code 7530). The Branch Head is responsible for the scientific, technical, and administrative supervision of about 50 civilian scientists, in three Sections, engaged in basic and applied research and technology transition to operations. The primary Branch objective is to increase the scientific understanding necessary to improve mesoscale and global NWP, with particular emphasis on the deterministic and probabilistic prediction of the troposphere with increasing interests in air-sea interactions, coupling to both the surface (land, ocean, and ice) and the stratosphere, and extended range prediction capabilities. The Branch Head requires scientific excellence in numerical methods, atmospheric dynamics, physics, and data assimilation and requires extensive knowledge and skill in the application of high performance computing to weather prediction.

2. Meteorological Application Development Branch Head (Code 7540). The Branch Head is responsible for the scientific, technical, and administrative supervision of about 30 civilian scientists engaged in basic and applied research and technology transition related to automated on-scene data analysis, nowcast, and forecast systems; multi-sensor meteorological satellite data applications; atmospheric aerosol data analysis and prediction systems; meteorological decision aids; hazardous weather-related applications guides; and high resolution weather information delivery techniques. He/she requires scientific excellence in atmospheric aerosol forecasting, electro-optical and electromagnetic propagation, satellite meteorology, on-demand data fusion techniques, and development of meteorological decision aids.

Applications should be emailed to jobs@nrlmry.navyy.mil by COB February 7, 2017. See the full advertisement at findajob.agu.org/jobs.

MMD is located in Monterey, California, which is within the highest General Schedule Locality Pay Area. The United States Government does not discriminate in employment on the basis of race, color, religion sex, national origin, political affiliation, sexual orientation, marital status, disability, age, membership in an employee organization, or other non-merit factor.

engage audiences from a wide spectrum of backgrounds. University of Washington is an affirmative action and equal opportunity employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, gender expression, national origin, age, protected veteran or disabled status, or genetic information.

Section Head, Atmosphere Section - Division of Atmospheric and Geospace Sciences, National Science Foundation (NSF)

NSF's Directorate for Geosciences (GEO) seeks candidates for the position of Section Head for the Atmosphere Section in the Division of Atmospheric and Geospace Sciences (AGS). The Head of the Section serves as a member of the Division leadership team and as the Directorate's principal spokesperson in the area of atmospheric science research. The Section Head is responsible to the AGS Division Director for the overall planning, management, and commitment of budgeted funds for the Section, which includes programs in Atmospheric Chemistry, Climate and Large-scale Dynamics, Physical and Dynamic Meteorology, and Paleoclimate.

Appointment to this Senior Executive Service position may be on a career or on a one to three-year limited-term basis, with a salary range of $160,300-$177,800. Alternatively, the incumbent may be assigned under Intergovernmental Personnel Act (IPA) provisions. The job opportunity announcement (AGS-2017-0006) with position requirements and application procedures may be viewed at: https://www.usajobs.gov/GetJob/ViewDetails/458944000. Applications must be received by January 23, 2017.

NSF is an equal opportunity employer committed to employing a highly qualified staff reflecting the diversity of our nation.

INTERDISCIPLINARY

Assistant Professor of Environmental Statistics, University of California, Riverside

The College of Natural and Agricultural Sciences at the University of California, Riverside is recruiting a tenure-track (academic year) Assistant Professor position in the field of Environmental Statistics with an expected start date of July 1, 2017. We seek candidates with exceptionally strong statistical skills or information management experience, with an emphasis in either spatial or temporal modeling of environmental, climatic or ecological processes. We are particularly interested in individuals who address complex, large-scale, or long-term multidisciplinary prob-

FACULTY POSITION IN EARTH SURFACE PROCESSES/GEOMORPHOLOGY

Young and research-intensive, Nanyang Technological University (NTU Singapore) is ranked 13th globally. It is also placed 1st amongst the world's best young universities.

