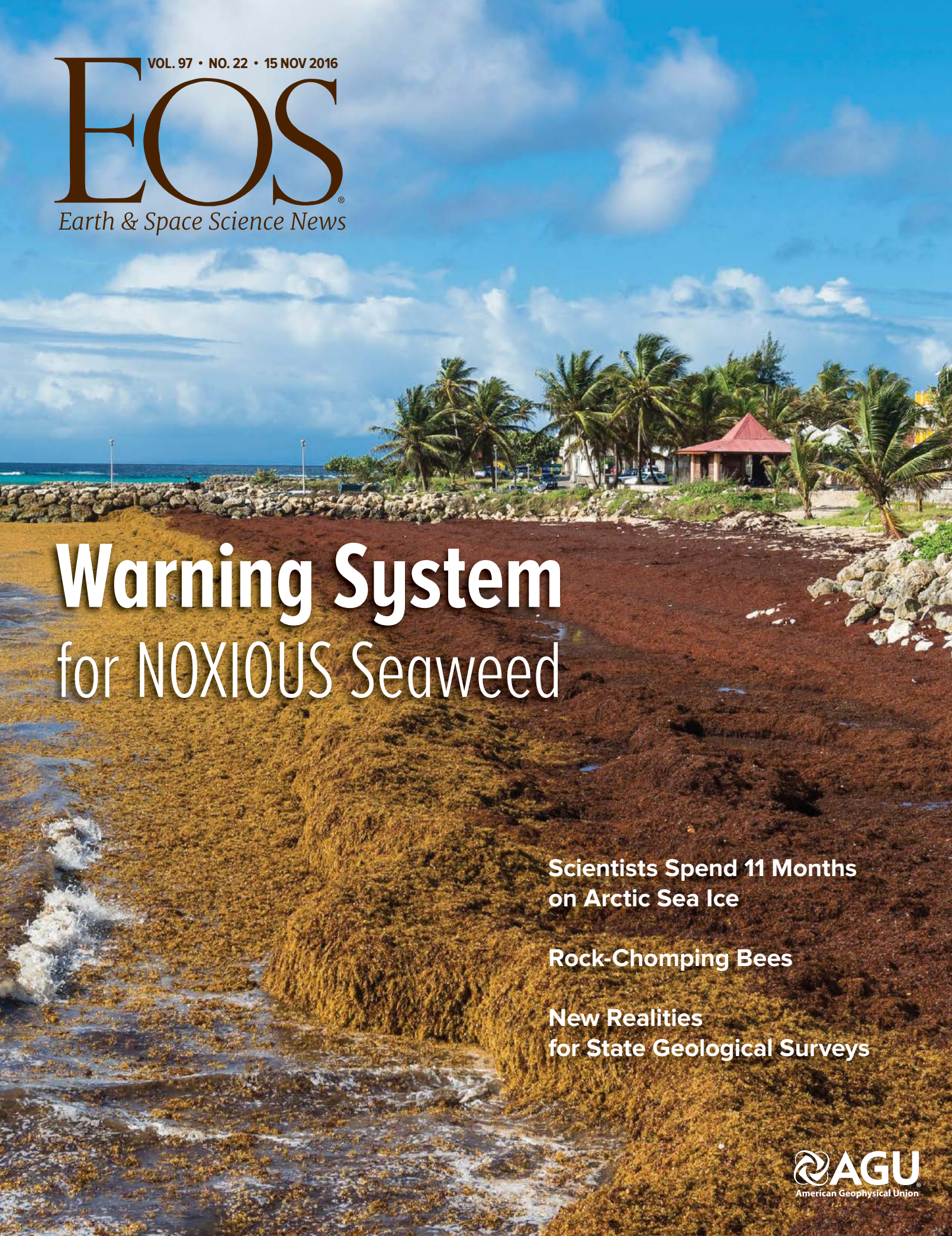
VOL. 97 • NO. 22 • 15 NOV 2016

EOS

Earth & Space Science News



Warning System for NOXIOUS Seaweed

Scientists Spend 11 Months on Arctic Sea Ice

Rock-Chomping Bees

New Realities for State Geological Surveys

AGU American Geophysical Union

AGU FALL MEETING

San Francisco | 12–16 December 2016

Education and Public Outreach Events

All events take place in the San Francisco Marriott Marquis

Monday, 12 December

Establishing and Sustaining an Undergraduate Research Program
8:00 A.M.–12:00 P.M., Golden Gate C1

Facilitating Classroom Innovation in the Geosciences: Taking Advantage of NSF Education Programs in the Division of Undergraduate Education
4:00 P.M.–6:00 P.M., Golden Gate C1

Geophysical Information For Teachers Workshop Day 1
7:30 A.M.–3:30 P.M., Golden Gate A

Research Mentoring of Young Scientists from Undergraduate to Postdocs
1:00 P.M.–4:00 P.M., Golden Gate C1

Tuesday, 13 December

Broadening Participation in the Geosciences: Making What Works Work for You
9:00 A.M.–12:00 P.M., Golden Gate C1

Diversity Reception
5:30 P.M.–6:30 P.M., Foothill C (Formerly Club Room)

Earth in Context: Resources for Integrating Earth Literacy with Societal Issues Across the Curriculum
3:00 P.M.–6:00 P.M., Golden Gate C1

Geophysical Information For Teachers Workshop Day 2
7:30 A.M.–3:30 P.M., Golden Gate A

Is it Harassment or Not? A Workshop for Women and Men
1:00 P.M.–3:00 P.M., Golden Gate C1

Networking Reception for Early Career Female Scientists and Students
6:00 P.M.–8:00 P.M., Golden Gate B

Wednesday, 14 December

Navigating the NSF System
9:00 A.M.–12:00 P.M., Golden Gate A

Opportunities Beyond Academia
4:00 P.M.–6:00 P.M., Golden Gate A

Success in Scientific Publishing and Outreach
2:00 P.M.–4:00 P.M., Golden Gate A

Thursday, 15 December

Geo-Games Showcase and Workshop
9:00 A.M.–12:00 P.M., Golden Gate A

Increasing Our Capacity to Address Climate Change Through Collective Impact: Developing a Model for Effective Regional Climate Literacy Networks
1:00 P.M.–5:00 P.M., Golden Gate A

For details, see education.agu.org

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COVER

Sargassum Watch Warns of Incoming Seaweed

The *Sargassum* Watch System processes satellite data and feeds results to a Web portal, giving decision makers timely information on seaweed location and warnings for potential beaching events.

PROJECT UPDATE

Scientists Spend 11 Months Adrift on Arctic Sea Ice

A hovercraft–based ice drift station gives researchers access to previously inaccessible regions of the changing Arctic sea ice cover off the coast of Greenland.

NEWS

5 Seismic Wave Videos Combine Sight and Sound

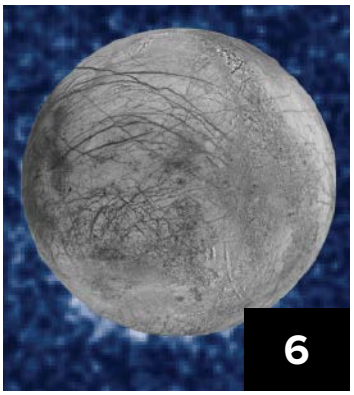
Researchers convert seismic data into sounds and animations, providing scientists and the public with a new way to view what happens to Earth during earthquakes.

OPINION

State Budgets, Geological Surveys, and the New Reality

As state geological surveys face budget cuts and reorganizations, scientists must step into political spheres to advocate for what they do.

DEPARTMENTS



Eos

Editor in Chief

Barbara T. Richman: AGU, Washington, D. C., USA; eos_ brichman@agu.org

Editors

Christina M. S. Cohen
California Institute of Technology, Pasadena, Calif., USA; cohen@srl.caltech.edu

Wendy S. Gordon
Ecologia Consulting, Austin, Texas, USA; wendy@ecologiaconsulting.com

Carol A. Stein
Department of Earth and Environmental Sciences, University of Illinois at Chicago, Chicago, Ill., USA; cstein@uic.edu

José D. Fuentes
Department of Meteorology, Pennsylvania State University, University Park, Pa., USA; juf15@meteo.psu.edu

David Halpern
Jet Propulsion Laboratory, Pasadena, Calif., USA; davidhalpern29@gmail.com

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Advertising: Jeff Borchardt, Development Director; Tel: +1-202-777-7536; Email: advertising@agu.org

Eos (ISSN 0096-3941) is published semi-monthly, on the 1st and 15th of the month by the American Geophysical Union, 2000 Florida Ave., NW, Washington, DC 20009, USA. Periodical Class postage paid at Washington, D. C., and at additional mailing offices. POSTMASTER: Send address changes to Member Service Center, 2000 Florida Ave., NW, Washington, DC 20009, USA.

Member Service Center: 8:00 a.m.–6:00 p.m. Eastern time; Tel: +1-202-462-6900; Fax: +1-202-328-0566; Tel. orders in U.S.: 1-800-966-2481; Email: service@agu.org.

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Views expressed in this publication do not necessarily reflect official positions of the American Geophysical Union unless expressly stated.

Christine W. McEntee, Executive Director/CEO

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Rock-Chomping Bees Burrow into Sandstone

Michael Orr

An Anthophora pueblo *bee pokes out of a sandstone tunnel carved by bee mandibles.*

Hundreds of tiny holes spread across a sandstone cliff wall in Utah's San Rafael desert. They weren't carved by humans or weather. Bees did it—specifically, a bee species new to science, named *Anthophora pueblo* for the Puebloan sandstone cliff dwellings that dot the deserts of the southwestern United States.

"The desert is a hard place to live," said Michael Orr, a doctoral student at Utah State University in Logan and lead author on a recent paper in *Current Biology* describing the species (see http://bit.ly/bee-paper). "*Anthophora pueblo* has pioneered a suitable niche between a rock and a hard place."

"Bees are a very conspicuous and well-studied group of insects, and the fact that we can still find these novel behaviors in bees is exciting," said Amy Toth, an entomologist at Iowa State University in Ames, who wasn't involved in the 12 September study.

Observing new species of bees will help to encourage more research in basic bee biology, Orr told *Eos*, which is necessary to help in conservation efforts. "If we don't know how many species are out there and how they live, we can't protect them and their varied roles in natural systems," Orr said.

Bees spread pollen from plant to plant, helping plants reproduce, so learning about *Anthophora pueblo* and other bee species "is crucial for actually maintaining biodiversity," he added.

Rocky Nests

Scientists have documented bees that nest underground by excavating silt or clay, in houses or trees by digging into wood, or even in the soil near volcanoes. "Despite the fact that most bee species are found in deserts," very few of them nest in rock, Orr said. Until now, no one has reported bees that excavate rock.

Forty years ago, a bee researcher named Frank Parker happened upon *Anthophora pueblo* nests in the sandstone and recognized what they were but never published his research. In 2015, Orr came across some rock samples that Parker had collected that contained tunnels excavated by the bees. Orr and Parker retraced the older researcher's steps and found the original *Anthophora pueblo* nests—surprisingly still active—along with five new nests in Utah. Since then, Orr has discovered more than 50 such rock nests in Utah, Nevada, California, and Colorado.

Gnawing the Stone

The bees use their mandibles to chew away at the sandstone, creating a network of tunnels. The bees also munch tiny pockets into the rock in which to gestate and nourish young bees.

The bees also collect water and use it to weaken carbonate crystals that make a cement between the grains of sand, Orr said. In fact, Orr found all the rock nests near water and even evidence of an emptied nest near a site where the water source had dried up.

It's not unusual for bees to use water, Toth said. Some bee and wasp species bring water to their nests to help cool them down, but she hadn't heard of bees using water to actually build nests.

"The fact that they're using water isn't all that surprising, but in the context of excavation, that's a pretty neat behavior," Toth said.

Why Sandstone?

Discovering these bees really pushes "the limits of what we thought bees could do as far as their toughness," Toth continued.

It takes a lot of energy to carve tunnels through sandstone, which had Orr and his team scratching their heads—why would a bee spend so much energy digging a tunnel through hard rock? Other *Anthophora* bees burrow into soil or clay, but this *pueblo* variety specifically seeks out sandstone.

It turns out, however, "that same durability that makes it harder to excavate is actually providing benefits," Orr said. For instance, durable sandstone protects the bees from flash floods or heavy rains.

Another benefit is protection from parasites, Orr said. As bees fly from plant to plant, they accidentally pick up larvae from parasitic beetles and carry them to their nest. Sometimes the larvae end up in a nest cell, where a baby bee develops. But because adult bees build hard sandstone lids over each nest cell, the beetle larvae—hungry for nourishment—can't get out again. Although the resident hatchling bee succumbs to a macabre fate, the rest of the nest is spared because the trapped beetle larvae can't grow and reproduce, Orr continued.

Climate Change, Conservation

Because of the bees' nesting limitations—ample sandstone near a water source—conservation will be an issue in the future, Orr said. Scientists anticipate that deserts will become drier as the planet warms, he continued, which could "reduce the number of water sources and could ultimately constrain where this bee can nest even further."

Toth "wholeheartedly" agreed that prospects for *Anthophora pueblo* will likely worsen. "Species that are more specialized on certain kinds of habitats, or little ecological niches, those are the ones that are most susceptible to disturbances," she said.

By **JoAnna Wendel,** Staff Writer

First Arctic Science Ministers' Confab Yields Cooperation Pledge

Science ministers from the United States and 24 foreign governments, as well as other parties, met recently at the White House and agreed to cooperatively study rapid changes in the Arctic and incorporate their findings into national policies and decisions regarding the region.

The ministers asserted "the importance of improving collaborative science efforts in the Arctic" in a joint statement (http://bit.ly/ArcSciMinisterial) following the first-ever Arctic science ministerial, a gathering of high-level science diplomats. The group also announced a series of new Arctic science initiatives and milestones following the meeting (see http://bit.ly/ASM-factsheet).

"For the sake of the future of Arctic residents, and to improve our understanding of how changes in the Arctic will affect the rest of the planet, we intend to contribute to and enhance a shared understanding of the causes, implications, and future changes to the Arctic environment," reads the statement issued by the eight members of the Arctic Council, including the United States and Russia, along with additional states and other parties. Those included China, India, and the United Kingdom, as well as the European Union (EU). Representatives of Arctic indigenous communities also took part in the meeting.

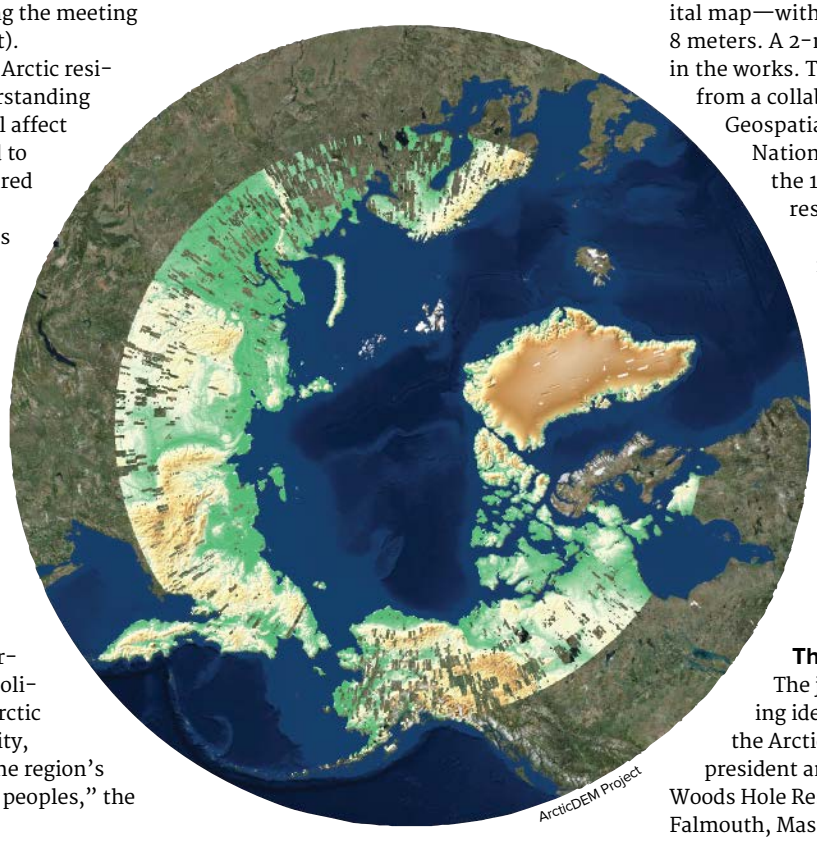
"We also intend to work to ensure that this increased understanding informs our national policies and decisions concerning Arctic development, commercial activity, stewardship, and the needs of the region's residents, including Indigenous peoples," the statement continues.

A Collective Process to Deal with a Looming Challenge

The 28 September meeting launched "a new stage" in Arctic science cooperation, Ambassador Mark Brzezinski, executive director of the U.S. government's Arctic Executive Steering Committee, told *Eos*.

"We needed a process for dealing collectively with the looming challenge that the Arctic represents," he said. The Arctic "is a delicate region, not just environmentally, but strategically. No one country can just dictate to everyone else what is needed."

There is now a "global commitment" at the highest level of science in the countries "to emphasize the Arctic as a region for investment in science and for international collaboration in science," added Fran Ulmer, chair of the U.S. Arctic Research Commission, an independent agency based in Arlington, Va., that advises the president and Congress on Arctic research. Ulmer, a U.S. delegation cochair at the meeting, told *Eos* that the ministerial was not a "one-shot deal," with the EU offering to host a follow-on in 2018.



After a 28 September Arctic science ministerial meeting, the United States released the first-ever digital elevation model of the Arctic (ArcticDEM). Above, a shaded-relief rendering of the 8-meter-resolution model overlays a satellite image of Earth's northern region. The gradation from green to white to tan indicates increasing elevation. Patches where the underlying satellite image shows through are areas where, so far, satellite data have not been available or of adequate quality to build the model at that location.

