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Monitoring Change in Great Salt Lake

Great Salt Lake is the largest hypersaline lake in the Western Hemisphere and the fourth largest terminal lake in the world (Figure 1). The open water and adjacent wetlands of the Great Salt Lake ecosystem support millions of migratory waterfowl and shorebirds from throughout the Western Hemisphere [*Aldrich and Paul,* 2002]. In addition, the area is of important economic value: Brine shrimp (*Artemia franciscana*) residing in Great Salt Lake support an aquaculture shrimp cyst industry with annual revenues as high as $60 million.

This globally significant ecosystem is facing increasing anthropogenic pollutants from industrial, urban, mining, and agricultural sources from a watershed that includes the highly urbanized Wasatch Front in northern Utah. In fact, about 90% of all treated sewage effluent in Utah is discharged into this water body. Because Great Salt Lake is a terminal lake, chemical inputs have no opportunity to be removed via water outflow from the system.

Furthermore, the completion of a rock-filled railroad causeway in 1959 divided the lake into northern (Gunnison Bay) and southern (Gilbert Bay) arms and significantly changed the water and salt balance while also changing biogeochemical conditions in the deeper sections of Gilbert Bay, which range in depth from 6.5 to 9 meters at current lake levels. About 90% of the fresh surface water inflows enter the lake south of the railroad causeway, resulting in consistently higher salinities in lake water north of the causeway that can approach and exceed halite saturation, meaning that the water is so salty that salt crystals readily precipitate out of solution. A persistent higher-density and oxygen-depleted layer in Gilbert Bay is supported by density-driven flow of highly saline water from Gunnison Bay from flow through the permeable fill material as well as constructed openings in the causeway. This oxygen-depleted layer contains elevated levels of mercury [*Naftz et al.,* 2008] and nutrients [*Belovsky et al.,* 2011].

Despite the ecological and economic importance of Great Salt Lake, only limited limnological and water quality monitoring has occurred historically. In response to recent and increasing public concern about contaminant input to this ecosystem, the U.S. Geological Survey (USGS), in cooperation with multiple state agencies, began to install and operate additional monitoring stations and networks. These involve gauges of lake level height and rate of inflow, an on-lake station providing real-time monitoring data, and multiple lake-bottom sensors tracking the movement of dense, ultrasaline water through the lake.

Lake Elevation and Inflow Gauges

USGS has operated a lake elevation gauge in Gilbert Bay (near the Saltair Marina) since 1938 and in Gunnison Bay (on the east shore; the gauge is named Saline) since 1966 (Figure 1). Short-term changes in lake elevations from sustained wind events and the associated seiches (low-frequency oscillations of lake surface elevation) can affect flow direction and velocity in the highly saline oxygen-depleted water layer on the bottom of Gilbert Bay. Because of the shallow nature of Great Salt Lake, updated lake elevations also provide recreational boaters with important information. Lake elevations are currently measured every 15 minutes using noncontact radar at the Saltair site and a calibrated shaft encoder at the Saline site.

Inflow sites to Great Salt Lake are monitored every 15 minutes with USGS gauges (Figure 1). Three other USGS gauges continuously monitor water exchange between Gilbert and Gunnison bays (Railroad Causeway Breach gauge), between Bear River and Gilbert bays (Bear River Bay gauge), and between Farmington and Gilbert bays (Farmington Bay Causeway Breach gauge). Because of low channel gradients, density-stratified flow, and wind influence on inflow rates and directions at the Bear River Bay, Farmington Bay, and Railroad Causeway Breach gauge sites, normal relations do not exist between water height and discharge rate. Instead, hydroacoustic equipment (acoustic Doppler profilers) is used in combination with velocity index methods to accurately gauge inflow.

Data from both elevation and inflow gauges are transmitted hourly via satellite and displayed in near real time on the USGS National Water Information System (NWIS) Web site. Nutrient loads into this terminal lake have been monitored at monthly to bimonthly intervals by collecting and analyzing water samples at each inflow site since 2009.

Lake Environmental Sensing Platform

During May 2010, a Lake Environmental Sensing Platform (LakeESP) was installed in Gilbert Bay (Figure 1a) to better understand hydrodynamic forcings in Great Salt Lake and short-term mixing of the mercury- and nutrient-enriched lower brine layer with the upper water column.