The Asian School of the Environment and the Earth Observatory of Singapore at Nanyang Technological University, Singapore invites applications for a full professor position in Earth Surface Processes/Geomorphology with emphasis on the geomorphic response to climate and/or anthropogenic change. Specific areas of interest include (but are not limited to) physical, chemical, and/or biological aspects of Earth-surface dynamics and evolution or changes in the Earth's surface as a result of human and natural impacts. Research approaches should encompass some combination of field, laboratory, and modeling. We seek an individual with research interests that augment our existing strengths in Earth systems science and surficial processes. This position is part of the continued expansion of the Asian School of the Environment.

We invite candidates who have developed an internationally recognized, externally funded, multi-disciplinary research program to apply at full professor level. Successful candidates will also be required to actively participate in our core undergraduate and graduate teaching and in the administration of the Asian School of the Environment.

To apply, please submit the following materials to:

ase-geomorphology@ntu.edu.sg

- Statement of research and teaching interests
- Curriculum vitae
- A copy of two relevant publications
- The names of three references who are familiar with your work

Further information about the Asian School of the Environment and the Earth Observatory of Singapore is available at **www.ase.ntu.edu.sg** and **www.earthobservatory.sg**.

Review of applications will continue until the position is filled.

NANYANG TECHNOLOGICAL UNIVERSITY

EARTH OBSERVATORY OF SINGAPORE

lems using large data sets, or statistical approaches for improving management or conservation practices for the sustainability of agriculture and natural resources. Candidates who specialize in spatial and temporal statistics such as time series analysis, hierarchical modeling, spatial modeling, and Bayesian methods or who have used such methods to analyze environmental, climatic, and/or ecological data are especially encouraged to apply. A successful candidate will choose a home among the departments/programs in the College, including Biology, Earth Science, Environmental Science, and Statistics and can interact with the newly-formed Center for Spatial Analysis, the Center for Conservation Biology, and the Environmental Dynamics and Geoecology Institute (EDGE). A Ph.D. degree in Biology, Earth Science, Environmental Science, Statistics, or related fields is required. The successful candidate will be expected to develop a well-funded, innovative research program with a national and international reputation, must have demonstrated potential for developing high-quality scientific publications, and must have excellent communication skills. Teaching duties include both undergraduate and graduate courses in the areas of statistical methods for spatial data and time series analysis.

Review of applications will begin on January 15, 2017. Applications will be accepted until the position is filled. Applicants should submit the following materials online at https://aprecruit.ucr.edu/apply/JPF00692 (1) a cover letter, (2) a curriculum vita, (3) a statement of research interests, (4) a statement of teaching interests, (5) a statement of contributions to diversity, and (6) three letters of recommendation (requested directly through our online application system). For additional information on the College and the campus, please visit http://cnas.ucr.edu/, and http://www.ucr.edu/, or contact Dr. Laosheng Wu laosheng.wu@ucr.edu, Department of Environmental Sciences at UC Riverside.

Advancement through the faculty ranks at the University of California is through a series of structured, merit-based evaluations, occurring every 2-3 years, each of which includes substantial peer input.

UCR is a world-class research university with an exceptionally diverse undergraduate student body. Its mission is explicitly linked to providing routes to educational success for underrepresented and first-generation college students. A commitment to this mission is a preferred qualification.

The University of California is an Equal Opportunity/Affirmative Action

Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, age, disability, protected veteran status, or any other characteristic protected by law.

Visiting Faculty Position – Volcanology and Geothermal Sciences, Kyoto University, Japan

Kyoto University invites applications for a visiting Professor or Associate Professor in volcanology, geothermal sciences and related disciplines. The successful applicant is expected to work at Aso Volcanological Laboratory or Beppu Geothermal Research Laboratory, Kyushu, Japan. Attractive salary and traveling expenses are provided from the university. The position is opened on October 1, 2017, and the tenure is 3 to 12 months. Send (1) CV including date of birth, nationality and publication list, (2) statement of research interests, (3) pdf files of 3 significant publications, (4) names and e-mail addresses of three references and (5) desired arrival date and place of assignment (Beppu or Aso) to Prof. Takahiro Ohkura through e-mail to VFP17*vgs.kyoto-u.ac.jp (Please replace "*" with "@" in the e-mail address), by March 1, 2017. For the details, please look at http://www.vgs.kyoto-u.ac.jp/english/e-index.html or http://www.vgs.kyoto-u.ac.jp/igse/.