Arctic-Wide Digital Elevation Model

Among the newly announced initiatives and products, the EU will launch a 5-year program to develop an Integrated Arctic Observing System and two projects to understand the impact of the changing Arctic on Northern Hemisphere weather and climate. Also, the U.S. Office of Naval Research will create the Arctic Mobile Observing System, and Finland and the United States will organize an international Arctic science, technology, engineering, and mathematics (STEM) education summit during the 2-year Finnish chairmanship of the Arctic Council that begins in 2017.

In addition, the United States released the first Arctic-wide digital elevation model (DEM)—in essence, a three-dimensional digital map—with land surface resolution of 8 meters. A 2-meter-resolution Arctic DEM is in the works. These products, which result from a collaboration between the National Geospatial-Intelligence Agency and the National Science Foundation, follow the 1 September release of a high-resolution DEM of Alaska.

"Topography is one of the most important data sets for the Earth sciences," Paul Morin, ArcticDEM project lead, told *Eos*. Morin, director of the Polar Geospatial Center at the University of Minnesota in St. Paul, said that the DEM will facilitate calculations of the changing volume of Arctic ice, identify where thawing permafrost is collapsing, and pinpoint coastal erosion.

The Right Priorities

The joint statement from the meeting identified the right priorities for the Arctic, according to Philip Duffy, president and executive director of the Woods Hole Research Center, a think tank in Falmouth, Mass., that works on climate issues. "Short of massive new resources, what can you do that can be more effective than what they have done?" he remarked to *Eos*. Duffy lauded the countries at the table for agreeing to some common priorities, but he noted that "there are parties who are really interested in resource extraction and don't necessarily want to highlight the dangers of climate change."

Brad Ack, senior vice president for oceans at the World Wildlife Fund, told *Eos* that the

meeting shone a spotlight on the need to get better at understanding, predicting, and modeling the critical changes in the Arctic. "We need to increase our level of certainty about these changes to get the kind of policy action that we need in the Arctic and on climate change," he said.

Getting top science advisers to say that Arctic research is a priority for their country "will go a long way," added Robert Rich, executive director of the Arctic Research Consortium of the United States, a nonprofit based in Fairbanks, Alaska. He said the next crucial step is to follow up "with real action and real implementation and real investment" in Arctic research.

The next crucial step is to follow up "with real action and real implementation and real investment" in Arctic research.

Perspective of Arctic Residents

The ministerial will heighten awareness among the general public that people living in the Arctic are seeing dramatic flux from climate change, several Arctic residents, including the mayor of Nome, Alaska, Richard Beneville, told *Eos*. Ellen Inga Turi, a member of the Saami Council, said that rapid changes create greater interest in regional economic development and an increased need and curiosity for Arctic research. Along with that, Turi called for strengthening the science capacity of the Saami people. She added that Saami who share their indigenous knowledge with the outside world "need to be ensured that the property rights will protect our knowledge, and it is not shared in the public domain without the knowledge owners' consent."

The ministerial cooperative research efforts are "groundbreaking," said Stephanie Pfirman, professor of environmental science at Barnard College and Columbia University in New York, N. Y. She coauthored a ministerial briefing paper about climate change and the Arctic. "The changes in the Arctic are dramatic, and the potential for global implications is strong. It is a time when people need to rise to the challenge that is being presented to them."

By **Randy Showstack,** Staff Writer

Seismic Wave Videos Combine Sight and Sound

A new video captures the surface and body waves from the extraordinarily powerful Tohoku earthquake that struck Japan in March 2011. The video (see http://bit.ly/Tohoku-waves) shows the surface and body waves as gold and violet light reverberating through Earth after the magnitude 9.0 quake.

Researchers at the Seismic Sound Lab at Columbia University's Lamont-Doherty Earth Observatory used a computational model to generate the animations. The video's sounds come from eight seismometers around the world that "heard" infrasound caused by the earthquake; video makers raised the sound-wave frequencies into the range of human hearing.

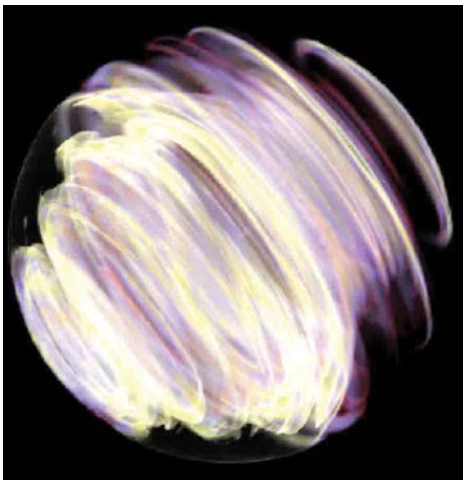
Besides sharpening researchers' perceptions of earthquakes themselves, the visualized seismic waves—modeled in a program originally developed by astrophysicist Matthew Turk to simulate the formation of stars—could also help reveal structures hidden deep within Earth, Ben Holtzman told *Eos*. He leads the Seismic Sound Lab, which is located in Palisades, N.Y.

"From each passage of seismic waves through the Earth, we get a little more information about how to build a seismic tomography model of Earth's interior. It's like a CAT scan of the brain," Holtzman explained.

Pattern Recognition

Even untrained listeners and viewers are adept at interpreting data patterns from sound and light, Holtzman said. So converting data to sound we can hear and light we can see makes it easier for researchers to discover patterns, he explained.

By homing in on these visual and sound patterns, researchers can improve their understanding of the natural phenomena that created the patterns. Specifically for sound, "the human auditory system can perceive a great deal of subtlety in seismic data, including direction, earthquake source, and also the physical nature of the crust near the seismometer," Holtzman said.



Ben Holtzman, Matt Turk, Jason Candler, CC BY-NC-SA (http://bit.ly/ccbyncsa4-0)

A still from a video simulation in which seismic body waves reverberate through Earth after the 2011 Tohoku earthquake in Japan. Translating seismic data into something researchers can see and hear helps them detect patterns in the data.

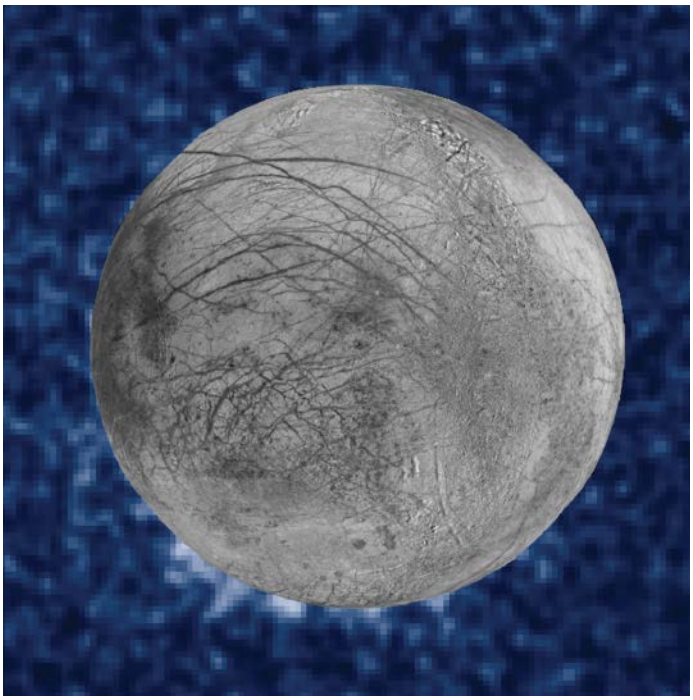
Translating data into sight and sound may also provide the general public with new perspectives, Holtzman added. To this end, starting 19 November, the American Museum of Natural History in New York City will open a special program at the Hayden Planetarium featuring this video and other similar presentations.

"We're taking patterns that are on much longer timescales and spatial scales than we can directly perceive and making them perceivable," said Holtzman. "It blows people's minds."

By **Elizabeth Jacobsen,** Production and Editorial Assistant

Visit this article online at http://bit.ly/wave-videos to see and hear the simulations of the 2011 Tohoku earthquake.

New Images Give More Proof for Europa's Plumes



NASA/ESA/W. Sparks (STScI)/USGS Astrogeology Science Center

A black-and-white composite image of Europa from the 1990s era Galileo mission overlays a recent blue-and-white image by the Hubble Space Telescope. Patches and streaks of white along the lower rim of Europa may indicate the presence of plumes of water vapor, observers said.

What could be towering plumes of water vapor that rise as high as 200 kilometers above the icy surface of Jupiter's moon Europa appear as no more than a few grainy pixels when viewed from Earth. Nonetheless, new images from the Hubble Space Telescope strengthen previous evidence that these otherworldly fountains do exist.

The results add to a long saga of interest in Europa. Ever since the Galileo mission discovered Europa's subsurface ocean in 1996, the intriguing moon has held the attention of both scientists and nonscientists as a space oddity—notably, one that might have the potential for life because of its liquid water.

If these plumes do exist, they would likely open the door to other avenues of investigation, according to Louise Prockter, director of the Lunar and Planetary Institute in Houston, Texas.

"It's potentially great if [the images] do show plumes from Europa…because that means Europa's subsurface is coming to us. We could sample the subsurface material without digging through ice," she said in an interview. Prockter, a former member of the Galileo Europa Mission, was not involved in the new Europa study.

Taking a Different View

The team of scientists, led by William Sparks, a researcher at the Space Telescope Science Institute in Baltimore, Md., used a novel method to acquire an independent corroboration of the plumes that they say is statistically significant.

The plumes were discovered by Lorenz Roth and his coauthors in 2012 when they surveyed a silhouette of Europa against the background of space for spectral lines of hydrogen and oxygen—indicators of water (see http://bit.ly/2012-plumes). Sparks and his colleagues, however, made their observations as Europa passed in front of its mother planet Jupiter, as Sparks explained at a late September press conference.

Exoplanet discoverers commonly use this method, called transit photometry, to find their quarry against the backdrop of the star it orbits. The technique relies on a simple principle: When an object moves in front of a light source, it blocks out part of that light. The amount of this occlusion can tell observers about the exoplanet, in much the same way that a shadow can tell them about the object that cast it.

Here the task was slightly different. Sparks and his team used Jupiter as a light source but went beyond just detecting dimmed light. Instead, Jupiter's glow provided a sufficiently smooth background against which potential plumes from Europa could be viewed.

The team took its photos of Europa's transit of Jupiter in 2014, but processing them to achieve adequate resolution to spot the plumes took months and months. By using a method different from that used for the original discovery, Sparks and his team gave further credence to the possibility that the plumes exist. They published their findings in the *Astrophysical Journal* on 29 September (see http://bit.ly/ApJ-29Sept).

"These are different approaches, but they complement each other," senior Hubble project scientist Jennifer Wiseman said during the press conference. Wiseman did not participate in the research but served as the transit observers' Hubble science expert.

Three of the 10 images the team made show signs of plumes, all in the same region. Still, Sparks urged caution, warning that the result was not 100% verifiable, in part because Hubble is at its technological limits and lacks the capacity to observe in greater resolution.

But most scientists are in agreement that at the very least, the results are cause for optimism. "Now an independent group using an independent technique seemed to have detected the same thing in more or less the same place," said Francis Nimmo, a professor at the University of California, Santa Cruz, and a collaborator on the first sightings in 2012.

Uncovering Mysteries

If Europa's plumes are really there, they could potentially reveal the secrets of the subsurface ocean to which they may be connected. They could also possibly help expand scientists' understanding of how planets, and icy satellites in particular, form and continue to exist, added Nimmo, an editor of AGU's *Journal of Geophysical Research: Planets.*

Enceladus, a moon of Saturn, had its own plumes confirmed about a decade ago. "What it's telling you is it's not too hard for icy bodies to hang on to their oceans," he said. "Enceladus is tiny, yet somehow, it has an ocean and that ocean has presumably lasted for billions of years."

Although NASA plans to send a spacecraft to Europa in the next decade and the James Webb Space Telescope promises better views of the moon after it becomes operational in 2018, scientists are relying until then on the Hubble Space Telescope for their sharpest views of the ice-encrusted moon.

"We can't fly a mission up close, so the next best thing is to use the Hubble Space Telescope to study Europa from afar," said the director of NASA's Astrophysics Division, Paul Hertz, at the press conference.

By **Daniel Garisto,** Science Writing Intern

Cubans, Americans Bridge a Scientific Rift

Simon Matzinger, CC BY 2.0 (http://bit.ly/ccby2-0)

A United Nations Educational, Scientific and Cultural Organization World Heritage site, the Viñales Valley in Cuba has a rich geologic history. The mountains are part of the fold and thrust belts of the Guaniguanico Terrane, and the area is known for its traditional agricultural techniques.

During a major geology conference in Denver this fall, scientists at the "Geologic Evolution of Cuba" session found themselves faced with four different scenarios for the tectonic evolution of the Caribbean region. Although the session encompassed a fairly small, specialized research community, the presentations—all of them mature hypotheses—seemed to come as fresh news to many of the geologists attending the talks.

How could scientists in the same narrow field be so out of touch with each other's research? Manuel Antonio Iturralde Vinent, a past president of the Cuban Geological Society, knew all too well what was going on.

As one of the organizers of the Cuban geology session at the Geological Society of America's annual meeting, he had helped bring about one of the few official gatherings of Cuban and American geologists since the United States' embargo of Cuba began in 1960. Although the embargo had not completely severed scientific cooperation between the countries, it greatly hampered communication and collaboration, and both countries lost out.

Because they were not able to work in Cuba for those many decades, "the North American scientists were not involved in the development of what was happening in Cuba," Iturralde Vinent explained. During this distant relationship, key details were literally lost in translation or never shared at all, and this history of spotty communication played out at the conference.

Attendees at the 28 September session (see http://bit.ly/CubaGeo-GSA) seemed eager to make up for lost time. Six Cubans made the trip, including four currently based on the island. Talks took place in both English and Spanish. The session offered geologists the opportunity to exchange ideas and build collaborations for the future, exactly the sort of interactions that have been missing for so long.

"There was a lot of interaction, and I think that's the point of this meeting, which was totally fulfilled," Iturralde Vinent said.

The Importance of Cuban Geology

Bob Stern, a geoscientist at the University of Texas at Dallas and another mastermind behind the session, said that Cuba offers researchers one of the world's most remarkable examples of plate tectonics in action. Almost every important geological theory for explaining the origins and evolution of the planet has been tested in Cuba, added Iturralde Vinent, but those investigations had taken place in isolation from many tectonics experts in North America.

Beyond its theoretical importance, the tectonic development of the Caribbean has practical ramifications. The tectonic history of the region dictates the location of ore deposits and potential hazards, Stern said, and an improved theory could potentially identify future earthquake threats and mineral deposits. The 2010 Haiti earthquake, for instance, occurred along the strike-slip boundary between the Caribbean and North American Plates.

Cuba contains many known resources currently available for development, including ore deposits and oil and gas reserves in the Gulf of Mexico. Home to pristine coral reefs and karst—the "last unspoiled place in the Americas," as Stern put it—the largely undeveloped landscape also provides a good platform for studying hurricanes and climate change.

Building Toward the Future

As political relations continue to thaw between the United States and Cuba, there are signs that collaboration will become easier in the coming years. The American Association for the Advancement of Science has already taken steps to advance scientific cooperation, and other scientific organizations are following suit.

Funding for Cuba projects remains a concern, although a representative from the National Science Foundation told the session that the agency is now accepting proposals for work in Cuba. However, these proposals must also include a white paper detailing how the research to be carried out aligns with U.S. foreign policy.

Whatever challenges may remain did not seem to faze the scientists. Planning had already begun for a Cuba field workshop, and there was talk of American scientists attending the Earth Sciences Convention and Fair next year in Havana.

Amid a festive atmosphere at the end of the session—Havana Club rum flowed, passed around in small paper cups—the geologists reflected on the importance of this year's meeting and expressed excitement for the future.

"It was a great experience for us all," said Yamirka Rojas-Agramonte, a Cuban scientist based in Germany and the supplier of the rum. After years of indoctrination about Americans, the trip was a positive surprise, both personally and scientifically, she noted.

"We are not just planning the future, but starting, talking, and creating the future right now," Iturralde Vinent said.

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

State Budgets, Geological Surveys, and the New Reality

iStock.com/underworld1111

Downsized state budgets mean that state geological surveys need to explore new approaches to survive.

In April, the Arizona legislature passed a bill that would zero out the budget of the Arizona Geological Survey (AGS), an independent state agency, and transfer its duties to the University of Arizona. By May, Arizona governor Doug Ducey had signed the bill into law.

The result: The AGS had a matter of weeks to relocate and negotiate for substantially reduced one-time funding from the university with no certainty of long-term appropriated support. Many AGS staff members, uncertain over their future, left to find new jobs. Those who remained faced a hurried relocation and the disposal and transport of data, records, and samples assigned to AGS's care.

The AGS is hardly alone. Across the nation, state geological surveys are facing dramatic budget shortfalls, dwindling resources, and shrinking staff. The survival of state surveys depends on creative funding sources and adaptable plans. Fundamentally—and this will be difficult—we must be willing to take risks, step into political arenas, and fight for the work that we do.

Shrinking Surveys: A Nationwide Trend

The AGS is not the first to be summarily relocated with a dramatic impact on its staff. In 2013 the Colorado Geological Survey was moved out of the state's Division of Natural Resources and into the Colorado School of Mines.

The AGS's move is not the first time that a state geological survey has faced significantly reduced financial support. This year, the Illinois State Geological Survey, along with its sister surveys at the Prairie Research Institute at the University of Illinois, was hit with a 20% budget cut. In 2011 the Nevada Bureau of Mines and Geology, part of the University of Nevada, Reno, absorbed a 50% budget reduction.

These are not outliers. In the past decade, at least 14 state geological surveys have gone through significant budgetary reductions, major structural reorganizations, or both; depending on your definition of "significant budgetary reductions," that number could be even higher. For example, my own state survey in Kansas has undergone smaller but regular budget cuts that have been passed along to us through our host institution, the University of Kansas.

Each of these stories is slightly different. Circumstances vary from state to state. But the result is the same: State geological surveys face existential threats, no matter if they are part of a university or a state agency, whether they are big or small. If you think it can't happen in your state, think again.