The LakeESP provides seasonal real-time monitoring of water column temperature at 15 depths; specific conductance and photosynthetically active radiation at 3 depths; and meteorological parameters that include

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Studying Bromine, Ozone, and Mercury Chemistry in the Arctic

Accentuated by a new record low in 2012, the springtime extent of Arctic perennial sea ice continues its precipitous decline. Consequently, the Arctic sea ice cover is increasingly dominated by seasonal sea ice, consisting of thinner and saltier ice with more leads (fractures), polynyas (areas of open water), nilas (sea ice crust less than about 10 centimeters thick), frost flowers (clusters of salty ice crystals on sea ice surface), and saline snow. The increase in the salinity of the sea ice cover is potentially conducive to ice-mediated photochemical and meteorological processes leading to ozone (O_3) and gaseous elemental mercury depletion from the atmosphere.

As the saltier season sea ice becomes more extensive, bromine explosions from sea salt sources may change the level of tropospheric ozone (a pollutant in the troposphere) and affect the surface deposition of atmospheric mercury originating from long-range pollution transport. As deposited mercury becomes toxic through subsequent biochemical processes, understanding the overall process may lend scientific support to international efforts to address adverse impacts of Arctic sea ice reduction.

Field Campaign Setting

To investigate implications of the perennial sea ice reduction on tropospheric bromine, ozone, and mercury chemical processes, transport, and distribution, the Bromine, Ozone, and Mercury Experiment (BROMEX) was conducted in March and April 2012 around Barrow, Alaska. BROMEX involved multiple satellite instruments, three aircraft, various field sites on sea ice and tundra, and meteorological buoys and stations (Figure 1). The field area extended from inland terrestrial sites to a large region of the sea ice offshore in the Beaufort Sea and Chukchi Sea, where energetic dynamics created large leads, providing a variety of sea, ice, and atmospheric conditions. BROMEX was carried out with international participation and contributions of 20 agencies and institutions from the United States, Canada, Germany, and the United Kingdom.

Satellite and Aircraft Observations

Data acquisitions from 14 different satellites were coordinated during BROMEX (for a listing of the satellites, see the supporting information in the online version of this brief report). These satellites provided observations of snow and sea ice changes, lead formations, and plumes emanating from open water areas. In addition, the Airborne Laboratory for Atmospheric Research was flown in 11 long-range excursions to obtain unprecedented views of the vertical profiles of bromine monoxide (BrO), aerosols, and ozone over the tundra snowpack and various types of sea ice surfaces. To measure thickness of snow and sea ice with radar and laser altimeters, the IceBridge NASA P3 aircraft was flown from the Beaufort Sea, across the Elson Lagoon, above the tundra, and offshore over the Chukchi Sea.

Ocean and Land Surface Measurements

Two instrument packages were deployed on sea ice with a helicopter: IceLander IL1 in the Beaufort Sea and IL2 in the Chukchi Sea. A primary strategy of BROMEX was to capture measurements by the IceLanders to characterize O_3 and BrO processes both upwind and downwind of areas where lead formation was active to investigate effects of both open water and freshly refrozen leads on bromine chemistry. IL1 was primarily stationary during BROMEX. IL2 drifted with the sea ice under changing conditions, including pack ice, lead formations and closures, and unconsolidated ice floes from March to June 2012, when it was toppled by a polar bear. Another similar instrument was installed at a fixed site near Barrow. O_3 data from IL1, IL2, and Barrow revealed that ozone depletion events occurred quite frequently. Moreover, Barrow data suggest a relationship between the seasonal end date of BrO activities and snow properties.

Data on gaseous elemental mercury, reactive gaseous mercury, and fine-particulate mercury were obtained simultaneously with Environment Canada's Out On The Ice

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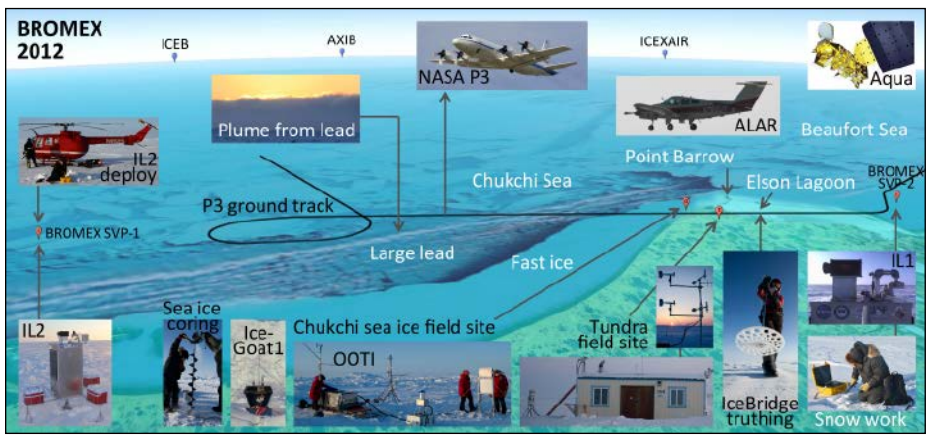