The applicant should be 65 years old or younger when his/her term in this position has terminated.

Inquire in advance to a member is encouraged.

OCEAN SCIENCES

Assistant Professor–Physical Oceanography, University of North Carolina, Wilmington

The Department of Physics and Physical Oceanography (http://www.uncw.edu/phy) at the University of North Carolina Wilmington invites applications for a tenure-track faculty position in physical oceanography at the assistant professor level starting August 2017. Applicants with research interests in any aspect of physical oceanography are encouraged. The department currently has faculty with research interests in surf zone dynamics, large scale distributions of sea surface salinity and its relation to the global water cycle, and remote sensing of ocean color in the coastal zone. The chosen candidate will be expected to excel in teaching basic physics at the introductory level and advanced undergraduate and graduate courses in areas of physical oceanography of interest to them; and to engage students in research at both the undergraduate and graduate levels. Additionally, expectations for this position include maintaining a strong externally-funded research program and providing service to the department and university. Degree programs offered by the department include a bachelor of science in physics with a concentration in physical oceanography, a master of science in marine science and a pending PhD program in coastal integrative marine science.

Priority consideration will be given to applications submitted before 2-Feb-2017, but the position will remain open until filled. For more information and application instructions see https://jobs.uncw.edu/postings/6960, or contact the search committee chair, Frederick Bingham (binghamf@uncw.edu).

Associate or Full Professor, Oceanography and Director of the Coastal Resources Center, The University of Rhode Island

The University of Rhode Island seeks applications for a tenure-track faculty position at the Graduate School of Oceanography, to carry out teaching, research, and graduate student advising and to serve as the Director of the Coastal Resources Center (CRC). The position will be filled at the Associate or Full Professor level. This is a tenure-track academic year position with anticipated start date of September 2017.

Provide overall leadership and direction for the CRC; teach graduate and/or undergraduate courses, advise graduate students, and conduct research that aligns with the mission of the CRC. Direct the programs and operation of the CRC, including over 25 staff and an annual budget of US $8-10 million. Initiate, design, and obtain funding for programs that support CRC's mission. Develop and initiate a long-term vision for the CRC as an international leader in the integrated management of marine and coastal ecosystems and the human communities that live and work in coastal regions. Initiate and coordinate active, collaborative work between the CRC and other governmental agencies, universities and organizations, as well as within the University of Rhode Island. Represent the University and the CRC at national and international forums especially on topics related to coastal and marine ecosystems and/or integrated management and sustainability. Perform short- and long-term strategic planning including personnel and budgeting to achieve CRC's mission. Through projects, publications, and participation in public service activities, enhance the CRC's position as a national and international leader in the field of integrated coastal and marine ecosystem research and management. Be a member of and participate on the Graduate School of Oceanography Dean's Staff. Perform other tasks, activities or responsibilities as

Section Head, Disciplinary Programs Section
Division of Earth Sciences
National Science Foundation (NSF)
Arlington VA

NSF's Directorate for Geosciences (GEO) seeks candidates for the position of Section Head for the Disciplinary Programs Section in the Division of Earth Sciences (EAR). The Section Head serves as a member of the Division leadership team and as a spokesperson for Earth Sciences research. The Section Head is responsible to the EAR Division Director for overall planning, management, and commitment of budgeted funds for the Section, which includes programs in Geobiology and Low Temperature Geochemistry, Geomorphology and Land Use Dynamics, Sedimentary Geology and Paleobiology, Hydrologic Sciences, Geophysics, Tectonics, and Petrology and Geochemistry.

Appointment to this Senior Executive Service position may be on a career or on a one to three-year limited-term basis, with a salary range of $160,300-$177,800. Alternatively, the incumbent may be assigned under Intergovernmental Personnel Act (IPA) provisions. The job opportunity announcement (EAR-2017-0001) with position requirements and application procedures may be viewed at: https://www.usajobs.gov/GetJob/ViewDetails/459469500

Applications must be received by January 24, 2017.