Are State Surveys Being Targeted?

On the basis of my review, I do not believe that the geosciences have been targeted for especially harsh treatment.

Budgets in many state governments have been cut over the past few years. A quick Google search turns up state budget problems from Connecticut to Alaska. A number of states, including Kansas, are struggling with revenue shortfalls, some caused by tax cuts, some due to lower energy prices in states that rely on oil and gas revenue.

Either way, it does not appear that state surveys are being singled out for cuts or relocation. But neither are they being spared. The geosciences do not seem to be any more valued than other components of state government. And they sometimes appear to be valued less.

To geoscientists, this lack of budgetary priority is deeply troubling. State geological surveys focus on research and service of direct relevance to the states they serve. In the midcontinent, state geological surveys provide information that is critical to understanding and managing the High Plains/Ogallala aquifer. In energy-producing states, state geological surveys provide data and collect samples that are important to oil and gas exploration. My own state geological survey has been heavily involved in studying and responding to induced seismicity. The Florida Geological Survey has been a leader in dealing with sinkhole issues. On the West Coast, state geological surveys are addressing geologic hazards such as seismicity, tsunamis, and landslides.

How Do We Get States to Recognize the Value of Surveys?

State geological surveys know the importance of explaining their relevance and impact, especially to the economic life of their states and to the general public. They know that communication is especially important in states that rely heavily on geologic resources or face significant geologic hazards.

Yet explaining our relevance is not enough. It appears to me, at least, that survival demands that we become more politically involved, making sure that decision makers know, understand, and are willing to argue for the work that we do.

This is not a role that comes naturally to scientists, but we have to make sure that decision makers, especially legislators, appreciate our work. By the time politicians question our value, it is already too late.

The worst time to develop a relationship is when you need it. Instead, proactively developing political support is central to our survival. At the Kansas Geological Survey, for example, we operate an annual multiday field

Rick Miller, KGS

Kansas Geological Survey (KGS) staff members Brett Bennett and Shelby Peterie install a seismograph station in Sumner County as part of a KGS study of induced seismicity in south central Kansas.

trip for legislators and other decision makers, exposing them to the state's natural resource issues and making clear the role we play in learning about those issues.

However, many geological surveys are not allowed to make direct contact with legislators and must rely heavily on the political support of their users. And that may not be enough.

State government is reinventing itself in all sorts of ways, right before our eyes, and that means state surveys must too. They must be more agile, develop diversified sources of funding, and take on new roles and responsibilities.

Some state surveys have done that and come out the other end of this process as even stronger, more vital organizations. But the change can be wrenching, the challenge considerable.

And it doesn't always work. The AGS had strong support from industry groups in mining, real estate, and home building, but the desire to reduce state government overrode their concerns.

Political Engagement Will Be Key

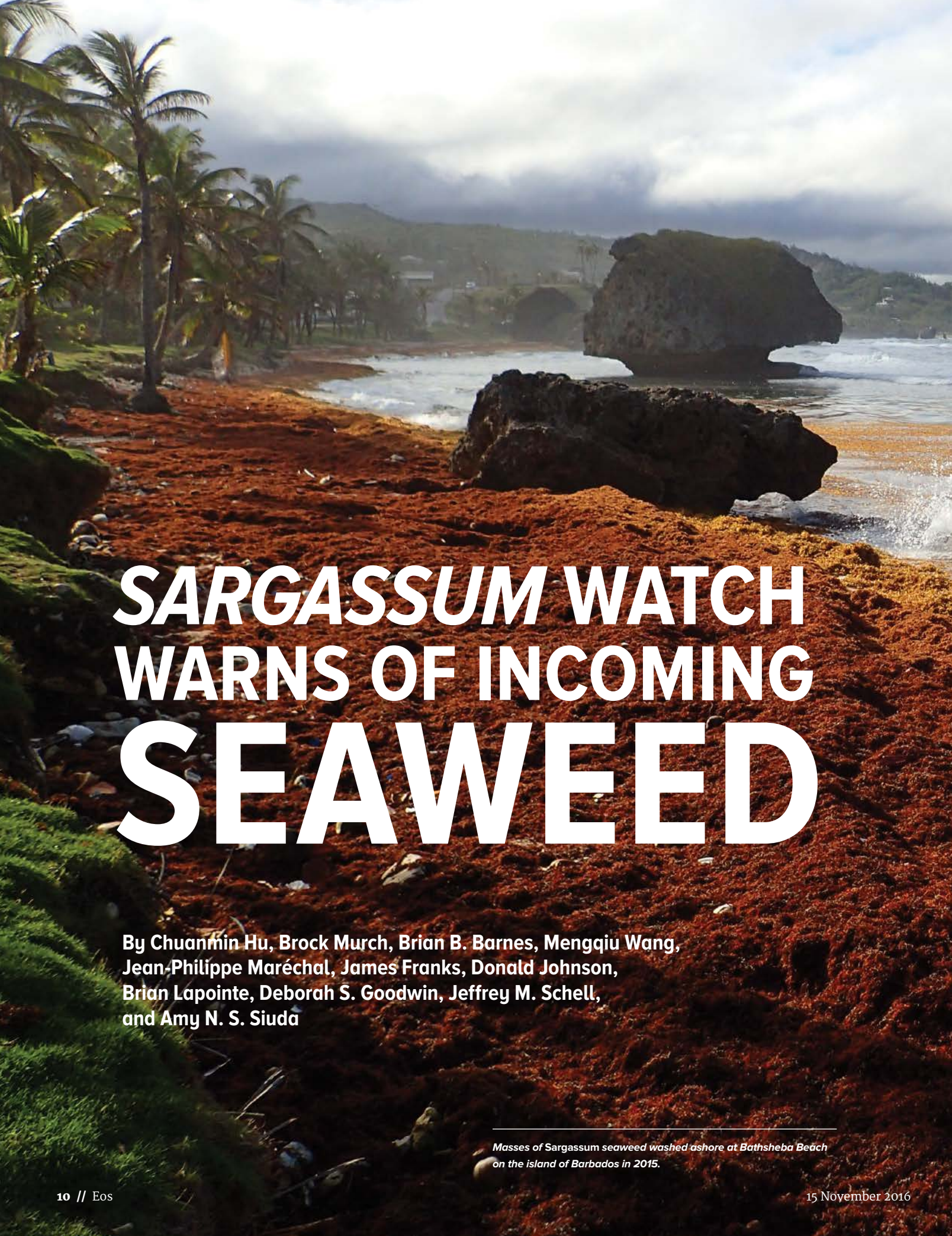
Perhaps more important, what has happened to some state geological surveys should serve as notice to the entire geoscience community. The larger world, including the political world, needs to know, understand, and appreciate what we do. We know our centrality to society and the economy. I'm not sure that society and its leaders know it.

We already do much to explain our work and contributions, but we need to do more and do it more effectively. We need to think harder about our place in the world and our willingness to engage in the political process—locally, statewide, nationally—that we may find distasteful. We need to speak the language that politicians understand, not the technical jargon that we are comfortable with.

Perhaps most important, we need to walk the fine line of entering the public arena and making ourselves heard, without losing our scientific credibility. The days of doing science in isolation are long gone. Climate change, fracking, water shortages, energy exploration, minerals, landslides, earthquakes (induced and otherwise)—these are huge topics that are in our wheelhouse. We know that. Lots of people don't.

We should be long past wake-up calls. Let's make sure we don't get another one.

By **Rex Buchanan,** Director Emeritus, Kansas Geological Survey, University of Kansas, Lawrence; email: rex@kgs.ku.edu



SARGASSUM WATCH WARNS OF INCOMING SEAWEED

By Chuanmin Hu, Brock Murch, Brian B. Barnes, Mengqiu Wang, Jean-Philippe Maréchal, James Franks, Donald Johnson, Brian Lapointe, Deborah S. Goodwin, Jeffrey M. Schell, and Amy N. S. Siuda

Masses of Sargassum *seaweed washed ashore at Bathsheba Beach on the island of Barbados in 2015.*

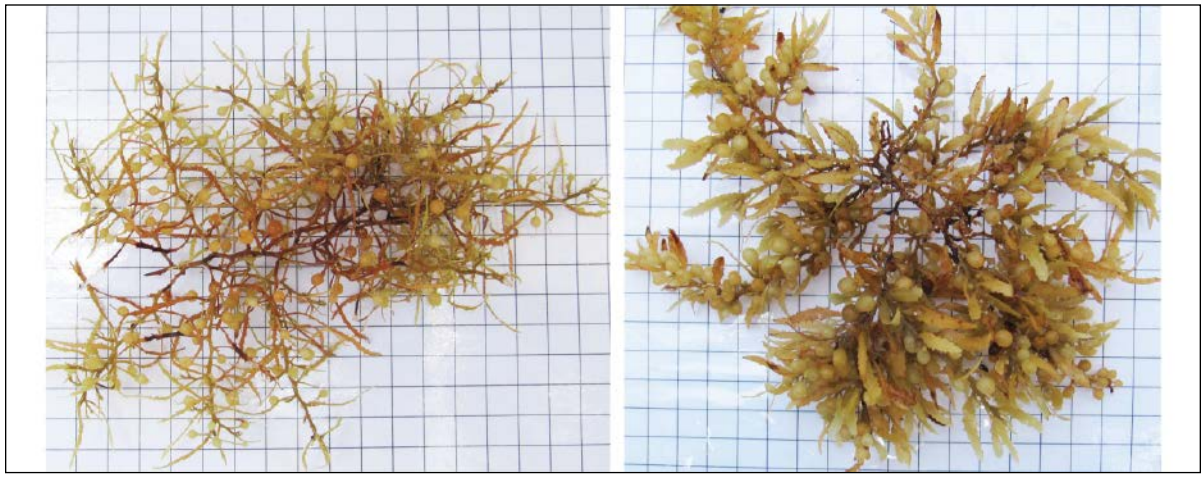
One summer morning in 2011, the smell of rotting eggs marred "another day in paradise" for residents of the eastern Caribbean nations. The distinctive smell signaled the beaching of mountains of *Sargassum* seaweed on their shores.

The unprecedented event represented just the beginning of an annually recurring and growing region-wide phenomenon. The largest quantity and frequency increase of *Sargassum* beachings to date occurred in 2015 (see http://wapo.st/2d84tLO); there have been fewer beachings so far in 2016). The algal masses covered popular tourist beaches, filled bays, and caused numerous environmental and economic problems.

The *Sargassum* beaching events in the Caribbean, West Africa, and other regions have received wide media attention (see http://bit.ly/Sargassum-beaching), prompting action by regional governmental agencies and environmental groups seeking to understand this new phenomenon. In 2015, excessive *Sargassum* beachings along the western Caribbean coast threatened the coastal economy in Mexico—the incidents became a cabinet-level crisis, and the Mexican Navy was called to take action (see http://wapo.st/2dfQWVx).

Long-term predictions of *Sargassum* blooms and beaching events will require a thorough biological and ecological understanding, as well as integration of observations of oceanographic and climate data into forecasting models. On the other hand, short-term predictions that rely on numerical models and timely information of the location and quantity of *Sargassum* at sea are vital for field survey planning

Hazel Oxenford



A. N. S. Siuda

(left) Sargassum natans *and (right)* Sargassum fluitans. *Each square represents 1 square centimeter.*

and short-term management decisions, as well as for tourism and other business development. Here we highlight recent activities regarding *Sargassum* observations. We also introduce a prototype integrated *Sargassum* Watch System to monitor and track *Sargassum* in near-real time using satellite imagery and numerical models and emphasize targeted research and monitoring needs.

Sargassum as a Habitat and a Marine Resource

Sargassum natans and *Sargassum fluitans* are mostly found in the Intra-Americas Sea (including the Gulf of Mexico and the Caribbean) and Atlantic Ocean. Unlike the more than 350 taxonomically identified ocean bottom-dwelling (benthic) *Sargassum* species worldwide, these are the only two holopelagic species of the *Sargassum* family, meaning that they spend their entire life cycle in surface water.

The benthic species reproduce sexually, but *S. natans* and *S. fluitans* reproduce solely by vegetative fragmentation. Generally, *Sargassum* seaweed are not differentiated into true leaves, stems, and roots; rather, they have tough, leathery, densely branched thalli, composed of axes, blades, and air bladders. Both *S. natans* and *S. fluitans* serve as unique and important habitats for a diverse group of marine animals, providing food, shade, and shelter to fish, shrimp, crabs, and turtles [*Witherington et al.*, 2012; *Lapointe et al.*, 2014].

Sargassum in the Atlantic Ocean is regarded as the "golden floating rainforest" by the Sargasso Sea Alliance [*Laffoley et al.*, 2011]. The Gulf Coast Research Laboratory has identified 139 species of fish associated with *Sargassum*, which also represents a marine resource for food and fuel. *Sargassum* serves as fertilizer for the sand dune plant ecosystems that help protect shoreline stability and promote biodiversity of seashore birds, crabs, and other small invertebrates.

A Beach Nuisance

Although it's an ecosystem boon to the open ocean, excessive amounts of *Sargassum* on beaches in populated areas represent a nuisance and must be physically removed (see http://bit.ly/Sargassum-removal).

Sargassum beaching events are new to many residents in the southern Caribbean, West Africa, and Brazil but are well known in the northern Gulf of Mexico (especially Texas), the Sargasso Sea, and the northern Caribbean islands. *Sargassum* emits hydrogen sulfide gas as it decomposes onshore, releasing an odor like rotting eggs. This decomposition causes many environmental problems by attracting insects, smothering turtle nesting sites, and killing sea turtles and fish [*Feagin and Williams*, 2010].

Sargassum beaching events cause economic problems as well [*Franks et al.*, 2011]. A survey of 424 private companies by the Chamber of Commerce of Guadeloupe estimated that diminished tourism caused an economic loss of $5.5 million dollars for the first half of 2015. However, despite a handful of studies, the driving factors leading to recent increases in beaching events remain largely unknown. Addressing these unknowns will require coordinated research, but increased beaching events call for immediate and effective monitoring and forecasting systems.

Sargassum Watch from Space

The University of South Florida's (USF) Optical Oceanography Laboratory (OOL) has been working on a virtual antenna system (VAS), which downloads and processes raw satellite data into customized images, since 2010. These images are distributed through a Web portal within 4–6 hours of the satellite overpass [*Hu et al.*, 2014], providing the infrastructure to implement a *Sargassum* Watch System (SaWS; http://bit.ly/Sargassum-watch).

Specifically, the USF OOL has used data from the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra and Aqua satellites to examine the red edge reflectance (enhanced reflectance in the near infrared) of floating vegetation, using a floating algae index (FAI) [*Hu*, 2009] or alternative FAI (AFAI) [*Wang and Hu*, 2016]. These indices are similar to the maximum chlorophyll index used for the first time by *Gower et al.* [2006] to detect *Sargassum* from space.

Because floating vegetation has enhanced reflectance in the near-infrared spectral bands, these products clearly show *Sargassum* aggregations as elongated slicks in

AFAI imagery that can be easily identified even with an untrained eye. The system covers the Intra-Americas Sea in subdivided regions (Figure 1), with the capacity to extend as far as West Africa and Brazil.

Tracking *Sargassum* Rafts

In addition to the AFAI imagery, SaWS also uses nightly updated surface current data from the Hybrid Coordinate Ocean Model (HYCOM), via the VAS. All data products (AFAI, HYCOM currents, sea surface temperature, and surface color patterns, among others) can be displayed in Google Earth™ mapping service with a simple mouse click, thereby facilitating visualization and navigation.

Within Google Earth™, once a *Sargassum* raft is identified, its latitude and longitude, combined with current speed and direction near the raft, can be used to predict the movement of the raft and a possible beaching time—in essence, forming an early warning system. This method has actually been used by a company called Nova Blue Environment, which has released *Sargassum* beaching risk alerts every week to local authorities in Guadeloupe (French West Indies) since May 2014 (see http://bit.ly/Nova-Blue). Several alerts were correlated to actual *Sargassum* beaching sites identified by helicopter surveys.

Thanks to the watch system, many local groups have been able to monitor and track large *Sargassum* aggregations on an almost daily basis. In Puerto Rico, researchers have been using it routinely to detect *Sargassum* aggregations and conduct research, finding excellent accuracy of the system when tracking large rafts and ocean eddies (J. Morell, University of Puerto Rico, personal communication, 2015).

Other *Sargassum* Tracking Remote Sensing Methods

The same red edge concept used on MODIS has been extended to Landsat sensors. Unlike MODIS's daily revisit cycle, Landsat passes a given region every 16 days. However, Landsat sensors have much higher (30-meter) resolution than MODIS, which can reveal small aggregations that are invisible in the 1-kilometer-resolution MODIS imagery. Currently, SaWS produces high-resolution FAI imagery from Landsat 8 in several selected regions in the Caribbean. Similarly, Landsat instruments have been used to provide early alerts on possible *Sargassum* beaching events along the Texas coast through a *Sargassum* Early Advisory System (SEAS) [*Webster and Linton*, 2013].

Likewise, local groups have used aircraft to assess the extent and severity of *Sargassum* beachings in Guadeloupe (F. Mazéas and M. Laurent, DEAL Guadeloupe, personal communication, 2015). Between 2011 and 2015, eight 2-hour Civil Security helicopter flights were completed to document the most affected areas of Guadeloupe Island, with a comprehensive report issued from each airborne survey.