Fig. 1. Description of the Bromine, Ozone, and Mercury Experiment (BROMEX) field campaign. The background image is a composite from Moderate Resolution Imaging Spectroradiometer (MODIS) Aqua bands 1, 2, and 7 on 25 March 2012: sea ice appears as blue, open water as dark blue, plumes from leads as long blue streaks, lagoon as light blue, and land as green. For satellites, Aqua is shown as an example among many other satellites used. Aircraft include Airborne Laboratory for Atmospheric Research (ALAR), NASA P3, and BO-105 helicopter. Balloons mark buoys (Surface Velocity Program buoy 1 (SVP-1); SVP-2; IceGoat1 buoy; Ice Beacon (ICEB) buoy; Airborne Expendable Ice Buoy (AXIB); and ICEXAIR, an air-droppable meteorological buoy built by Christian Michelsen Research). The IceLander1 (IL1) and IL2 instruments, as well as Environment Canada's Out-On-The-Ice (OOTI) system for mercury measurements are also shown. Several other field sites, instruments, networks, and activities are depicted. Photo and image credits: NASA and the BROMEX Team. A version of this figure with larger versions of the inset photos can be found in the supporting information in the online version of this brief report.

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net long- and short-wave radiation, humidity, air temperature, wind speed and direction, barometric pressure, and precipitation. A Sontek Argonaut-XR, which is an acoustic Doppler velocity meter (ADVM), is also integrated with LakeESP to provide data on current directions and velocities. ADVM data are collected every 20 minutes, and all other data are collected once per minute. Data are transmitted hourly via cell phone to a shore station, and selected data are displayed in near real time via NWIS.

Hydroacoustic and Salinity Monitoring Network

Bathymetric mapping of Gilbert Bay by USGS revealed a natural "spillway-like" structure on a bottom ridge trending from southwest to northeast. This structure acts as a conduit to transport oxygen-depleted, high-density, and mercury-, nutrient-, and salinity-enriched bottom water into the southern part of Gilbert Bay (Figure 1).

A single monitoring station was installed on the bottom of the spillway structure (see CENT, Figure 1) in March 2012 to monitor the flow direction and velocity (with a Sontek Argonaut-XR), temperature, and specific conductance of water moving through this area of Gilbert Bay. Direction and velocity data are collected at 60-minute intervals, and temperature-specific conductance data are collected at 15-minute intervals. The data are stored internally and retrieved every 2 to 3 months. In response to potential construction modifications to the existing railroad causeway (e.g., the proposed addition of a second causeway breach, still under review by the U.S. Army Corp of Engineers), five additional stations with similar monitoring equipment were added during September 2012 (Figure 1).

Monitoring Data Applications

Figure 1b provides an example of how the high-frequency monitoring data from the spillway and railroad causeway breach sites can be combined to provide insights into the hydrodynamic processes controlling water movement across this geographic restriction (D. Naftz et al., Density stratified flow events in Great Salt Lake, Utah, USA: Implications for mercury and salinity cycling, submitted to *Chemical Geology,* 2013). Wind-driven, flow reversal events "push" water from Gunnison Bay into Gilbert Bay via the railroad causeway breach, which results in the accelerated movement of water across the natural spillway structure.

Future applications of monitoring data collected from Great Salt Lake include calibration and verification of a three-dimensional hydrodynamic model of water exchange between Gilbert and Gunnison bays, insights into loading and biogeochemical cycling of nutrients in Gilbert Bay, and assessment of limnological and salinity impacts from modifications to the existing railroad causeway. Together, these efforts will provide important tools and data for state and federal regulators that can be used to make informed decisions regarding future management of the Great Salt Lake ecosystem.