NSF is an equal opportunity employer committed to employing a highly qualified staff reflecting the diversity of our nation.

For more information, please refer to: www.qnlm.ac/en/index

Qingdao National Laboratory for Marine Science and Technology (QNLM) was launched in Qingdao, a seaside city in Shandong Province of China, in 2015. It is designed to become a world-class comprehensive marine research center and an open platform for collaborative innovation, focusing on basic research as well as R&D of cutting-edge technologies related to marine science.

Major research areas of QNLM include: ocean dynamic processes and climate change, marine life processes and resource utilization, evolution and protection of marine ecological environments, benthic processes and oil and gas resources, extreme environments and resources in deep sea and polar regions, and marine technologies and equipment. Around the six research areas, QNLM has established eight functional laboratories and nine joint laboratories with other domestic research institutions and large state-owned enterprises. Eleven large research platforms are under construction.

QNLM Global Talent Search

QNLM is currently seeking talented researchers from around the world. We invite you to join us, building up a great career and a wonderful life here.

I. Positions and job descriptions

1. Principal investigators (PI) for the six major research areas

Building a high-quality research team to conduct frontier research and train talented researchers; set strategic development plans; manage major projects throughout the whole lifecycle.

2. One director for each joint lab *(High-End Ocean Equipment, Ocean Observing and Detecting, Blue Fishery, Smart Ocean, Intelligent Marine Computing and Big Data, Ocean Oil-Gas Resource Prospecting, New Marine Materials, Sustainable Ocean Energy, Deep-Sea Extreme Environment)*

Make development plans and propose strategic research directions; organize and lead state-level or international major scientific projects; build high-level research teams.

3. One chief engineer for each public research platform *(R&D Center for Marine Instruments and Apparatuses, Center for Marine Isotopes and Geochronology)*

Lead the planning, construction and operation of public research platforms; provide technical support for the operation and maintenance of equipment; lead equipment testing and R&D for major state project; build a high-level technical support team.

II. Qualifications

1. For PIs and directors

(1) Having held professorship (or principal investigator) or other senior positions;

(2) World-recognized academic achievements in relevant areas;

(3) Outstanding leadership skills

(4) Full-time affiliation or at least six months for PIs in QNLM each year.

2. For chief engineers

(1) Relevant experience of equipment maintenance and R&D at world-famous institutions, along with rich management experience for major research projects;

(2) Excellent R&D track;

(3) Full-time affiliation or at least six months each year in QNLM during the transition period (up to two years for overseas applicants)

III. Remunerations

1. For PIs

(1) Allowance: RMB 1-1.2 million per year;

(2) Research subsidy: RMB 3-5 million;

(3) RMB 5 million home purchase subsidies on a contract of six years or longer with QNLM; or a rental-free apartment of around 180m^2 on a less-than-six year contract with QNLM.

2. For directors and chief engineers

Open to face-to-face negotiations; refer to relevant QNLM Aoshan Talent policies.

IV. How to apply

(1) Applicants need to submit a CV, previous research achievements (a list of up to ten most significant publications or patents), a research plan and work objectives and three references, all in PDF;

(2) The complete submission, referenced as "Application for QNLM Aoshan Recruitment Program", should be emailed to: jwzheng@qnlm.ac

V. Deadline

Review of applications will begin immediately and continue until the positions are filled.

VI. Contact information

Tel: +86-532-5871 9798

Fax: +86-532-5871 9758

E-mail: jwzheng@qnlm.ac

assigned by the Dean. Contribute to GSO's graduate and undergraduate teaching mission, bringing an applied science and management perspective.

Visit the URI jobs website at https://jobs.uri.edu to apply and view complete details for posting (F00023). Please attach 3 documents (PDF) to your online Faculty Employment Application: (#1) Letter of application; (#2) Curriculum Vitae to include the names, email address, and telephone numbers of at least three professional references, and (#3) "Other Document" is to include a statement of teaching and research interests (one combined PDF document).