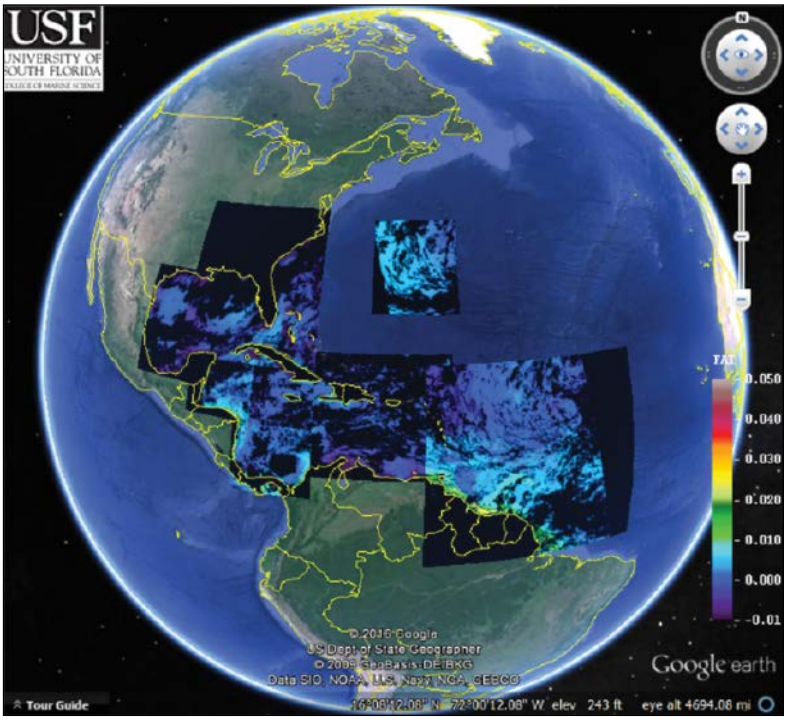
A combination of the various systems may maximize the value of both spaceborne and airborne observations through coordinated efforts.

Sargassum Watch from Ships

Observing pelagic *Sargassum* is not new—it started with the voyage of Columbus and other early explorers and became a quantitative science almost a century ago [*Parr*, 1939]. Shipboard studies in the 1980s and 1990s were the first to suggest that with a reproduction rate that doubles or triples biomass every 25 days [*Lapointe et al.*, 2014] this vegetation was more productive than previously thought [*Lapointe*, 1995]. Systematic *Sargassum* surveys have been conducted by the Sea Education Association since the 1970s during annually repeated 6-week cruises, resulting in biomass per unit area data for more than 7000 net tows between 1992 and 2015.

Data synthesis is still under way, but preliminary results show distinct distribution patterns across time and space for each *Sargassum* species, as well as proliferation of a previously rare morphological form (*Sargassum natans VIII*) and decreased abundance and diversity of associated fauna during the 2015 Caribbean inundation event [*Schell et al.*, 2015].

Other researchers and volunteers have also made field observations, including *Sargassum* beaching times and locations. The Gulf Coast Research Laboratory manages a Web portal specifically designed for ad hoc reporting of *Sargassum* sightings made during at-sea encounters or



USF OOL, NASA, NOAA

Fig. 1. Near-real-time SaWS at the University of South Florida covers the Intra-Americas Sea with NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) and VIIRS. Selected regions are covered with Landsat 8.

coastal observations (see http://bit.ly/Sargassum-reporting). Such information complements that obtained from systematic ship surveys to provide a more complete picture of *Sargassum* distributions.

Research Needs

Both remote sensing and ship surveys may provide information on the distribution, relative abundance, and long-term trend of this important marine habitat. *Wang and Hu* [2016] used MODIS data to provide a long-term time series for the central west Atlantic region (Figure 2) that showed dramatic increases in *Sargassum* abundance from 2013 to 2015. However, a full understanding of *Sargassum* biology and ecology [e.g., *Carpenter and Cox*, 1974; *Lapointe*, 1995] requires efforts far beyond those outlined here.

For example, how much total biomass is in a certain region? What is the chlorophyll, carbon, nitrogen, phosphorus, and iron content of this biomass? How does the associated fauna community vary between geographic regions and *Sargassum* species or morphological forms? How does *Sargassum* influence the oceanic carbon and nutrient cycles? What environmental factors drive its productivity, growth, and distribution? How does *Sargassum* respond to such global changes as increasing reactive nitrogen and carbon dioxide? How do ocean warming and changes in ocean currents affect *Sargassum*?

Without addressing these research questions, it is difficult to explain the sudden increases in tropical Atlantic and Caribbean *Sargassum* blooms after 2011. In situ observations of abundant *S. natans VIII* suggest that recent *Sargassum* blooms in the Caribbean did not originate from the Sargasso Sea [*Schell et al.*, 2015]. Results from *Gower et al.* [2013] and our preliminary analysis also indicate a tropical Atlantic origin. However, we still don't know why the blooms tend to originate there.

Furthermore, even though *Sargassum* biomass per area may be comparable to that of water column phytoplankton, *Sargassum* has generally been considered insignificant to marine productivity and is rarely addressed in oceanic biogeochemical studies. Clearly, because only a handful of studies focusing on its biogeochemistry and ecology are available, more coordinated research is urgently needed. The unprecedented beaching events in recent years may promote opportunities to conduct dedicated research to fully understand this ecologically and economically important marine algae.

Long-Term Perspective

Massive *Sargassum* beaching events are an entirely new phenomenon for many residents in the Caribbean and West Africa. The seaweed has caused many negative effects, but at the same time it may also provide raw materials for commercial use. Local residents need a system to forecast *Sargassum* blooms and *Sargassum* beaching in both the long and short terms. This is essential for investment decisions in cleanup strategies and technologies and in development of value-added commercial products and manufacturing infrastructure.

At present, no one can predict the long-term trend of *Sargassum* blooms, but it is unlikely that the beaching events of the past 5 years will stop (see http://bit.ly/Sargassum-prediction). Continuous and improved monitoring and forecasting systems at regional and local scales are necessary for management and decision making. The Visible Infrared Imaging Radiometer Suite (VIIRS, 2012 to present) is equipped with spectral bands similar to those of MODIS, and currently, VAS generates and distributes VIIRS AFAI imagery in the same manner as MODIS. NASA and the European Space Agency are also planning several advanced ocean color missions (Plankton, Aerosol, Cloud, Ocean Ecosystem (PACE), Geostationary Coastal and Air Pollution Events (GEO-CAPE), Sentinel-3) with improved spectral and temporal resolutions to enhance SaWS capabilities. Additionally, high-resolution sensors such as the Multi-Spectral Instrument (MSI; 10–60 meters) on Sentinel-2 (2015 to present) and follow-on sensors can also be used to track small *Sargassum* aggregations, similar to the use of the Landsat 8 Operational Land Imager (OLI).

Various governmental agencies are taking actions to facilitate research, monitoring, and forecasting. For example, a Gulf Coast *Sargassum* Symposium in April 2015 (see http://bit.ly/Sargassum-symposium) brought together various stakeholders concerned with the effects of *Sargassum* on coastal states of the Gulf of Mexico to discuss the current status and future directions in *Sargassum* research, monitoring, and forecasting. The Predicting *Sargassum* Blooms (PSB-CARIB) project has been recently funded by the French Environment and Energy Management Agency, Regional Council Martinique, and Direction de L'environnement de L'aménagement et du Logement Guadeloupe to study *Sargassum* blooms in the central Atlantic and the Caribbean. Similar projects in French Guiana, Mexico, and other countries or regions are also under way.

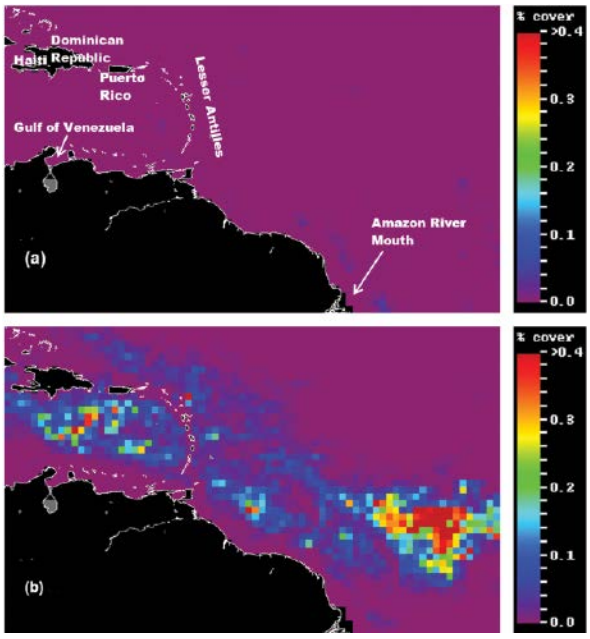


Fig. 2. Mean percentage cover of Sargassum *in the central west Atlantic and eastern Caribbean (0°–23°N, 75°–38°W) for (a) July 2013 and (b) July 2015, determined from MODIS observations using an objective method [*Wang and Hu, *2016]. The color scale indicates percentage of surface coverage (areal density). The integrated pure* Sargassum *coverage for July 2015 was estimated to be more than 3000 square kilometers.*

SaWS received direct support from NASA to improve and enhance its capacity for near-real-time monitoring and tracking of *Sargassum* blooms. Further, NASA's Jet Propulsion Laboratory has partnered with the Sargasso Sea Commission to develop a prototype data portal to compile all relevant data (e.g., *Sargassum* location and abundance, sea surface temperature, sea surface height, ocean currents, winds), which will help us understand spatial and temporal *Sargassum* distributions.

Collaboration and Coordination

With increased funding and research activities to study *Sargassum* ecology, biogeochemistry, and how *Sargassum* responds to environmental changes, our knowledge of *Sargassum* and our short- and long-term predictive capabilities are expected to improve significantly in the near future. At the same time, better collaboration and coordination will help research and monitoring efforts to develop long- and short-term forecasting. Moreover, improved public access to data products will assist with management decisions and economic development.

Acknowledgments

Most of the satellite-based *Sargassum* watch has been supported by NASA through its Ocean Biology and Biogeochemistry program and Gulf of Mexico Program. We thank NASA, the National Oceanic and Atmospheric Administration's National Environmental Satellite, Data, and Information Service, and the U.S. Geological Survey for providing MODIS, VIIRS, and Landsat data. We also thank the HYCOM consortium for providing numerically modeled ocean currents. We are grateful to three anonymous reviewers, the editor of *Eos*, and the staff members of the editorial office for helping to improve the presentation of this article.

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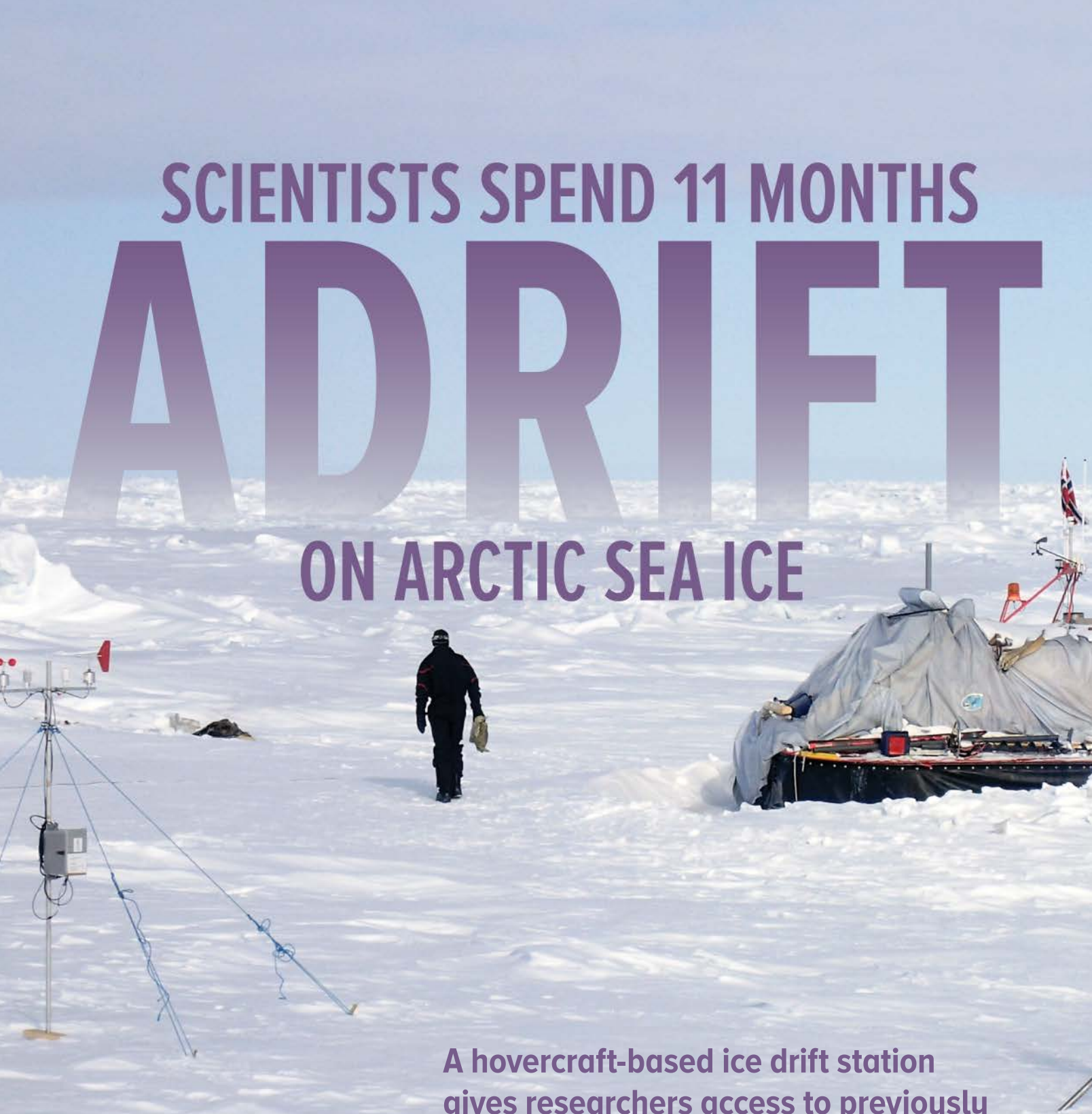
Author Information

Chuanmin Hu, Brock Murch, Brian B. Barnes, and **Mengqiu Wang,** College of Marine Science, University of South Florida, St. Petersburg; email: huc@usf.edu; **Jean-Philippe Maréchal,** Nova Blue Environment, Martinique, French West Indies; **James Franks** and **Donald Johnson,** Gulf Coast Research Laboratory, University of Southern Mississippi, Ocean Springs; **Brian Lapointe,** Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce; and **Deborah S. Goodwin, Jeffrey M. Schell,** and **Amy N. S. Siuda,** Sea Education Association, Woods Hole, Mass.

For a map of ship-based survey sites and examples of how the *Sargassum* Watch System uses satellite imagery to track *Sargassum* rafts, visit this article online at **http://bit.ly/Eos-Sargassum-watch**.

SCIENTISTS SPEND 11 MONTHS ADRIFT ON ARCTIC SEA ICE



A hovercraft-based ice drift station gives researchers access to previously inaccessible regions of the changing Arctic sea ice cover off the coast of Greenland.

By Yngve Kristoffersen, Audun Tholfsen, John K. Hall, and Ruediger Stein

Audun Tholfsen

The Fram-2014/15 ice camp on 6 May 2015. The weather station is visible on the left, and the radiation flux instruments are in the foreground (right).

Imagine spending the winter camping near the North Pole, drifting on a raft of sea ice—temperatures below −30°C, 5 months of almost total darkness, and roaring sounds of crushing ice nearby (but you don't know exactly where).

On 30 August 2014, our two-man crew prepared to do just that. For the next 11.5 months, the sea ice and a hovercraft would be their home. Our goal was to obtain ocean sediments for studies of the Mesozoic and Cenozoic history of Arctic Ocean from 252 million years ago until the present time.

The venture is the product of cooperation between Norway and Germany, under the direction of the Nansen Environmental and Remote Sensing Center, located in Bergen, Norway. Our project, the Fram-2014/15 (see http://bit.ly/Fram-2014-15)—these nations' first

ice drift in the central Arctic Ocean in more than 100 years—shows that scientifically successful mobile ice drift stations can be established in the Arctic at low cost.

A Journey into the Unknown

Our scientists started from the Makarov Basin near the foot of the Lomonosov Ridge off the coast of northeast Greenland [*Stein*, 2015]. The German icebreaker *Polarstern* deployed our ice drift station, the Fram–2014/15, with its 18 metric tons (20 tons) of equipment, supplies, and fuel, onto a base of sea ice about 1.1 meters thick.

Our eventual destination was the Alpha Ridge, where the U.S. ice drift station T-3 atop an iceberg named Fletcher's Ice Island had taken core samples during the late 1960s (Figure 1). Canada's Expedition to Study the Alpha Ridge (CESAR) drift also sampled there in 1983. We were particularly interested in revisiting these sites, where scientists had collected 50- to 70-million-year-old sediments.

Unfortunately, ice conditions proved to be too difficult for the icebreaker to take us to the Alpha Ridge, so we decided on a deployment location upstream of prospective areas of exposed deeper strata on the slope of the Lomonosov Ridge, about 20 kilometers away [*Jokat et al.*, 1992].

Setting Up a Hovercraft-Based Research Station

Constructing a temporary station on drifting sea ice provides a means for scientists to make in-person observations over a full annual cycle, and it provides them with access to areas of the Arctic Ocean presently out of reach for icebreaker surveys.

The icebreaker brought along the hovercraft R/V *Sabvabaa* (an Inuit name meaning "flows swiftly over it") to assist in this endeavor (Figure 2). The 11-meter-long hovercraft, with its 2.2-ton payload, is outfitted as a polar research platform (see http://www.polarhovercraft.no). It is capable of carrying out many of the same measurements as a modern deep-sea research vessel [*Kristoffersen and Hall*, 2014].

The hovercraft platform provided living quarters, data logging, and communication facilities. An enclosed workspace was set up and connected to the hovercraft. This workspace contained a "hydrohole," an access hole through the ice for the air gun (for seismic reflection measurements) and winch operations for lowering the sediment corer, rock dredge, camera sled, and conductivity-temperature-depth (CTD) instrument.

A Mobile Platform

Ice activity forced us to relocate our station four times. Twice, the camp area was totally disrupted. In one of these incidents, an advancing pressure ridge completely annihilated our camp, and we lost two oceanographic instruments (Figure 3).