Acknowledgments

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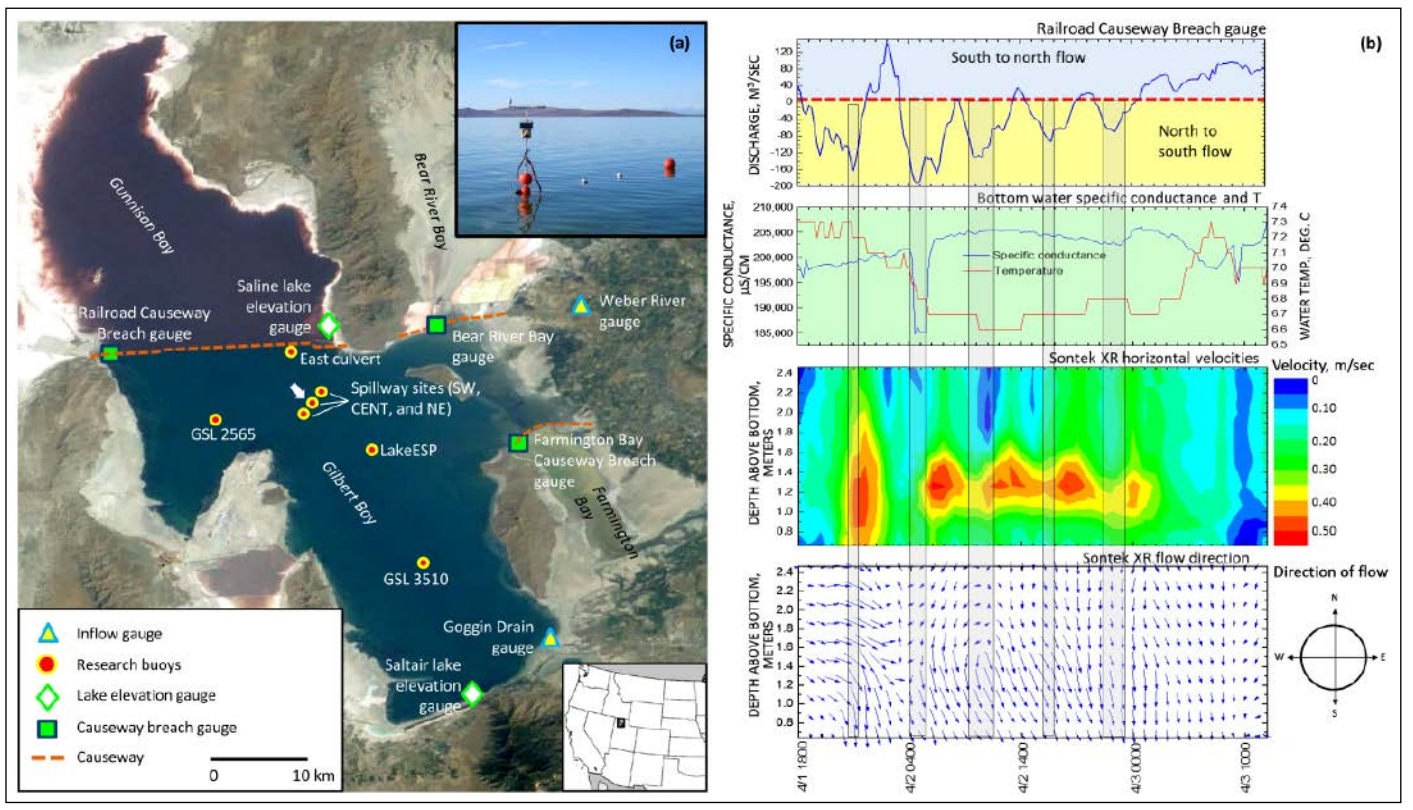

Fig. 1. Map of Great Salt Lake monitoring sites and networks. White arrow shows the approximate location of the naturally occurring spillway structure on the lake bottom. Background map is from the Image Science and Analysis Laboratory, NASA Johnson Space Center: "The Gateway to Astronaut Photography of Earth" (see http://eol.jsc.nasa.gov/scripts/sseop/photo.pl?mission=ISS002&roll=707&frame=87). (a) Photograph of the Lake Environmental Sensing Platform (LakeESP) research buoy after installation. (b) An example of the high-resolution monitoring data collected at the Railroad Causeway Breach and CENT spillway sites during 1–3 April 2012. Gray vertical bars on Figure 1b outline discharge peak during reverse flow events at Railroad Causeway Breach gauge.

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(OOTI) system for mercury measurements over the Chukchi Sea ice site and over the snow-covered Arctic tundra (Tundra field site). From initial analyses, mercury cycling showed clear differences between the sites: higher mercury levels deposited in the surface snow at the Chukchi Sea site were associated with higher ion concentrations over the Arctic Ocean, while higher levels of mercury reemitted into the atmosphere were observed above the tundra land. Mercury and halogen chemical processes are found to be influenced by vapor plumes emanating from leads in sea ice. A high-definition video showing vapor plumes from leads in the Chukchi Sea is included in the supporting information in the online version of this brief report.