Note: Other relevant material in support of your application may be sent directly to the search chair, David Smith at: dcsmith@uri.edu

Application Deadline: This is an open until filled search. First consideration will be given to applications received by February 1, 2017. Second consideration may be given to applications received by March 1, 2017. Applications received subsequent to second consideration (March 1, 2017) may not be given full consideration.

APPLICATIONS MUST BE SUBMITTED ONLINE ONLY.

The University of Rhode Island is an AA/EEOD employer. Women, persons of color, protected veterans, individuals with disabilities, and members of other protected groups are encouraged to apply

MS graduate assistantship in Physical Oceanography and Climate Dynamics, Texas A&M, Corpus Christi

The Department of Physical and Environmental Sciences at Texas A&M University-Corpus Christi is inviting applications for a fully-funded MS student. The successful applicant will work on a research project related to ocean and air-sea interaction processes in the tropical and subtropical Indo-Pacific region. A specific research topic will be selected based on the student's interest. Qualified applicants should contact Dr. Toshi Shinoda (tshinoda@tamucc.edu). More information about the Department of Physical and Environmental Sciences, MS programs can be found at http://pens.tamucc.edu/.

Texas A&M University-Corpus Christi is a rapidly growing research university, located on the beautiful coast of the Gulf of Mexico.

Toshiaki Shinoda, Associate Professor Department of Physical and Environmental Sciences Texas A&M University-Corpus Christi 6300 Ocean Drive, Unit 5892, Corpus Christi, Texas 78412-5892 Phone: (361) 825-3636 Email: tshinoda@tamucc.edu Web: http://faculty.tamucc.edu/tshinoda/

Applicants should have a BS degree in Oceanography, Atmospheric Sciences, Physics, Mathematics, Computer Sciences, or relevant fields. Strong physics and math background is desirable.

SPACE PHYSICS

Ionospheric Research Scientist - U.S. Naval Research Laboratory, Space Science Division

The Geospace Science and Technology Branch of the Space Science Division at the Naval Research Laboratory invites applications for a permanent Research Scientist position. We conduct research to observe, understand, model, and forecast the ionosphere, in order to improve capabilities for the Navy/Marine Corps, other services, and agencies. For more information see our web site, https://www.nrl.navy.mil/ssd. Experience in one or more of the following research areas is required: physics-based modeling, data assimilative modeling, ionospheric sensor data analysis, radio propagation modeling, or the effects of the ionosphere on radio-based systems. A PhD, or equivalent, and postdoctoral experience are highly desirable. Salary will be determined based on background, experience, and market consideration. Candidates should send their application electronically to geospace@nrl.navy.mil. The application consists of a curriculum vitae, including a list of publications and a description of research interests. Candidates should also be prepared to arrange for three letters of reference to be forwarded electronically upon request. US citizenship is required and candidates must be able to obtain and maintain a DoD Security Clearance. NRL is an Equal Opportunity Employer.

Section Head, Geospace Section - Division of Atmospheric and Geospace Sciences, National Science Foundation (NSF)

NSF's Directorate for Geosciences (GEO) seeks candidates for the position of Section Head for the Geospace Section in the Division of Atmospheric and Geospace Sciences (AGS). The Head of the Section serves as a member of the Division leadership team and as the Directorate's principal spokesperson in the area of geospace science research. The Section Head is responsible to the AGS Division Director for the overall planning, management, and commitment of budgeted funds for the Section, which includes programs in Aeronomy, Magnetospheric Physics, Space Weather, Solar Terrestrial Research, and Geospace Facilities.

Appointment to this Senior Executive Service position may be on a career or on a one to three-year

limited-term basis, with a salary range of $160,300–$177,800. Alternatively, the incumbent may be assigned under Intergovernmental Personnel Act (IPA) provisions. The job opportunity announcement (AGS-2017-0004) with position requirements and application procedures may be viewed at: https://www.usajobs.gov/GetJob/ViewDetails/458868000. Applications must be received by January 23, 2017.

NSF is an equal opportunity employer committed to employing a highly qualified staff reflecting the diversity of our nation.