Relocation was not onerous, however, thanks to our mobile hovercraft platform (visit http://bit.ly/sabvabaa-hovercraft to see the R/V *Sabvabaa* in operation). The logistic mobility of the hovercraft platform played a key role in reducing the inconvenience of relocating the research station over the 11.5 months it was deployed. This was especially important because the station was managed by a crew of only two people.

Collecting Data in Subzero Temperatures

Once we had the ice station set up, we began taking data. We monitored the annual energy budget at the surface using a weather station and by measuring incoming and outgoing short- and long-wave radiation. Below the ice, we suspended a 300-meter-long chain of thermistors at 10-meter intervals to monitor upward heat transport. We monitored upper ocean currents, down to 500 meters, with an acoustic Doppler current profiler. We used two

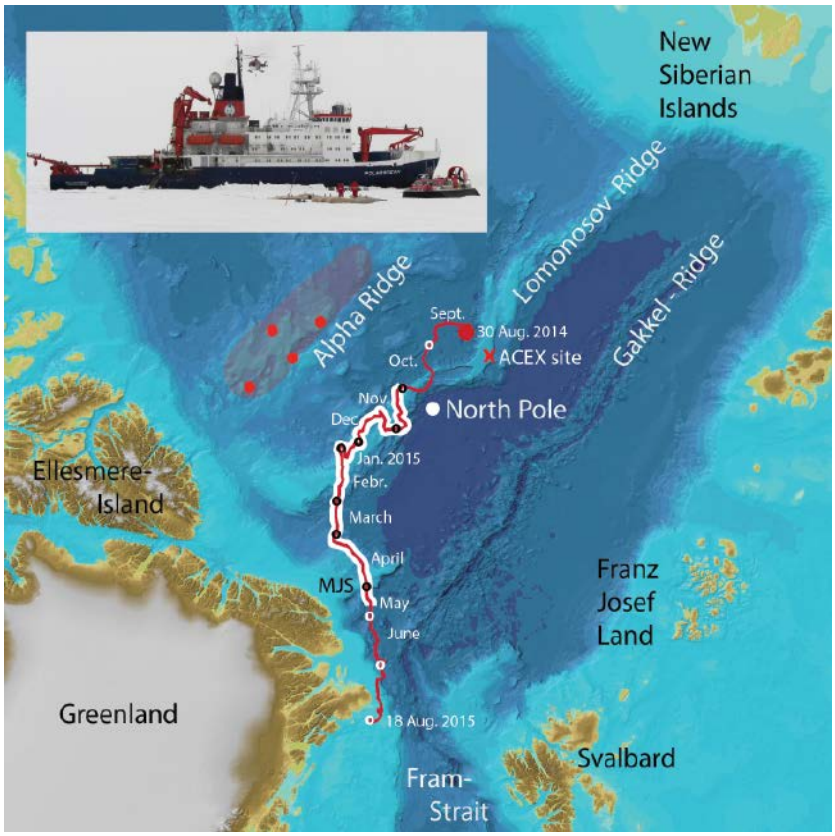


Fig. 1. The drift track of ice drift station Fram-2014/15 (red). The heavy white line shows sections not accessible for geophysical surveys from icebreakers. The inset shows the icebreaker Polarstern *and ice camp deployment in progress. Locations of short cores of Eocene-Campanian age sediments on Alpha Ridge (red dots) are within an area (transparent red) of heavily disturbed seabed [*Kristoffersen et al., *2009]. The location of International Ocean Discovery Program (IODP) scientific drilling by the Arctic Coring Expedition (ACEX) in 2004 [*Moran et al., *2006] is indicated by a red cross. MJS is the Morris Jesup Spur.*

Yngve Kristoffersen

Fig. 2. The hovercraft platform and its capabilities. CTD = conductivity-temperature-depth; EM = electromagnetic ice thickness measurements.

recording current meters suspended at 200 and 800 meters to measure the deeper currents.

The main focus of our marine geophysics and geology measurements involved obtaining 1000 kilometers of single-channel seismic reflection data along the track, penetrating about 1.5 kilometers below the ocean floor, which we successfully achieved. Our goal was to obtain data along as much of the track as possible. We consider 1000 kilometers a great achievement, considering that we operated for 85 days at temperatures below −30°C and 15 days below −40°C.

We had planned to carry out sediment sampling with a hydrostatically boosted sediment corer, but when temperatures remained below −30°C, we were forced to return to a light corer, which recovered 12 short cores, each less than 1 meter long.

We measured ocean depths at the site of the camp and with five autonomous echo sounder buoys placed as far as 6 kilometers away from the camp. To explore the seabed, we used a towed camera sled at 17 locations in water depths ranging from 800 to 2650 meters.

Expedition Produces Results

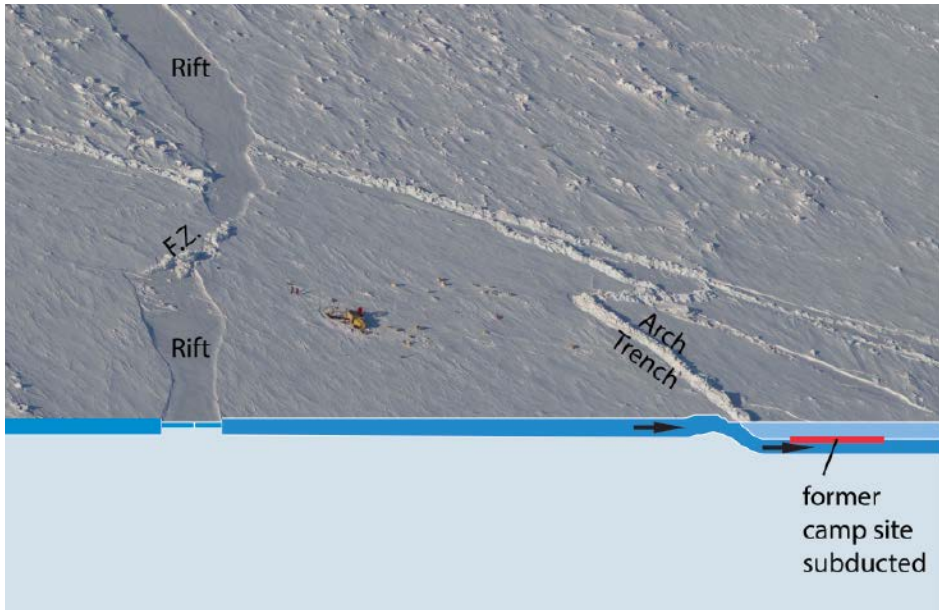
The expedition obtained new data relevant to a number of important aspects of Arctic science. We established the areal extent of an unconformity, or break in the sedimentary record, that extends across the top of the Lomonosov Ridge and jumps from Eocene to Mesozoic at the 2004 Arctic Coring Expedition drill site [*Moran et al.*, 2006].

We also observed deformed sediments along the foot of the ridge, which are probably related to shearing parallel to the ridge that occurred at some stage of Amerasia Basin evolution [*Cochran et al.*, 2006]. Much to our surprise, the Morris Jesup Spur appears to be underlain by northwest dipping sediments rather than a pile of volcanics [*Feden et al.*, 1979].

In addition, we saw and recorded two species of half-meter-long eelpouts (*Gaidropsarus argentatus* and *Lycodes frigidus*) at the sea bottom at 10 locations in water depths of 800 to 2080 meters. The Arctic Biodiversity Assessment report had not listed *Gaidropsarus argentatus* among the 13 species of fish found in the Arctic Central Basin (see http://bit.ly/Arctic-fish), so finding this life at such depths will force ecologists to rethink the eelpouts' species ranges.

Reviving a Western Presence in the Arctic

The former Soviet Union and Russia have maintained ice drift station activity more or less continuously since 1950. In contrast, the last time a Western sea ice station has remained occupied throughout the winter was September 1960 to March 1961, when Arctic Research Laboratory Ice



333 Squadron, Norwegian Air Force

Fig. 3. Aerial view of the ice dynamics around the Fram-2014/15 camp area in late March 2015. Over the span of 11.5 months, the ice camp had to be relocated four times. Once, an advancing pressure ridge completely annihilated the camp site (shown in cross section), causing us to lose two oceanographic instruments. F.Z. = fracture zone.

Station I (ARLIS 1), operated by the Arctic Research Laboratory of the U.S. Office of Naval Research, spent the winter atop Fletcher's Ice Island, an iceberg adrift in the Arctic Ocean. And before that, the last ice drift station deployed by Norway and Germany in the central Arctic Ocean was Fridtjof Nansen's legendary drift with the ship *Fram*, more than 100 years ago (see http://bit.ly/Nansen-1895).

Our deployment site, the Lomonosov Ridge, is a linear, 3-kilometer-high, flat-topped submarine ridge of continental rocks. It divides the Arctic Ocean basin into two age provinces: the Cenozoic Eurasia Basin and the Mesozoic Amerasia Basin [*Wilson*, 1963]. The Fram-2014/15 ice station crossed this submarine mountain chain five times. Half of this drift track crossed areas previously inaccessible to surveys by Western icebreakers—even when they were accompanied by a nuclear icebreaker (Figure 1).

Ice Stations for a Changing Arctic

The thickness and area of the Arctic Ocean sea ice cover are changing, and it is increasingly difficult to find suitable multiyear ice floes for scientific studies [*Kwok and Rothrock*, 2009; *Lindsay and Schweiger*, 2015]. Thus, the Arctic and Antarctic Research Institute in St. Petersburg, Russia, has announced that Russia will no longer maintain year-round drifting stations in the Arctic Ocean [*Staalesen*, 2012].

In this changing environment, the joint operation between an icebreaker and a hovercraft presented a win-win situation that enabled access to areas out of reach for icebreaker surveys. The advantages of mobility and low cost hold promise for a new generation of compact and efficient ice drift stations based on hovercraft technology.

Acknowledgments

We thank our cooperating partner, Alfred Wegener Institute for Polar and Marine Research, Germany, for showing us the confidence in deployment of Fram-2014/15. The two support missions by the 333 Squadron of the Norwegian Air Force and one by the Danish Air Force ensured continued science operations. Advice from A. Heiberg (University of Seattle), Griffon Hoverwork (Southampton), H. Berge, G. Hope, and O. Meyer (University of Bergen) was crucial to maximize uptime throughout the year and contributed to the safety of the expedition. The expedition was made possible by Blodgett-Hall Polar Presence providing the hovercraft platform and support supplemented by Lundin Norway and the Norwegian Petroleum Directorate.

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Author information

Yngve Kristoffersen and **Audun Tholfsen,** Nansen Environmental and Remote Sensing Center, Department of Earth Science, University of Bergen, Bergen, Norway; email: yngve.kristoffersen@geo.uib.no; **John K. Hall** (retired), Geological Survey of Israel, Jerusalem, Israel; and **Ruediger Stein,** Alfred Wegener Institute of Polar and Marine Research, Bremerhaven, Germany

Celebrating the 2016 Class of Fellows

The new class of AGU Fellows has been selected and will be recognized at the upcoming Fall Meeting in San Francisco, Calif. The newly elected class will be presented by President-elect Eric Davidson during the Honors Ceremony on Wednesday, 14 December 2016. A brief statement of the achievements for which each of the 60 Fellows has been elected is provided below.

Hajime Akimoto

For advancing our fundamental understanding of atmospheric chemistry and transport and the implications for air quality and climate from regional to global scales.

Marc F. P. Bierkens

For contributions in understanding hydrological processes across scales and the modeling and analysis of climate change and human water use on global groundwater stocks.

Julie Brigham-Grette

For fundamental contributions in understanding Arctic paleoenvironments and for unstinting efforts on behalf of the Arctic science community.

Thure Cerling

For developing and applying novel geochemical methods to understand the coevolution of climate, landscapes, and mammalian evolution.

Martyn P. Clark

For development of new methods of identifying the role of model structural and parameter uncertainty on hydrologic model predictions.

John T. Clarke

For numerous and significant contributions to the fields of planetary science and solar system space physics.

Robert W. Clayton

For development of fundamental seismic theory, including back-projectionseismic tomography, and discoveries of the seismic structure of the crust and mantle.

James Cloern

For innovative research over 4 decades defining the unique patterns and processes of ecosystem variability where land and sea meet.

Steven Constable

For innovative and sustained development of marine electromagnetics and for fundamental work on the electrical conductivity of the Earth's crust and mantle.

Steven A. Cummer

For development and application of innovative radio techniques for remote measurement of lightning processes.

Jon Davidson

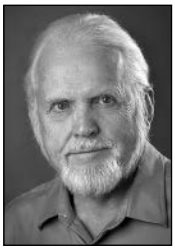
For fundamental contributions to the understanding of magmatic processes and crustal formation in island and continental arcs.

Paolo D'Odorico

For fundamental work on the interactions between noise and nonlinearity in the soil-plant system and in problems related to land degradation and water-food sustainability.

Linda T. Elkins-Tanton

For convincingly elucidating the formation and differentiation of rocky planets and planetesimals, from their interiors to their atmospheres.



Robert W. Embley

For pioneering contributions to our understanding of deep-sea volcanism by fostering interdisciplinary investigations with advanced technologies.

Matthew England

For exceptional and sustained contributions to the understanding of large-scale ocean circulation and its impact on regional and global climate.

Charles Eriksen

For pioneering robotic ocean measurements and exploring the world ocean's internal waves, fronts, circulation, and mixing.

Mary K. Firestone

For defining the role of soil microbial communities in ecosystem structure and function.

Nat Gopalswamy

For significant contributions to the understanding of coronal mass ejections and solar radio emission and to space weather prediction and for tireless leadership effort.

Michael Lon Goulden

For his fundamental contributions to our understanding of terrestrial ecosystem responses to global climate change.

Gordon Elliot Grant

For insightful contributions to the geomorphic and hydrologic functioning of rivers and for developing watershed perspectives for managing public lands.

Peter K. Haff

For pioneering work on the physics of ion sputtering, granular flows, and sediment transport and the coupling of humans, technology, and natural processes.

Judson W. Harvey

For seminal contributions to understanding transport at groundwater–surface water interfaces, related reactions, and their basin-scale significance.

Gabriele Clarissa Hegerl

For world-leading research in understanding the drivers of historical climate change and communicating these results clearly to policy makers.

Harry Holman Hendon III

For sustained contributions over 3 decades improving understanding and predictions of intraseasonal to interannual climate variations.

Mary C. Hill

For development of innovative methods for parameter estimation and sensitivity analysis in hydrologic modeling.

Brent N. Holben

For fundamental contributions to the remote sensing of aerosol optical properties from ground-based and satellite observations.

Masahiro Hoshino

For pioneering work on particle acceleration in collisionless magnetic reconnection and shock waves in planetary and astrophysical plasmas.

Satoshi Ide

For fundamental contributions to our understanding of the physics of slow and rapid fault slip on all scales.

Trevor R. Ireland

For fundamental contributions to microanalysis of terrestrial and meteoritic materials and their application to key problems in geochemistry and cosmochemistry.

Tony Jakeman

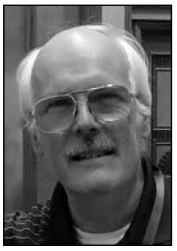
For sustained contributions to the science of hydrological modeling and pioneering leadership in integrated assessment of water resource systems.

Tim Jickells

For world-leading research in marine and atmospheric biogeochemistry and especially for work on element cycling and its role in Earth system science.

Fei-Fei Jin

For seminal contributions to the understanding of the dynamics of the El Niño–Southern Oscillation phenomenon.



Robert W. Kay

For fundamental discoveries about the mantle and continents based on mid-ocean ridge, ocean island, and arc magmatism, and continent delamination.

Deborah Kelley

For major contributions to the discovery and innovative investigation of seafloor hydrothermal phenomena and their chemosynthetic ecosystems.

Lynn M. Kistler

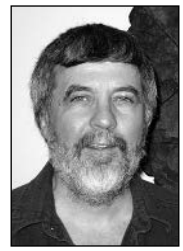
For prolific seminal contributions to our understanding of the role of heavy terrestrial ions in magnetospheric structure and dynamics.

Shaun Lovejoy

For fundamental and pioneering contributions to the theory and applications of scaling and multifractals to complex geosystems.

Yiqi Luo

For fundamental contributions to our understanding of the mechanisms by which global change influences carbon and nutrient dynamics in terrestrial ecosystems.



Paul Mahaffy

For exemplary contributions to planetary science, particularly in development and use of compositional instrumentation to address problems of fundamental importance.

David Mohrig

For discovering new sedimentary phenomena: alluvial-bedrock transitions in low-slope rivers, long-runout hydroplaning debris flows, and incisional-depositional deltas.

Mark Pagani

For pioneering research in reconstructing paleo-pCO_2, climate change, and climate sensitivity.

Claire L. Parkinson

For pioneering work in the modeling and remote sensing of polar sea ice and for leadership of the Earth-observing Aqua satellite mission.

Tai Phan

For fundamental contributions to the understanding of magnetic reconnection through in situ spacecraft measurements.

André Revil

For outstanding contributions toward the development of a unified model of hydraulic, electrical, and mechanical properties of porous media.

Dar Alexander Roberts

For developing spectral mixing models that drive pixel-based interpretation of remote sensing data to solve environmental problems.

Susan Y. Schwartz

For fundamental work that places subduction zone earthquakes in tectonic context.

Thomas Winslow Sisson

For exemplary research blending painstaking observations with incisive analysis to produce lasting advances in igneous petrology and volcanology.

Peter K. Swart

For many transformative contributions to our understanding of the mechanisms and causes of stable isotopic variations in natural systems.

Eiichi Takahashi

For fundamental and outstanding contributions to igneous petrology through laboratory high-pressure experiments.

Uri ten Brink

For fundamental contributions to our understanding of plate rheology and its implications for earthquake and tsunami hazards at plate margins worldwide.

Andréa Tommasi

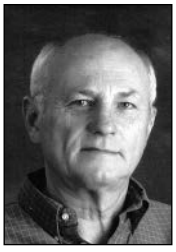
For pioneering work on deformation mechanisms and microstructures within the Earth and their impact on plate tectonics.

Paul J. Treguer

For tireless leadership and forefront research that has led to a comprehensive understanding of the role of silica in global biogeochemical cycles.