Halogen, ozone, and mercury measurements were also made at a tundra site about 5 kilometers inland, southeast of the town of Barrow. Near-continuous measurements of diatomic bromine (Br_2), bromine monoxide (BrO), hypobromous acid (HOBr), diatomic chlorine (Cl_2), and chlorine monoxide (ClO) were made with 1-minute time resolution using chemical ionization mass spectrometry. Br_2 production was examined from various saline snow and sea ice samples exposed to sunlight and ozone within an outdoor snow chamber. Surface snow collected above tundra and first-year sea ice was found to be an efficient substrate for bromine activation that was dependent on acidity and bromide/chloride ratios [*Pratt et al.,* 2013].

In addition, portable weather stations were installed to measure wind and temperature. Buoys from the International Arctic Buoy Programme (IABP) deployed offshore from the field camp and beyond provided measurements vital for large-scale analyses. The IceGoat1 meteorological buoy, acoustic instrumentation systems, and thermochrons were also deployed. Analyses of temperature data revealed complexities that emphasize the need for a rigorous protocol to be developed for accurate and consistent temperature measurements across the Arctic. Field excursions were also launched to collect extensive in situ data for sea ice and snow measurements for remote sensing validations.

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Need for Future Monitoring of Arctic Chemistry

BROMEX successfully acquired a vast array of coordinated measurements beyond the initial intention of the research scope. While analyses are ongoing, the results from BROMEX are already beginning to further advance scientific understanding of bromine processes (activation, distribution, and termination), together with ozone depletion in the troposphere and mercury deposition into sea ice. In view of the Minamata Convention, a landmark agreement reached in January 2013 for a global treaty to curb mercury pollution, interdisciplinary research such as that conducted as part of the BROMEX project needs to be sustained in establishing the scientific foundation to assess the efficacy of the treaty. As climate change profoundly alters the Arctic, monitoring chemical and environmental changes in the new Arctic is crucial to account for their potential impacts.

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NEWS

New EPA Director Calls Climate Change a Fundamental Economic Challenge

"Climate change isn't an environmental issue; it is a fundamental economic challenge for us," said Regina "Gina" McCarthy, the newly confirmed administrator of the U.S. Environmental Protection Agency (EPA), during a 30 July speech at Harvard University's Kennedy School of Government. In this first public address since her confirmation on 18 July as the 13th EPA administrator, McCarthy insisted that protecting the environment makes good economic sense.

McCarthy said the agency also faces challenges related to other key issues, including water and environmental justice. In addition, she acknowledged the need to refresh the agency's image, which has been criticized by some who believe that various EPA regulations have had a negative effect on the U.S. economy. She said EPA needs to listen to all stakeholders and should convince the American public that the agency is taking advantage of the best thinking, the newest technologies, and the most cost-effective, sustainable solutions to meet the needs of the public.

"That means understanding how climate change solutions and other environmental protections fit as part of a sound national and global environmental and economic agenda," McCarthy noted. "We have to move beyond all those old discussions about [how] there's no inherent conflict between environment and economy. How many times have we said that? We really need to recognize that the future—our future, my children's future—depends on an economy that moves beyond that dichotomy issue and that recognizes that the limitations of the world's resources are real, the fragility of the world's ecosystems are real, the threats posed by pollution and a changing climate are real, and that to turn those challenges around we need a strong, sustainable economy that embraces these issues and behaves in accordance with what we know about science, the environment, technology, public health." She said, "We need the economy to serve the needs of current and future generations. That's where jobs will grow. That's how we have to look at the world looking forward."

McCarthy added, "For too long we have been focused on a false choice: It's not a choice between the health of our children and the health of our economy. We have endlessly debated that choice even in the face of 43 years of documented history that should by now have put that issue to rest. Today the truth is that we need to embrace cutting carbon pollution as a way to spark business innovation," she said. "We need to cut carbon pollution to grow jobs; we need to cut carbon pollution to strengthen the economy. Let's talk about this positively. Let's approach this as an opportunity of a lifetime, because there are too many lifetimes at stake to not embrace it this way, the way this country always embraces challenges: head on. That's how we need to deal with this issue."

The new EPA administrator said that President Barack Obama's recent remarks about the need for action on climate change in a Georgetown University talk (see *Eos, 94*(27), 239, doi:10.1002/2013EO270003) were "the most compelling and most important speech on climate change any president has ever delivered." She added that she welcomed EPA playing a key role in moving forward on climate change issues. McCarthy also credited numerous state and local efforts on climate change and said that EPA will learn from what is being done around the country.