Tenure Track Faculty, Clemson University

The Department of Physics and Astronomy at Clemson University seeks candidates to fill a faculty position in our Atmospheric and Space Physics group. We seek candidates with a strong proven record in experimental work with emphasis on the Earth's upper atmosphere and ionosphere. The atmospheric and space physics group within the department currently has strong research programs in rocket and ground-based observations, with technical support provided by the department's instrument shop. Our research program also includes work in satellite diagnostics, modeling and big data, and we seek someone that can complement and enhance the research activities of the department. The successful candidate will be expected to establish a vigorous externally funded research program, exhibit a record of substantive research, and a commitment to excellence in teaching at both the undergraduate and graduate level. Required qualifications include a PhD in Physics, or closely related field. Applications should be submitted via Interfolio (apply.interfolio.com/39806) and include a curriculum vitae, publication list, statements of research interests and accomplishments, a research plan, a statement of teaching philosophy, and the names of at least three references. Applicant evaluations will begin on February 15, 2017 and continue until the position is filled. Information about our research and educational programs can be found at physics.clemson.edu. For further information, please contact cuphysicsjob@clemson.edu. Clemson University is an AA/EEO employer and does not discriminate against any person or group on the basis of age, color, disability, gender, pregnancy, national origin, race, religion, sexual orientation, veteran status or genetic information. Clemson University is building a culturally diverse faculty and staff committed to working in a multicultural environment and encourages applications from minorities and women.

Postcards from the Field

Hi, Everyone.

Our research team, Remote, In Situ, and Synchrotron Studies for Science and Exploration (RIS4E; https://ris4e.labs.stonybrook.edu/), involves geologists at SUNY Stony Brook and NASA's Goddard Space Flight Center and Johnson Space Center. We've been working together in the rift zones of Kilauea volcano in Hawaii since 2008 studying the geochemistry of rocks and how they are altered when exposed to volcanic gases that are being released from the summit and along fumaroles. As we conduct this research, we are evaluating the use of portable and handheld instruments in helping to make sure that we can conduct the best science possible with limited field time.

This effort provides NASA with an understanding about how to build and operate instruments for use by astronauts as we prepare for humans exploring the Moon, Mars, and beyond. For more information on RIS4E, check out our online report produced by Stony Brook's School of Journalism (http://reportingris4e.com/). Here we are in our most recent field campaign working in the shadow of Kilauea's plume with our portable XRF, XRD, spectral imager, hyperspectral camera, and lidar.

—Jacob Bleacher, Planetary Geology, Geophysics, and Geochemistry Laboratory, Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, Md.

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

AGU

HONORS

PROGRAM

Devendra Lal Memorial Medal

Established in 2016, the Devendra Lal Medal will be given annually in recognition of outstanding Earth and/or space sciences research by a scientist belonging to and working in a developing nation. The medal will allow AGU to strengthen its recognition and engagement in the international community and establish a mechanism to support international collaboration, particularly by underrepresented groups.

Medal Includes

- Engraved Medal
- AGU Conferred Fellowship (if honoree is not already an AGU Fellow)
- Lifetime AGU membership
- Complimentary registration for the annual meeting during the award presentation year
- Invitation to present a lecture at the annual meeting, during the award presentation year

Deadline: 15 March 2017

honors.agu.org

EARTH & SPACE SCIENCE

virtual poster showcase

Wondering How to Take Your Research Experience to the Next Level?

AGU's Online Poster Platform, Part of a Suite of Talent Pool Programs, Makes It Easy

Students need to take only these three simple steps to gain valuable experience presenting their research.

1. **Submit an abstract**
2. **Upload a poster and accompanying video presentation**
3. **Evaluate the posters of peers and receive feedback on their own poster**

What students say about Virtual Poster Showcase:

"I especially liked that fellow students reviewed posters, as that gave me experience in critically thinking about the research other students were doing as well as my own."

"It was a really valuable experience for me, and I know I am much more ready to participate in a bigger, in-person conference."

Spring showcase opens in February 2017.

Learn more at **virtualposter.agu.org**

AGU