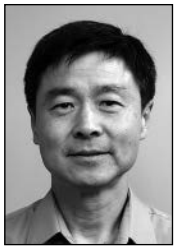
Jeffrey D. Vervoort

For contributions to understanding lutetium-hafnium geochemistry and geochronology of the solar system and the origin and evolution of continental crust.



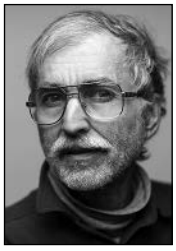
Thomas H. Vonder Haar

For seminal contributions to space-based observations and analysis of the Earth radiation budget, clouds, and water vapor.



Kelin Wang

For discoveries and sustained impact in the study of subduction zone geodynamics, lithosphere thermal structure, and earthquake processes.



Stephen Warren

For seminal contributions to the understanding of radiative properties of snow, ice, and clouds and their role in the climate system.

Robert White

For contributions to understanding melt generation due to mantle plumes and its role in continental rifting and ridge-plume interaction using state-of-the-art geophysical methods.

Sean D. Willett

For pioneering development of numerical models for the interaction of mantle-lithosphere dynamics and surface processes and their coupling through climate.

Shang-Ping Xie

For fundamental contributions to understanding the dynamics of ocean-atmosphere interaction, climate variability, and climate change.

Howard A. Zebker

For pivotal developments in radar remote sensing and for furthering our understanding of fundamental processes shaping Earth and other bodies in the solar system.

Weijian Zhou

For exceptional contributions to radiocarbon dating and our understanding of East Asian and global environmental changes using radionuclides as tracers.

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The Gravity of Volcanic Eruptions

USGS

A view of Kīlauea's summit lava lake on 7 September 2016, when the lake was just 8 meters below the floor of Halemaʻumaʻu Crater.

In the United States, nearly a quarter of the country's 169 active volcanoes could pose a threat to public safety as more communities settle and grow in areas adjacent to them. Monitoring volcanoes in real time allows scientists to understand potential future volcanic activity, which helps public officials and emergency managers to make decisions and minimize losses during an eruption. Volcanoes can erupt with little to no warning, so finding ways to continually monitor small changes in activity could provide important information before potential future eruptions.

Part of the challenge of forecasting eruptions is that scientists can't look directly inside a volcano to gauge what's happening. Currently, scientists track seismic activity, gas emissions, and surface deformation for clues. Researchers can also look at changes in gravity, which reflect small variations in activity beneath the surface. Since anything with mass has a gravity field, Earth's gravitational pull is stronger in areas with more mass and weaker in areas with less mass. Therefore, a change toward stronger gravity in a certain area—from more magma, for instance—can potentially be indicative of future volcanic activity.

In a new study, *Poland and Carbone* continually monitored gravity changes at Kīlauea Volcano in Hawaii from 2011 to 2015 to understand how gravity varied with volcanic activity. Using data from a gravimeter located within the volcano's caldera, they noted that gravity change correlated strongly with both deformation and the depth of a lava lake inside the summit's eruptive vent. This allowed the scientists to assess the density of the lava lake over time.

Using this 5-year set of observations, the researchers found that the density was relatively low overall—slightly more than that of water—which reflects the large amount of gas in the lava lake. A few spikes in density over time were also recorded, possibly indicating accumulation of a small amount of magma beneath the surface that was not accompanied by surface deformation—a process that would not have been recognized by any other monitoring method. Some of these spikes were associated with changes in seismicity that had been interpreted as possible magmatic intrusions, emphasizing the importance of gravity in mapping transient and potentially hazardous volcanic activity.

Continually tracking changes in gravity near highly active and accessible volcanoes, the authors say, could have great potential for sensing previously overlooked or underappreciated volcanic signals. (*Journal of Geophysical Research: Solid Earth*, doi:10.1002/2016JB013057, 2016) **—Wudan Yan, Freelance Writer**

Mars's Climate May Have Been Wet Much Later Than Thought

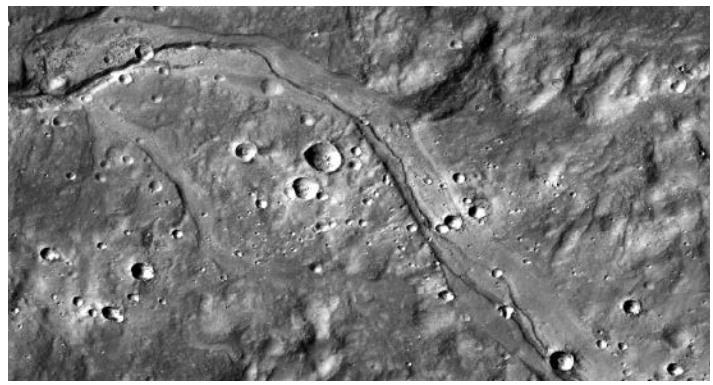
Scientists believe that ancient Mars had a relatively warm, wet climate. Running water carved deep and complex networks of valleys and collected in lake beds, the remains of which are still visible in satellite images today. About 3.5 billion years ago, the Red Planet became colder and drier, and valley formation slowed as precipitation dwindled—or so scientists thought.

New research from *Wilson et al.* suggests that flowing water, perhaps from snowmelt, formed midlatitude valleys between 2 billion and 3 billion years ago, near the transition between Mars's Hesperian and Amazonian periods. This could be evidence that Mars had a cold, wet climate during the transition and possibly well into the Amazonian.

These findings arose from efforts to uncover the history of distinctive, water-carved features known as fresh shallow valleys, which are found in midlatitude regions across Mars. Fresh shallow valleys are narrower, shallower, and less degraded than other ancient valleys, suggesting that they might also be younger.

Wilson's team used high-resolution images and topographic data collected by satellites to examine the size, shape, age, and distribution of fresh shallow valleys in Arabia Terra, a large region just north of the Martian equator. They also used a computer model to simulate water flow and re-create rivers and lakes that may have existed in the Red Planet's past.

The results suggest that fresh shallow valleys in Arabia Terra formed between the late Hesperian period, which ended 3 billion years ago, and the mid-Amazonian, about 2 billion years ago. The shape and shallow depths of the valleys indicate that they were likely active for a geologically short period of time, probably carved by seasonal melting of snow that flowed across the surface.



NASA/JPL-Caltech/Malin Space Science Systems

A channel on the surface of northern Arabia Terra, a region north of Mars's equator. New research suggests that some water-carved valleys in this area are relatively young, indicating that the climate on Mars was wet much later than scientists previously thought.

Other researchers have speculated that volcanic activity, asteroid impacts, or other local heat sources could have melted enough water to form relatively young valleys on Mars. However, these hypotheses are inconsistent with the authors' findings. Instead, the researchers say the appearance and wide distribution of the valleys in the midlatitudes point to a global Martian climate that was wet—and potentially habitable—much later than has been assumed. (*Journal of Geophysical Research: Planets*, doi:10.1002/2016JE005052, 2016) **—Sarah Stanley, Freelance Writer**

No Evidence for Unknown Source of Ozone Precursor

Atmospheric nitrous acid (HONO) is a known precursor to ground-level ozone, but its origins and exact role in atmospheric chemistry still contain numerous mysteries. HONO is known to be emitted from combustion sources, such as fires and automobiles, and formed from reactions of hydroxyl (OH) radicals and nitric oxide (NO). Although HONO quickly breaks down in the presence of sunlight, some modeling and field studies suggest that background levels of HONO across the troposphere are high enough that an additional yet unknown source of HONO might exist.

Now *Neuman et al.* report on aircraft measurements that seek to shed light on this mystery. In June and July 2013, in the midst of smog season, National Oceanic and Atmospheric Administration aircraft made 18 flights—14 during the day and 4 at night—and sampled the air across the southeastern United States from near the surface to as high as 6.4 kilometers above ground. An onboard chemical ionization mass spectrometer analyzed these air samples for HONO content.

The authors were particularly interested in measuring HONO emissions and production from power plants, urban areas, and industrial and agricultural combustion sources. To quantify those emissions, the authors relied on nighttime measurements, when HONO-degrading sunlight was absent. Daytime measurements allowed the authors to look for other sources of atmospheric HONO.

The authors detected significant levels of HONO at nighttime in agricultural fire plumes, urban plumes, and power plant plumes. Nighttime HONO abundance was greatest in plumes from agricultural burning, the authors found; during the daytime, the ratio of HONO to carbon monoxide was one tenth as high as it was at nighttime, consistent with sunlight breaking down HONO, the authors said.

Outside of these agricultural and power plant plumes, however, observed HONO levels fell below the detection limit and were indistinguishable from zero. The authors conclude that HONO formation in power plant plumes was explained solely by known gas phase reactions of OH and NO.

The findings call into question other studies that have invoked unknown sources to explain HONO levels, the authors said, and suggest evidence is lacking for some other widespread HONO source. Still, the authors noted a limitation to their work: The measurement detection limit was not low enough to rigorously explore HONO formation in the background atmosphere. (*Journal of Geophysical Research: Atmospheres*, doi:10.1002/2016JD025197, 2016) **—Puneet Kollipara, Freelance Writer**

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ATMOSPHERIC SCIENCES

Assistant Professor

Assistant Professor with focus on Atmospheric Sciences. The College of Earth, Ocean, and Atmospheric Sciences at Oregon State University located in Corvallis, Oregon invites applications for a full-time (1.0 FTE) 9-month or part-time (0.75 FTE) 12 month tenure-track position. We seek an atmospheric science faculty member who will teach and mentor undergraduate and graduate students; develop and maintain a vigorous, externally funded research program; and collaborate with colleagues. We have a new degree option in climate science and are expanding our undergraduate and graduate courses with emphasis on experiential learning and multidisciplinary sciences. The position will take a leading role in furthering both the educational mission and research portfolio within the growing climate science program. Requires: Ph.D. in atmospheric science, oceanography, or a closely related field by the start of employment. Demonstrated ability or potential: for teaching excellence and commitment to student success; to develop and teach courses in climate science, basic meteorology, or atmospheric physics at an undergraduate level; for mentoring undergraduate students, graduate students and post-doctoral scholars; and commitment to educational equity. Scholarly potential demonstrated by a record of peer-reviewed publications and a clearly defined research agenda commensurate with academic rank. For college information see: http://ceoas.oregonstate.edu. To apply submit CV, letter of interest, and statements online at https://jobs.oregonstate.edu/postings/33732. For full consideration, apply by 11/28/2016. Closing date: 01/09/2017.

GEOCHEMISTRY

ASSISTANT PROFESSOR IN ORGANIC GEOCHEMISTRY

The University of Oklahoma invites applications for a tenure-track position in organic geochemistry at the level of Assistant Professor. The ConocoPhillips School of Geology and Geophysics has a distinguished history in organic geochemistry. We seek an individual who will complement our existing strengths in the geochemical study of organic matter, and who will help us move forward into new and exciting areas of research. The successful candidate must show potential to be an effective teacher who will contribute to our core undergraduate curriculum as well as offer advanced classes in the discipline. The successful applicant will hold a Ph.D. at the time of application, develop an externally funded research program, and sponsor and train graduate students at the Masters and Doctoral levels.

The ConocoPhillips School of Geology and Geophysics is housed in the Sarkeys Energy Center. Our research facilities, which are detailed at http://www.ou.edu/content/mcee/geology/Research.html, include extensive laboratory capabilities in mass spectrometry of carbon compounds and bulk and compound-specific stable isotopic analysis. As the chemistry of carbon figures prominently in research campus-wide, this position in organic geochemistry fills a prominent role with many avenues for collaboration with faculty within and outside of the School.

Review of applications will begin January 1, 2017. The search will continue until the position is filled. The anticipated start date for the position is Fall semester 2017. Applicants can apply online at http://apply.interfolio.com/38699. Applicants will be required to submit a vita/resume, statement of plans for sponsored research, teaching interests, and a list of five references who can be contacted, including telephone numbers, e-mail addresses, and mailing addresses. Questions or information requests should be addressed to the Chair of the Organic Geochemistry Search Committee, at (405) 325-3253 or ougeochemistrysearchchair@ou.edu.

The University of Oklahoma (OU) is a Carnegie-R1 comprehensive public research university known for excellence in teaching, research, and community engagement. In 2014, OU became the first public institution ever to rank #1 nationally in the recruitment of National Merit Scholars, with 311 scholars. The 277-acre Research Campus in Norman was named the No.1 research campus in the nation by the Association of Research Parks in 2013. Norman is a culturally rich and vibrant town located just outside Oklahoma City. With outstanding schools, amenities, and a low cost of living, Norman is a perennial contender on the "Best Places to Live" rankings. Visit http://soonerway.ou.edu for more information.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Individuals from underrepresented groups are encouraged to apply.

Assistant Professor

The Department of Geology at the University of Georgia seeks to fill a position for a tenure-track assistant professor in the field of petrology/mineralogy, welcoming applications from scientists in both the Earth and Planetary sciences to complement the department's growing focus in planetary sciences. We encourage applications from petrologists/mineralogists with strong backgrounds in chemistry and physics who may employ unconventional and interdisciplinary approaches to address big-picture

questions including but not limited to petrologic and/or mineralogical aspects of planetary evolution involving core, mantle, and/or crustal processes. A Ph.D. in Geology, Earth or Planetary Science or other related discipline is required by August 1, 2017. The successful candidate must be comfortable teaching our undergraduate core curriculum classes in mineralogy and/or petrology, a graduate course in their specialty, as well as introductory courses in geology. The successful candidate will be expected to establish an externally funded research program to attract outstanding graduate students in their field, and our core electron microprobe facility with dedicated, long-standing technical support may be critical to that effort. Applicants should submit a cover letter, curriculum vitae, a statement of research and teaching interests and contact information for 3 references. Application materials should be uploaded to facultyjobs.uga.edu. Review of applications will begin January 16, 2017. The position will remain open until filled, but to ensure full consideration, all application materials should be submitted by 5 PM January 16, 2017.

The Franklin College of Arts and Sciences, its many units, and the University of Georgia are committed to increasing the diversity of its faculty and students, and sustaining a work and learning environment that is inclusive. The University is an Equal Opportunity/Affirmative Action employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability, gender identity, sexual orientation or protected veteran status. Georgia is well known for its quality of life in regard to both outdoor and urban activities (exploregeorgia.org). UGA is a land and sea grant institution located in Athens, 90 miles northeast of Atlanta, the state capital (www.visitathensga.com; www.uga.edu).

Curator in Earth and Planetary Science, American Museum of Natural History

The Division of Physical Sciences of AMNH seeks to hire a tenure-track assistant curator in the Department of Earth and Planetary Sciences. We seek candidates who will bring petrological and geochemical methods to bear on problems related to planetary evolution. For example, candidates might integrate field, analytical, and theoretical studies of the rock record to provide insights into fundamental aspects of climate, environmental, and biogeochemical variability through time. The successful candidate will have demonstrated scientific creativity and the potential to build and sustain an innovative research program. They will be expected to take advantage of resources available at AMNH, which include world-class geological collections; a wide range of optical, electron beam, and x-ray analytical tools; experimental laboratories; LA-ICPMS facilities shared with Lamont Doherty Earth Observatory of Columbia University; and a program supporting scientific expeditions. They will oversee and expand the AMNH petrology collection. We welcome an intention and ability to collaborate with colleagues within AMNH and the regional community, including Columbia University and CUNY, and to engage in AMNH's MA in Teaching of Earth Science and other education initiatives. Applications should include a cover letter; CV; research statement; statement addressing teaching, exhibition, and public outreach; PDFs of up to 5 publications; and three letters of reference. All materials should be submitted by December 16, 2016 to EPSsearch@amnh.org. Inquiries about the position should be directed to Denton Ebel (debel@amnh.org). The American Museum of Natural History is an EEO/AA Employer.

Marine Organic Geochemistry

The Interdepartmental Graduate Program in Marine Science (IGPMS: www.igpms.ucsb.edu) at the University of California, Santa Barbara invites applications for a tenure-track or tenured faculty position in marine organic geochemistry at the rank of Assistant or Associate Professor starting July 1, 2017. We are searching for an innovative, collaborative marine scientist who focuses on the geochemistry of organic molecules in marine habitats ranging from the water column to sediments and from coastal zones to the open ocean. Research covering timescales ranging from the geologic past to the modern, and topics ranging from natural cycles to anthropogenic impacts will be considered, with the ideal candidate proposing a strong analytical or computational research program. The successful candidate will hold an appointment in one or more academic departments that participates in the IGPMS, and is expected to develop an internationally recognized research program, mentor graduate and undergraduate students in the candidate's area of expertise, and teach both graduate and undergraduate courses. A Ph.D or an equivalent degree in Marine Science, Chemistry or a related area is required at the time of appointment.

Applicants should submit the following: 1) cover letter; 2) curriculum vitae; 3) statement of research accomplishments/plans; 4) statement of teaching experience/interests; and

5) up to three publications. Applicants should also request three referees to send letters of evaluation by the date listed below. Submit applications and reference letters online at: https://recruit.ap.ucsb.edu/.

For primary consideration apply by December 19, 2016; review of applicant files will continue until the position has been filled.

The school is especially interested in candidates who can contribute to the diversity and excellence of the academic community through research, teaching and service.

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

HYDROLOGY

Assistant Professor, University of North Dakota

The Harold Hamm School of Geology and Geological Engineering in the University of North Dakota's College of Engineering and Mines invites applications for a tenure-track faculty position in geological engineering at the assistant professor level. We seek an outstanding candidate in the field of hydrogeology who will develop or maintain a dynamic research program that will attract and support graduate students through external grant funding. Teaching responsibilities will include classes in hydrogeology, snow hydrology, and groundwater with other undergraduate and graduate geological engineering courses in the candidate's area of expertise. Applicants must have an undergraduate degree in engineering (geological preferred) and hold a Ph.D. in geological engineering, engineering geology, or a closely related science or engineering field. The successful candidate will be expected to (1) develop a strong external funded research program, (2) contribute to the School's graduate and undergraduate programs through teaching, and (3) provide service to help the faculty and administration attain School, College of Engineering and Mines, and University goals, and (4) direct activities in the School's Environmental Analytical Research Laboratory (EARL). EARL is a water analysis lab that supports teaching and research by students and faculty.