Since 2009, McCarthy served as assistant administrator for EPA's Office of Air and Radiation, where she was instrumental in a number of issues including mercury and air toxics standards and EPA's proposal for carbon pollution standards for new power plants. Previously, she was commissioner of the Connecticut Department of Environmental Protection and deputy secretary of operations within former Massachusetts governor Mitt Romney's Office for Commonwealth Development.

She was confirmed as EPA administrator by the U.S. Senate on 18 July following her nomination by President Obama on 4 March and a drawn-out Senate process that called for her to respond to numerous questions primarily from Republican senators. "Getting confirmed 2 weeks ago, it was truly an honor of a lifetime and that's a very good thing, because I swear it took two lifetimes for me to get confirmed," McCarthy mused. "Okay, it's a slight exaggeration. But it was 1000-plus questions, 70-plus Senate visits, 147 days later, and here I am. That was easy."

U.S. Senator Joe Manchin (D-W.Va.), the only Democrat who voted against her confirmation, called McCarthy pragmatic and a talented scientist. "My fight is not with her. My fight is with President Obama and the EPA, the regulatory agency that has consistently placed unreasonable regulations and unobtainable standards on energy production rather than focus on efforts to develop a domestic all-of-the-above energy strategy for the future," he said. Manchin commented that as EPA assistant administrator for air and radiation, McCarthy "has been responsible for overseeing some of EPA's most unreasonable and restrictive proposals. Because of this, I do not believe she is the leader who we are looking for to make this all-of-the-above plan a reality."

Sen. Rand Paul (R-Ky.) noted, "By nominating Gina McCarthy to serve at the helm of President Obama's overreaching EPA, he has essentially promoted his lieutenant in the war on coal to be commanding general."

Edison Electric Institute president Tom Kuhn said that McCarthy "has a keen understanding of the challenges facing our industry, and we have had a long and constructive relationship. We will continue to work with her and her team to ensure that EPA considers the environmental benefits as well as the energy and economic impacts—particularly on customers—of each rulemaking that affects our industry." Kuhn noted that a number of electric power industry issues are on EPA's regulatory agenda, including a rule for cooling water intake structures, coal ash regulations, and new source performance standards for new and existing power plants.

USEPA

Environmental Protection Agency administrator Gina McCarthy

American Gas Association president and CEO Dave McCurdy stated that he and McCarthy "have a constructive working relationship based on open and honest dialogue that will continue as we work towards the shared goal of improving the data available on the environmental impact of natural gas. The natural gas industry is actively engaged in a fact-based dialogue about building a clean and secure energy future for our nation. Recent EPA estimates of greenhouse gas emissions from the well to natural gas customers' homes and businesses have been dramatically reduced and America's natural gas utilities are committed to continuing to lower them further. We look forward to working with Gina and her staff on that effort."

The environmental community generally praised McCarthy. For example, Natural Resources Defense Council president Frances Beinecke called her "one of the most qualified, capable and collaborative leaders ever to head [EPA]."

In her talk at Harvard, McCarthy maintained her focus on the economy as well as on health and other benefits from previous EPA rulemaking, and she highlighted some specific EPA successes. For instance, she said that between 1970 and 2011, the U.S. gross domestic product grew 212% and the U.S. population rose 52%, while emissions of air pollutants dropped 68%. She added that the benefits from the Clean Air Act outweigh costs by a ratio of more than 30:1 and that brownfield cleanup programs have leveraged more than $20.8 billion in economic development since 1995. "That is how you use federal dollars to advance the public interest," she said. "That is what EPA is all about. We are not just about rules and regulations. We're about getting environmental improvement wherever it makes sense to improve. And frankly, that still is everywhere. We still can be doing better, because the more you look at the science, the more it drives you to improvement."

McCarthy said that while climate change is an important issue, "we can't be all about climate as if the only thing we have to do is to figure out how to deal with the energy world." She cautioned that in a changing climate, with floods and droughts, there is a need to understand how to address challenges related to the delivery of clean drinking water, for example. With regard to environmental justice, she said that many of the same communities that have borne the burdens of environmental and health challenges may also bear the brunt of a changing climate. She said that EPA needs to help reduce toxic waste in those communities and help them build resilience to climate change.