Applications will be accepted until the position is filled, with screening to begin immediately. The appointment will begin January 1, 2017. Applicants must submit, in PDF format, a brief letter of application describing their qualifications for the position, curriculum vitae, statement of teaching and research interests, and the names and addresses of three references to Jolene.marsh@und.edu.

ENDOWED DISTINGUISHED PROFESSORSHIP IN GEOLOGICAL SCIENCES

The University of Texas at San Antonio (UTSA) invites applications from senior scholars in the field of Hydrology to fill a tenured position at the Professor or Associate Professor level, subject to qualifications, to begin Fall 2017. The successful candidate will be awarded the Dr. Weldon W. Hammond, Jr. Endowed Distinguished Professorship in Geological Sciences. Read more about the endowed chair at http://www.utsa.edu/geosci/pdf/wwh_endowment_brief.pdf.

The Department of Geological Sciences aspires to be recognized for research strength in hydrology. We currently offer B.S. and M.S. degrees in Geology, and through affiliation, Ph.D. degree in Environmental Science and Engineering. Multidisciplinary collaboration with other departments is encouraged, commonly through research centers such as the Center for Water Research, the Water Institute of Texas, and the Texas Sustainable Energy Research Institute. The successful candidate is expected to establish an externally funded research program that will expand the impact of our existing strengths in hydrology. Quality teaching will be expected at both the graduate and undergraduate levels. Responsibilities will include outreach to the multi-disciplinary scientific community in the San Antonio region, and service for the University, College, and Department.

Full Professor Required qualifications: Applicants must have a Ph.D. in Geoscience or a closely related discipline, with a sustained record of scholarly study in the geological sciences. Preferred qualifications: Active research in broad areas of hydrology. A nationally or internationally recognized record of academic excellence with an outstanding record of peer-reviewed scholarship, grant activity, and evidence of inspired teaching and graduate student supervision.

Associate Professor Required qualifications: Applicants must have a Ph.D. in Geoscience or a closely related discipline, with a substantial record of scholarly study in the geological sciences. Preferred qualifications: Active research in broad areas of hydrology. An active research program as demonstrated by a significant record of peer-reviewed publications and external funding, and a record of outstanding teaching and graduate student supervision.

To apply for either the Associate or Full Professor, please click: https://jobs.utsa.edu/postings/4634.

Required Supporting Documents:

- Cover Letter, including the level of position for which applying
- Curriculum Vitae
- Research Statement
- Teaching Statement
- Two representative publications
- List of three professional references with names, postal and e-mail addresses, telephone numbers

Applicants who are selected for interviews must be able to show proof that they will be eligible and qualified to work in the United States by time of hire. Finalists for this position will be subject to a pre-employment criminal background check. Tenure is contingent upon Board of Regents approval. Review of completed applications will begin on November 18, 2016, and continue until position is filled. Questions about the position

Assistant/Associate/Full Professors - Physical and Biological Oceanography, Marine Geophysics/Geology, and Ocean Engineering

South University of Science and Technology of China

The school of oceanography at the South University of Science and Technology of China (SUSTC) invites applications for several tenure-track (or tenured) faculty positions at the ranks of Assistant, Associate, and Full Professor. Applicants must have earned Doctoral degrees in marine geophysics/geology, physical oceanography, biological oceanography, ocean engineering or closely related field. Successful applicants will be expected to establish a robust, externally funded research program and demonstrate a strong commitment to undergraduate and graduate teaching, student mentoring, and professional service. These positions will be open until filled.

SUSTC is a young university at Shenzhen in southern China since 2010 which is set to become a world-leading research university, to lead the higher education reform in China, to serve the needs of innovation-oriented national development and the needs of building Shenzhen into a modern, international and innovative metropolitan. These positions are created with a significant development to establish a vigorous research program in oceanography at SUSTC to serve the national call for China's important role in deep sea research and resource-oriented exploration in the world oceans.

To apply submit a cover letter, complete vitae with list of publications, and three names of references via http://talent.sustc.edu.cn/en/, or to Dr. Y. John Chen, Chair Professor at School of Oceanography, South University of Science and Technology of China, No 1088, Xueyuan Rd., Xili, Nanshan District, Shenzhen, Guangdong, China 518055.

Berkeley
University of California

Faculty Position in Earth and Planetary Science

The University of California, Berkeley Department of Earth and Planetary Science invites applications for a position at the Assistant Professor level with an expected start date of July 1, 2017. We seek outstanding candidates from any area of Earth and planetary science. Candidates whose research falls into this discipline are invited to apply.

Applicants are asked to provide their most recently updated curriculum vitae, a statement of research interests, a statement of teaching interests covering experience and goals in teaching, statement of contributions to diversity covering any experience or aspirations relevant to campus goals for diversity and inclusion, and the names and contact information for three to five referees. Letters of reference will only be solicited for those under serious consideration. A Ph.D. or equivalent degree is required by the date of hire. To apply and for information about the position, including required qualifications and application materials go to **http://apptrkr.com/893441**. All applications must be submitted by November 30, 2016. For questions please contact Andrew Jan, Administrative Affairs Coordinator, Department of Earth and Planetary Science.
email: epsfacultysearch@berkeley.edu.

The University of California, Berkeley is an AA/EEO employer.

can be directed to the search committee chair Dr. Judy Haschenburger (210-458-8592; judy.haschenburger@utsa.edu).

UTSA is an Affirmative Action/Equal Opportunity Employer. Women, minorities, veterans, and individuals with disabilities are encouraged to apply. Further information about the participating departments and UTSA is available on our Web page: http://www.utsa.edu/geosci/.

Tenure-Track Assistant Professor Position

The University of Alabama (UA) Department of Geological Sciences invites applications for a tenure-track faculty position in integrated hydroclimate modeling, beginning August 2017. The position will be filled at the Assistant Professor level. Candidates must have a strong record of research and a Ph.D. by the time of appointment in hydroclimate systems science, water-atmospheric science, and/or a closely related field, preferably with specialization in integrated modeling of atmospheric processes and hydrologic response, as they impact water management, availability, distribution, and sustainability. The candidate's research would ideally aim to understand and model the movement of water between the atmosphere, land surface, soil, and/or subsurface reservoirs, and how changes in future climate affect water resources and/or environment from regional to global scales. The successful candidate will be expected to establish a strong, externally-funded research program and to attract high-quality Ph.D. and M.S. graduate students. The candidate will also be expected to teach introductory courses related to their field and undergraduate and graduate courses in hydroclimate sciences and modeling, water resources, and water-atmosphere interactions, advise graduate students, and contribute to the Department's research program in water resources and environmental geology. Existing working relationships and collaboration with entities such as NOAA, NASA, USGS, NCAR, DOE, and/or NSF is seen as positive. Opportunities for research collaboration also exist with the NOAA National Water Center, the Environmental Institute, the Geological Survey of Alabama, the Center for Sedimentary Basin Studies, the Center for Freshwater Studies, and the Water Policy and Law Institute, all located on The University of Alabama campus. The Department has a broad range of resources and existing facilities, including modeling and computational resources, field and laboratory equipment, and chemical and stable isotope analytical facilities. Questions should be directed to Dr. Geoff Tick (gtick@ua.edu), Chair of the Integrated Hydroclimate Modeler Search Committee. Applicants should submit a cover letter, curriculum vitae, research statement, teaching statement, and names and contact information for at least three referees through the UA Jobs Website at: facultyjobs.ua.edu. Review of applications will begin December 1, 2016, and continue until the position is filled. The University of Alabama is an equal opportunity/affirmative action employer and actively seeks diversity in its employees.

INTERDISCIPLINARY

Assistant or Associate Professor in Space Systems Engineering

The School of Earth and Space Exploration (SESE) invites applications for an Assistant or Associate Professor with expertise in space systems and technology, to begin August 2017. Rank and tenure status will be commensurate with experience. The School encourages applications from a pool of diverse candidates with expertise in one or more of the following areas: space hardware development including CubeSats and nanosatellites; instrument design and assembly; software and systems development for space applications; sensor development for extreme environments including space qualification of sensors, hazard detection and avoidance; autonomous systems and technologies for robotic/human exploration. Spaceflight hardware, software and/or mission operations experience is strongly desired. The successful candidate will connect science drivers with engineering solutions, teach at the undergraduate and graduate levels, conduct research publishable in top-tier journals, and participate in service to the institution and profession as appropriate.

The School of Earth and Space Exploration (SESE) at Arizona State University brings together all of Earth and space science into one school, breaking traditional disciplinary boundaries to investigate the biggest questions. SESE combines the strengths of science, engineering, and education, to set the stage for a new era of exploration. An essential part of the SESE mission is to design, develop, and deploy new technologies to enable scientific exploration in space. SESE is currently leading at least four funded CubeSat missions: LunaH-Map, SWIM-Sat, Phoenix and AOSat, with many more smallsat missions and technology development efforts in various stages of development (https://sese.asu.edu/research/smallsats). In addition, SESE is participating in several larger space missions including the Lunar Reconnaissance Orbiter, OSIRIS-REx, Mars 2020, Mars Odyssey, Opportunity, and EMIRS. SESE faculty benefit from a variety of state-of-the-art facilities on the Tempe AZ campus, including high-bay assembly clean rooms, thermal-vacuum facilities, spaceflight qualified machine shops and a ground-station to communicate with spacecraft.

Minimum Qualifications: experience in space systems and technology and a Ph.D. in a related discipline by the time of appointment; evidence of scholarly contributions in space systems and technology; and a commitment to quality teaching at the graduate and undergraduate levels.

Desired Qualifications: research expertise in the preferred areas noted above, demonstrated success meeting the needs of diverse student populations or reaching out to diverse communities.

To apply, please submit as a pdf to sesenewfac@asu.edu the following materials: 1) a cover letter that includes a description of the applicant's research and teaching interests and experience; 2) a current CV; and 3) the names, addresses and telephone numbers of three references. https://sese.asu.edu/about/opportunities/faculty-positions.

Initial deadline for receipt of complete applications is December 15, 2016; if not filled, reviews will continue weekly until search is closed. A background check is required for employment.

Arizona State University is a VEVRAA Federal Contractor and an Equal Opportunity/Affirmative Action Employer. All qualified applicants will be considered without regard to race, color, sex, religion, national origin, disability, protected veteran status or any other basis protected by the law. http://www.asu.edu/aad/manuals/acd/acd401 http://www.asu.edu/titleIX/.

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

FACULTY OF PHYSICS

As one of Europe's leading research universities, Ludwig-Maximilians-Universität (LMU) in Munich is committed to the highest international standards of excellence in research and teaching. Building on its more than 500-year-long tradition, it offers a broad spectrum that covers all areas of knowledge within its 18 Faculties, ranging from the humanities, law, economics and social sciences, to medicine and the natural sciences.

The **Faculty of Physics** invites applications for a

Professorship (W2) (6 years/tenure track) of Theoretical Meteorology

commencing as soon as possible.

An outstanding scientist is sought with expertise in the science underpinning weather prediction, including for example data assimilation, predictability and probabilistic methods, numerical modelling or atmospheric dynamics. The Meteorological Institute at LMU Munich is a leading center for atmospheric research with foci on atmospheric dynamics, data assimilation, radiative transfer and remote sensing of clouds and aerosols. It provides a strong environment in a major research university and is closely integrated with the DLR Institute for Atmospheric Physics in Oberpfaffenhofen. Close collaboration with the German Weather Service (DWD) is ensured by the Hans-Ertel-Zentrum Data Assimilation Branch located at the university.

The successful candidate will contribute to innovative approaches to research and the development of new projects, and should have experience in project management, teaching and team leadership. He or she will contribute nine hours per week (during semester) to the teaching activities in the "Bachelor Physics plus Meteorology" and in the "Master Meteorology".

LMU Munich seeks to appoint a highly qualified junior academic to this professorship and, therefore, especially encourages early-career scholars to apply. Prerequisites for this position are a university degree and a doctoral degree or a comparable specific qualification. With an excellent record in research and teaching to date, prospective candidates will have demonstrated the potential for an outstanding academic career.

The initial appointment will be for six years. After a minimum of three years, it can be converted into a permanent position pending a positive evaluation of the candidate's performance in research and teaching as well as his or her personal aptitude and if all legal conditions are met.

Under the terms of the "LMU Academic Career Program", in exceptional cases and subject to outstanding performance in research and teaching, the position may be converted from a W2 into a W3 Full Professorship at a later date.

LMU Munich makes a point of providing newly appointed professors with various types of support, such as welcoming services and assistance for dual career couples.

LMU Munich is an equal opportunity employer. The University continues to be very successful in increasing the number of female faculty members and strongly encourages applications from female candidates. LMU Munich intends to enhance the diversity of its faculty members. Furthermore, disabled candidates with essentially equal qualifications will be given preference.

Please submit your application comprising a curriculum vitae, documentation of academic degrees and certificates as well as a list of publications to the **Dean of the Faculty of Physics, Ludwig-Maximilians-Universität München, Schellingstrasse 4, 80799 München, Germany**, not later than **December 5, 2016.**

Endowed Chair

The Department of Earth, Atmospheric, and Planetary Sciences at Purdue University invite applications for the Steven and Karen Brand Chair in unconventional energy resources. Candidates with a core expertise in unconventional energy with a strong and consistent track record of applying this expertise to unconventional petroleum resources will be considered. Candidates with expertise including, but not limited to, unconventional exploration and production, tight reservoir characterization, geophysics and seismic data analysis, subsurface integration, hydraulic fracture mechanics, pore/fluid interactions, water and environmental issues, and enhanced oil and gas recovery are encouraged to apply. Excellence in and/or commitment to multi-disciplinary research and teaching is a requirement. It is expected that the candidate hired would significantly enhance Purdue's visibility and impact in this key area; increase opportunities for industry collaboration and grant funding; and inspire and train the next generation of leaders in the field.

This is an open-rank search; senior or mid-career scientists with academic, national laboratory, and industry background are all encouraged to apply. Applicant must hold a doctorate in an appropriate field; salary and rank are commensurate with qualifications and experience. The Department of Earth, Atmospheric, and Planetary Sciences, and the College of Science at Purdue embrace diversity and seek candidates who will have experience working with diverse groups.

The department, in collaboration with other departments, has expertise in solid earth geophysics and crustal seismology, fracture mechanics, fluid flow in porous media, hydrogeology, clay mineralogy and surface chemistry, and basin analysis. The department has a long tradition of training students for careers in the petroleum industry and is part of a new multidisciplinary initiative at Purdue University aimed at addressing the energy needs of the country and is affiliated with the newly established Enhanced Oil Recovery Laboratory located in Discovery Park. Faculty members have a long history of working closely with and providing leadership to various Purdue University Discovery Park Centers (www.purdue.edu/DP). The successful applicant will conduct research, will advise graduate students, will teach undergraduate and graduate level courses, and will perform service. The successful applicant will be expected to work across these existing areas of Purdue expertise and build on them with a focus on unconventional resources. Applicants should have a vision for the design and execution of a cross-functional program that achieves the intended mission as described above.

Interested applicants should visit https://hiring.science.purdue.edu; submit a curriculum vitae, a research statement, a vision statement, a teaching statement, and complete contact information for at least 3 references. Review of applications will begin October 31, 2016, and continue until the position is filled. Questions related to this position should be sent to Ken Ridgway, Chair of the Search Committee, email ridge@purdue.edu. Applications will be accepted until the position is filled.

Purdue University is a dynamic, growing university and a great place to work. Our inclusive community of scholars, students and staff impart an uncommon sense of larger purpose and contribute creative ideas to further the university's mission of teaching, discovery and engagement.

Purdue University is an EOE/AA employer. Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. All qualified applicants for employment will receive consideration without regard to race, religion, color, sex, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability or status as a veteran.

Lindahl Ph.D. Scholarships

Lindahl Ph.D. Scholarships: The University of Alabama, Department of Geological Sciences seeks Ph.D. students with specializations that complement faculty research interests. Exceptional students will receive Research or Teaching Assistantships and a Lindahl Scholarship totaling $22,000 for a nine month appointment, and the cost of non-resident tuition is covered. Funding is renewable for 4 years if expectations are met. Other fellowships are available from the Graduate School. Further details are at http://www.geo.ua.edu/. Applicants should contact Dr. Robinson (dmr@ua.edu) to express interest. Review of applications for Fall 2017 admission will begin January 15, 2017.

Postdoctoral Fellowships

The Geophysical Laboratory, Carnegie Institution of Washington, invites applications for postdoctoral fellowships. The Geophysical Laboratory emphasizes interdisciplinary experimental and theoretical research in fields spanning geoscience, microbiology, chemistry, and physics. The Laboratory supports world-class facilities in high-pressure research; organic, stable isotope and biogeochemistry; mineral physics and petrology; and astrobiology.

Please visit https://jobs.carnegiescience.edu/jobs/carnegie-fellowships-for-the-geophysical-laboratory-4/ to view a list of required materials and application instructions. Also, see http://www.gl.ciw.edu/ for a listing of personnel, current research interests, and major facilities.

Completed applications for Carnegie fellowships should be submitted by November 30, 2016.

The Geophysical Laboratory is located in Washington, DC, and is an equal opportunity employer.

Postdoctoral Scholars in Ecosystem Monitoring and Modeling

Northern Arizona University seeks two postdoctoral researchers to participate in research projects focused on mapping, monitoring and modeling ecosystem changes, incorporating climate, land use and disturbance dynamics. The successful candidates will work closely with the principle investigator and collaborators, incorporating satellite observations in models to analyze the influence of various factors on forested and arctic ecosystem dynamics. This position requires advanced remote sensing experience, including the ability to manipulate large data sets using personally developed scripts. The position will involve processing multi-sensor imagery, primarily satellite-based but also airborne remote sensing, to derive geospatial products characterizing ecosystem properties (e.g. canopy structure, biomass, disturbance severity, regrowth dynamics). The research will advance analyses of ecosystem disturbance and the drivers of composition and change through time. Exploration of state-of-the-art techniques to derive geophysical properties in permafrost environments is desirable. Ability to synthesize complex information and develop structured analyses in written and visual form is essential.

The qualified candidates should have a PhD in Environmental Science, Remote Sensing, Computer Science and/or a related discipline, with experience using earth observation imagery and a demonstrated ability to write scripts, conduct spatial analysis and manage large data sets. Applicants should be confident in using a variety of software/geospatial tools and possess the ability to continuously learn new technical skills as needed. Publishing findings in peer-reviewed venues is a priority.

NAU is a committed Equal Opportunity/Affirmative Action Institution.

Tenure-track faculty position—Geophysics and Geodynamics

The Department of Earth and Environmental Sciences at the University of Rochester invites applications for a tenure-track position in the broad field of geophysics and geodynamics. We anticipate hiring at the Assistant Professor level but exceptional candidates at the Associate and Full Professor level will be given full consideration. We are interested in dynamic educators and researchers who use experimental, computational and/or field approaches in their research and can establish externally funded, internationally recognized research programs that involve graduate students. The field of specialization is open, but preference will be given to individuals who can offer a research and teaching program that complements and expands upon our existing strengths in solid Earth processes and climate science. See http://www.ees.rochester.edu for more information about the Department's strengths in geochemistry, geophysics, tectonics, and climate science. We also encourage interdisciplinary applicants who can bridge the gap between traditional Earth Science and planetary science, as well as applicants who can utilize other outstanding research facilities at the University, including the Laboratory for Laser Energetics http://www.lle.rochester.edu and the Goergen Center for Data Sciences https://www.rochester.edu/data-science/.

The University of Rochester is a highly ranked research university, and the Rochester area's cultural, educational, and recreational assets frequently place it among the best places to live, work, and raise a family in the United States. Applicants should submit materials via: https://www.rochester.edu/faculty-recruiting. Materials include a curriculum vitae, select reprints, statements of research and teaching goals, and the names and contact information of four references. The review of applications will begin December 31 2016 and will continue until the position is filled. The preferred start date for the position is July 1 2018. The University of Rochester, an equal opportunity employer, has a strong commitment to diversity and actively encourages applications from candidates from groups underrepresented in higher education.

EOE / Minorities / Females / Protected Veterans / Disabled

Tenure-Track Professor in Climate Science

The Department of Earth and Planetary Sciences (EPS) and the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) plan to make a series of hires in the area of climate, beginning with two positions at the assistant, associate (untenured) or full professor (tenured) level with an expected start date of July 1, 2017. We invite applications in the broad area of climate science, includ-

YACHAY TECH

Yachay Tech, Ecuador
School of Geological Sciences and Engineering
Faculty positions available

The School of Geological Sciences and Engineering at Yachay Tech invites applications for tenure track assistant professors in the following fields: geophysics, sedimentology, structural geology, economic geology, hydrology and hydrogeology, climate and oceanography.

Yachay Tech faculty will develop active research programs, direct PhD students, involve undergraduate students in collaborative research projects, and teach (in English) undergraduate and graduate courses in their fields of specialty.

To apply, please send a letter of interest, curriculum vita, statements of research and teaching interests, and names and contact information for three references to Maria del Carmen Alvarado (malvarado@yachaytech.edu.ec), assistant to the Dean. Employment will begin in March 2017 with classes beginning in April 2017.

Yachay Tech is a public, research-intensive university, located in the Inter-Andean valley of Ecuador about two hours north of Quito. Since opening in March 2014, the undergraduate student population has grown to a total of approximately 1000 undergraduates. We anticipate initiating a doctoral program this September 2016.

ing the oceans, cryosphere, land, and atmosphere, as well as their interactions. Approaches involving observations, theory, experiments, and modeling using biology, chemistry, or physics are all welcome. We are especially interested in candidates that will expand and complement existing strengths in climate science within EPS and SEAS.

A doctorate or terminal degree in the broad area of climate science is required by the expected start date. We also seek candidates who have a commitment to teaching.

Required application documents include a cover letter, curriculum vitae, three representative publications, a statement of research and teaching interests, and contact information for 3–5 potential references. We will evaluate applications beginning November 15th, and will conclude when the positions are filled. EPS and SEAS value diversity among their faculty, and we are committed to building a culturally diverse intellectual community. We particularly encourage applications from historically underrepresented groups, including women and minorities.

Further information about EPS and SEAS are available at http://www.eps.harvard.edu/ and http://www.seas.harvard.edu/. Address questions about the position to Professor Peter Huybers (phuybers@fas.harvard.edu) or Professor Frank Keutsch (keutsch@seas.harvard.edu) and about the application process to Kathleen McCloskey (kmccloskey@fas.harvard.edu).

We are an equal opportunity employer and all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability status, protected veteran status, or any other characteristic protected by law.

Weiss Visiting Professor

We are soliciting applications for the Wiess Visiting Professor in the Department of Earth Science at Rice University. Our department has lively research programs in

1. Carbonate and Clastic Sedimentology and Coastal Processes
2. Paleoclimatology
3. Atmospheric Chemistry
4. Biogeochemistry
5. Geobiology
6. Low and High Temperature Geochemistry
7. Petrology
8. Rock Physics and Geomechanics
9. Environmental, Exploration, Solid Earth and Theoretical Seismology
10. Crustal and Mantle Structure and Geodynamics
11. Planetary Science

We invite applications from established scientists whose research falls in any of these areas, and request that you identify one or more of our faculty whose research interests overlap yours. The department is characterized by collegiality and interdisciplinary research. Our faculty have ties to the Rice Departments of Biosciences, Chemistry, Computational and Applied Mathematics, Mechanical Engineering, and Physics and Astronomy. We also have strong ties to the local petroleum industry, the NASA Johnson Space Center, and the Lunar Planetary Institute.

The Wiess Visiting Professorship provides travel expenses to and from Rice, and living expenses while in residence, details are negotiable. Visiting Professors are typically in residence from a few months to a full academic year. Ideally Wiess Visiting Professors interact at a high level with members of our department, often through topical seminars. We particularly encourage women and minority geoscientists to apply.

See:

http://earthscience.rice.edu for more details about our Department, and

http://earthscience.rice.edu/directory/wiess-visiting-professor/ for a list of previous Wiess Visiting Professors.

Please provide a curriculum vita, research statement, and indication of availability. Applications and inquiries can be sent to

Chair, Wiess Visiting Professor Committee
Department of Earth, Environmental and Planetary Science
Rice University, MS-126
6100 Main Street
Houston, TX 77005
or
esci-search@rice.edu

Please put Wiess Visiting Professor on the subject line.

Rice University, located in Houston, Texas, is a private, coeducational, nonsectarian university that aspires to path-breaking research, unsurpassed teaching, and contributions to the betterment of our world. Rice fulfills this mission by cultivating a diverse community of learning and discovery that produces leaders across the spectrum of human endeavor. From its beginning in 1912, Rice has been dedicated to excellence in all regards.

Rice University is an Equal Opportunity Employer with commitment to diversity at all levels, and considers qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national or ethnic origin, genetic information, disability or protected veteran status.

OCEAN SCIENCE

International Faculty Cluster Hire in Geological Oceanography

The Department of Geological Oceanography (http://dgo.xmu.edu.cn) is expanding its international faculty with the addition of six (6) new

icdp

The International Continental Scientific Drilling Program (ICDP)

Call for Proposals

The International Continental Scientific Drilling Program, ICDP coordinates and supports multinational endeavours in continental scientific drilling. The program focuses on challenging themes of global geoscientific and socio-economic relevance, including Climate & Ecosystem, Sustainable Georesources, and Natural Hazards.

With this announcement, the ICDP invites Earth scientists to submit project proposals in which drilling is required to achieve critical research goals. This call is open to investigators from ICDP member countries (Austria, Belgium, China, Czech Republic, Finland, France, Germany, Iceland, India, Israel, Italy, Japan, New Zealand, Norway, South Korea, Spain, Sweden, Switzerland, The Netherlands, United Kingdom, United States of America) as well as from countries considering membership in the ICDP. Please note that ICDP provides operational support and allocates co-funding for drilling-related costs only; research grants for the project should be sought from other funding agencies. This concept of commingled funding and international cost sharing, in addition to an exchange of technological capabilities and know-how, has proven very successful over the years.

PROPOSAL PREPARATION

The submission of proposals to the ICDP is normally handled in a 2-step procedure. The first step is the submission of a *pre-proposal* in which a request to hold an ICDP-funded workshop is submitted. The proposal should outline the main objectives, the scientific importance of the planned project, details of the proposed drill site, the expertise of the group of proponents and envisaged international collaboration. The workshop serves to bring together a competitive international research team which can develop a *full drilling proposal*. Principal Investigators should note that they are responsible for planning and running pre-site surveys needed to facilitate the choice of an appropriate drill site. Following a successful pre-proposal and workshop a full proposal can be submitted in a second step.

PROPOSAL EVALUATION

All proposals are evaluated by the Science Advisory Group (SAG) of the ICDP, which makes recommendations to the Executive Committee (EC) based on scientific quality and priority. The EC then reviews technical and financial issues in order to ensure that projects are feasible within the constraints of ICDP's annual and long-range plans. The EC informs the Principal Investigator(s) of the outcome of the evaluation, and states whether further development of the proposal is to be encouraged or not.

ICDP aims to foster joint projects with the International Ocean Discovery Program, IODP. We therefore cordially invite project proposals in which coordinated drilling on land and at sea is required or land-sea transect drilling series are planned ("amphibious projects"). Joint project proposal submission will be accepted by both programs and jointly evaluated.

The deadline for submission of all proposals to the ICDP is **January 15, 2017**. Please submit a digital copy as single file via email to:

Uli Harms, GFZ German Research Centre for Geosciences, Telegrafenberg, D-14473 Potsdam, Germany, phone +49-331-288-1085, fax: +49-331-288-1088, e-mail: u.harms@icdp-online.org

Detailed information on the scope of the ICDP, the submission of proposals, proposal format, and the process for development of a successful proposal is available on the ICDP home page at: **http://www.icdp-online.org/proposals**.

positions planned for the second phase. Already one of China's top oceanography schools, the College (http://coe.xmu.edu.cn:82) aims to establish the Department of Geological Oceanography as a premier center in land-ocean interactions, sedimentary processes/records, and global change. The ranks of the appointments are open, and are commensurate with the applicants' qualifications and experience.

At this time, we seek highly qualified candidates in three complementary and synergistic areas of study:

Stratigraphy/Geophysics/Seafloor Imaging - Two (2) positions are available in the general area are of seafloor imaging and subbottom profiling. Although all qualified candidates in this area will be considered, we are especially interested in candidates who apply state-of-the-art seagoing surface and/or subbottom mapping tools and analysis skills to the investigation of coastal and continental margin environments.

Sediment Transport Dynamics—Two (2) positions are available in the general area of observational sediment transport. We seek highly qualified candidates who use new and novel field approaches and tools to examine the flux and fate of terrestrial matter in and across continental margins, including rivers, estuaries, shelf and slope environments.

Numerical Modeling of Sediment Processes and Stratigraphy—Two (2) positions in numerical modeling are available in areas that support the observational program in land-ocean interaction and sedimentary records. Examples of areas that are of particular interest include, but are not limited to: 3-D modeling of sediment transport and deposition/erosion, stratigraphic modeling, seabed diagenesis, surface processes/fluvial geomorphology.

We seek applicants with proven record or promise to contribute to the interdisciplinary research and teaching missions of the College. A Ph.D. degree is required at the time of appointment and in the case of a Chinese degree two years in an overseas postdoctoral position.

In conjunction with the State Key Laboratory of Marine Environmental Science (http://mel.xmu.edu.cn/en/index.asp), the College has access to state-of-the-art instrumentation and offers internationally competitive compensation, start-up and relocation packages. Special recruitment programs are available to exceptionally well-qualified candidates. Xiamen University recently launched a 3600-ton (78 m) research vessel and is completing construction of a marine station for cutting-edge education and research in oceanography. XMU envisions the development of a world-class program in Geological Oceanography with focus on interdisciplinary studies of sediment processes and the sedimentary record in China's diverse marginal seas.

Xiamen University, located along China's SE coast, was founded in 1921 with the vision to become the leading international university in China (http://www.xmu.edu.cn/en/about/xmu_at_a_glance). Xiamen University has inter-university cooperative ties with over 270 institutions of higher education at home and abroad, including the establishment of a new campus in Malaysia (http://www.xmu.edu.my/a/5.html).

To apply email a cover letter, CV, contact information for 3-5 references, and a statement of research and teaching philosophy and goals to Dr. Steven A. Kuehl, Interim Chair, Department of Geological Oceanography (kuehl@xmu.edu.cn). Applications will be considered beginning February 1, 2017, however the positions will remain open until filled.

PLANETARY SCIENCES

Assistant Professor of Planetary Materials

The Department of Earth, Atmospheric, and Planetary Sciences (EAPS), within the College of Science, Purdue University, invites applications for a tenure-track faculty position at the rank of Assistant Professor in the area of Planetary Materials. The Planetary Science Group within EAPS has an international reputation, extensive involvement in spacecraft missions, and newly developed undergraduate and graduate programs. We seek to grow and are looking for someone who conducts laboratory analysis of planetary materials or their terrestrial analogues. Candidates must have completed their PhD in an appropriate field. The appointee is expected to develop and maintain a vigorous, externally funded, internationally recognized research program and to teach and mentor students at the undergraduate and graduate levels.

Applications should be submitted electronically at https://hiring.science.purdue.edu. Applications should include a curriculum vitae, a statement of research, a teaching statement, and contact information of three individuals who can provide letters of reference. Questions related to this position should be addressed to Dr. Chris Andronicos (candroni@purdue.edu), Chair of the Search Committee. Review of applications will begin on December 1, 2016, and continue until the position is filled.

Purdue University is an EOE/AA employer. All individuals, including minorities, women, individuals with disabilities, and veterans are encouraged to apply.

THAYER SCHOOL OF ENGINEERING AT DARTMOUTH

The Thayer School of Engineering at Dartmouth seeks an outstanding candidate to be the inaugural holder of the newly-endowed Evans Family Professorship. The successful candidate will have a doctorate in engineering or a related field; will lead a strong externally-funded research program in engineering related to Arctic environments; will be a gifted teacher with motivation and expertise that complements the Thayer School's interdisciplinary approach to engineering education; and will contribute to Dartmouth's strong research effort in cold regions science and engineering. The Thayer School of Engineering is undertaking a significant expansion of faculty and programs: this position is the first of three new hires at Dartmouth in an interdisciplinary cluster focused on "Ice, Climate, and Energy" with strong potential for collaborations with Thayer School's long-established Ice Research Laboratory, Dartmouth's newly-announced Institute for Energy and Society, and with the nearby U.S. Army's Cold Regions Research and Engineering Laboratory.

Review of applications will be begin on February 1st and will continue until the position is filled. A complete CV, statement of research and teaching interests, and contact information for three references should be sent as a PDF via email to Thayer.Ice.Search@dartmouth.edu. Enquiries about the position should be directed to Professor Ian Baker, Ian.Baker@Dartmouth.edu.

Dartmouth is a member of the Ivy League and consistently ranks among the world's greatest academic institutions. Home to a celebrated liberal arts curriculum and pioneering professional schools, Dartmouth has shaped the education landscape and prepared leaders through its inspirational learning experience. The College has forged a singular identity, combining its deep commitment to outstanding undergraduate liberal arts and graduate education with distinguished research and scholarship in the Arts and Sciences and its three leading professional schools — Geisel School of Medicine, Thayer School of Engineering, and Tuck School of Business. For more information see http://engineering.dartmouth.edu.

Home to Dartmouth College, the Upper Connecticut Valley is a vibrant, academic and professional community offering excellent schools, lively arts, and an unmatched quality of life in a beautiful setting. Amenities associated with urban areas in Boston MA, Burlington VT, and Montreal QC are all within a few hours drive.

Dartmouth College is an equal opportunity/affirmative action employer with a strong commitment to diversity and inclusion. We prohibit discrimination on the basis of race, color, religion, sex, age, national origin, sexual orientation, gender identity or expression, disability, veteran status, marital status, or any other legally protected status. Applications by members of all underrepresented groups are encouraged.

Postcards from the Field

Hi, Folks,

Had to move our work on dating Quaternary alluvial fans along a little quickly the other day as the Blue Cut Fire started heading our way. Hopefully, we will be back to the Canyon Pass near San Bernardino in Southern California to finish sampling our pit in the very near future.

Best wishes,

—Lewis Owen, Professor of Geology and Head, Department of Geology, University of Cincinnati, Cincinnati, Ohio

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

Networking and Career Events for Students

Sharing Science Communication Clinic
Monday, 2:30 P.M.–3:45 P.M.
Moscone West, Room 2001A

Student Mixer
Monday, 6:00 P.M.–8:00 P.M.
Moscone North-Exhibit Hall,
Back Right Corner

Career Center & Student Lounge
Monday–Friday, 9:00 A.M.–6:00 P.M.
Moscone South, Halls A–C: Poster Hall

Career Advice Talks
Monday–Friday, 9:00 A.M.–6:00 P.M.
Moscone South, Career Center

Pop-Up Talks
Monday–Tuesday, 4:00 P.M.–6:00 P.M.
Moscone West, Room 2001A

Student Breakfast
Tuesday, 7:00 A.M.–8:00 A.M.
San Francisco Marriott Marquis, Salon 7

Recruitment Luncheon
TICKETED EVENT
Tuesday, 11:30 A.M.–1:00 P.M.
Moscone South, Career Center

Career Opportunities Networking Lunch
TICKETED EVENT
Wednesday, 12:30 P.M.–2:30 P.M.
San Francisco Marriott Marquis,
Golden Gate C1–C3

Career Fairs
Tuesday–Thursday, 10:00 A.M.–5:00 P.M.
Moscone South, Career Center

Outstanding Student Paper Award Resource Center
Monday–Friday, 8:00 A.M.–6:00 P.M.
Moscone South, Halls A–C: Poster Hall

AGU FALL MEETING
San Francisco | 12–16 December 2016