—RANDY SHOWSTACK, Staff Writer

MEETINGS

Future Arctic Research: Integrative Approaches to Scientific and Methodological Challenges

The Arctic Hub—Regional and Global Perspectives; Kraków, Poland, 16 April 2013

Climate change has significant consequences for both the natural environment and the socioeconomics in the Arctic. The complex interplay between the changing atmosphere, cryosphere, and ocean is responsible for a multitude of feedbacks and cascading effects leading to changes in the marine and terrestrial ecosystems, the sea ice cycle, and atmospheric circulation patterns. The warming Arctic has also become a region of economic interest as shipping, natural resource exploitation, and tourism are becoming achievable and lucrative with declining sea ice. Such climatic and anthropogenic developments are leading to profound changes in the Arctic, its people, and their cultural heritage.

While these changes are occurring at a quick pace, researchers have yet to develop comprehensive functional models of the Arctic system and accurate predictions to support governance frameworks and policies. However, there is a growing need to respond urgently to the ongoing and upcoming socioeconomic changes to map the path for a sustainable Arctic future. Under these circumstances, going beyond traditional information delivery systems for integrating knowledge and promoting informed decision making is needed. Under this premise, the Association of Polar Early Career Scientists (http://www.apecs.is) held a 1-day workshop prior to the Arctic Science Summit Week conference in Kraków, Poland.

During the workshop, 28 early-career researchers from 11 countries and 20 disciplines along with 6 senior researchers with science, policy, and indigenous peoples' perspectives and backgrounds came together to participate in a series of plenary talks, breakout sessions, and discussion groups. Discussions were focused around how scientific and socioeconomic questions can be addressed and how key stakeholders—specifically indigenous people—can be involved continuously in research to meet the Arctic challenges in a timely manner. Emphasis was put on co-developing these ideas with early-career researchers, who will take leadership roles in the near future.

Topics discussed included changes in the carbon cycle in marine ecosystems, appropriateness of the current legal regime to protect the fragile Arctic environment, and application of sustainable development practices with concern for the physical environment that could have a positive global influence.

There was a general agreement that scientists play an important role in raising awareness for the need of action, as well as in developing the capacity for action in local communities and among policy makers. Thus, it is important that scientists develop skills to communicate the pressing issues in understandable ways. Within this context, co-design of usable knowledge was identified as a new approach to engaging stakeholders in science, making current research more practically oriented where appropriate, and fostering ownership of the solution among all parties, which increases the likelihood for timely action.

Concrete outcomes of this workshop include a proposed internship program that will allow early-career researchers to experience different science and policy-relevant environments and a close collaboration with the Arctic Council Indigenous Peoples' Secretariat, including a workshop in 2014 and a future early-career researchers' community field school.

For a more detailed summary of the identified driving Arctic issues and results from the discussions, please visit http://www.apecs.is/apecs-meetings-a-events/assw-2013.

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Robust Results From Climate Model Simulations of Geoengineering

GeoMIP 2013; Potsdam, Germany, 15–16 April 2013

Solar geoengineering has been proposed as a temporary means of alleviating some of the consequences of anthropogenic greenhouse gas emissions. Single-model studies characterizing the resulting climate effects often used different greenhouse gas concentration profiles and different amounts of geoengineering, making intercomparison difficult. The Geoengineering Model Intercomparison Project (GeoMIP) created a framework of four core simulations, designed to reveal robust features and key uncertainties of climate model responses to geoengineering (B. Kravitz et al., The Geoengineering Model Intercomparison Project (GeoMIP), *Atmospheric Science Letters, 12*(2), 162–167, doi:10.1002/asl.316, 2011). These experiments simulate solar geoengineering via uniform solar reduction or creation of stratospheric sulfate aerosol layers using state-of-the-art climate models.

The third GeoMIP workshop, held at the Institute for Advanced Sustainability Studies (IASS), Potsdam, Germany, assessed the findings from GeoMIP regarding geoengineering: (1) Models widely agree on the sign of spatial patterns of temperature, precipitation, and net primary productivity responses. (2) All monsoon areas show reduced precipitation, manifested as reduced numbers of intense precipitation events. (3) Moisture availability for plants may be unaffected, as evapotranspiration is also reduced. (4) If geoengineering is abruptly ceased, the rate of climate change for several years after is many times greater than the rate caused by carbon dioxide increases alone. (5) Key uncertainties in aerosol formation, growth, and deposition and lack of ability to accurately simulate some of the dynamical effects of volcanic eruptions remain prominent limitations in geoengineering research.

The workshop involved discussions of nearly 30 planned peer-reviewed articles, including contributions to a GeoMIP special issue of *Journal of Geophysical Research-Atmospheres*. Three new GeoMIP experiments to investigate artificial brightening of marine stratocumulus clouds were outlined during the meeting. Also discussed was the provision of climate model output to the impacts assessment community, including coordination with the Inter-Sectoral Impact Model Intercomparison Project, a model intercomparison dealing with the impacts of climate change.

The interdisciplinary mission of IASS provided an atmosphere where physical and social scientists could directly interact. Social scientists at IASS presented legal and economic perspectives on geoengineering and studies of how GeoMIP has affected discourse. Further interdisciplinary discussions and studies are planned.

The workshop included 37 members of the physical and social science communities from 10 different countries. Results from 12 climate models are currently available, and continued analyses of the simulated climate effects are under way. The official GeoMIP Web page (http://climate.envsci.rutgers.edu/GeoMIP) discusses simulation specifics and current progress and will be updated as more information becomes available.

Author Ben Kravitz is supported by the Fund for Innovative Climate and Energy Research (FICER). The Pacific Northwest National Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under contract DE-AC0576RL01830. Author Alan Robock is supported by U.S. National Science Foundation grants AGS-1157525 and CBET-1240507, which also partially supported the workshop. Financial support for the workshop was provided by IASS, which is funded by the German Federal Ministry for Education and Research (BMBF), Brandenburg Ministry for Science, Research and Culture (MWFK), and the FONA research program. We thank all participants of the workshop for their contributions, and we thank Mark Lawrence, Achim Maas, and Corinna Bobzien for local support and Melissa Arnesen for assistance with travel arrangements.

—BEN KRAVITZ, Atmospheric Sciences and Global Change Division, Pacific Northwest National Laboratory, Richland, Wash.; E-mail: ben.kravitz@pnnl.gov; ALAN ROBOCK, Department of Environmental Sciences, Rutgers University, New Brunswick, N. J.; and PETER IRVINE, IASS Institute for Advanced Sustainability Studies, Potsdam, Germany

GEOPHYSICAL YEAR MEETINGS CALENDAR

This column announces upcoming meetings and symposia of interest to Earth and space scientists. To submit an announcement for the Geophysical Year Meetings Calendar, go to http://www.agu.org/cgi-bin/geosoc/cal-submit?cal=gycal. There is no fee for these brief listings.

■ 16–25 August 2013 **Impacts and Their Role in the Evolution of Life**, Kuressaare, Republic of Estonia. Sponsors: Nordic Network of Astrobiology and the University of Helsinki. (Wolf Dietrich Geppert, Stockholm University; Tel.: +46 8 5537 8649; E-mail: wgeppert@fysik.su.se; Web site: http://www.nordicastrobiology.net/Impacts2013/)

■ 1–5 September 2013 **The 9th International Symposium on the Cretaceous System**, Ankara, Turkey. Sponsor: Middle East Technical University. (Ýsmail Ömer Yýlmaz, Middle East Technical University, Ankara, Turkey; E-mail: ioyilmaz@metu.edu.tr; Web site: http://www.cretaceous2013.org/en/default.asp)

■ 2–6 September 2013 **International Conference on Soil Mechanics and Geotechnical Engineering (18th ICSMGE)**, Paris, France. Sponsor: International Society for Soil Mechanics and Geotechnical Engineering. (Violaine Gauthier, Tel.: +33 1 70 94 65 04; Fax: +33 1 70 94 65 01; E-mail: secretariat@paris2013-icsmge.org; Web site: http://www.issmge2013.org)

■ 2–6 September 2013 **IAMG 2013: Frontiers of Mathematical Geosciences: New Approaches to Understand the Natural World**, Madrid, Spain. Sponsors: The Geological Survey of Spain; The North American Mathematical Science Institute. (Cristina Berbel and Carolina Guardiola Albert, E-mail: congresosfg@rect.ucm.es and c.guardiola@igme.es; Web site: http://www.igme.es/internet/iamg2013/default.htm)

■ 22–27 September 2013 **10th Applied Isotope Geochemistry Conference–AIG-10**, Budapest, Hungary. Sponsor: International Association of GeoChemistry (IAGC). (Attila Demény, AK Congress, P.O. Box 245, H-1519 Budapest, Hungary; Tel.: +36 1 464 8218; Fax: +36 1 464 8221; E-mail: demeny@geochem.hu; Web site: http://www.aig10.com/)

■ 24–27 September 2013 **Whistler 2013: Geoscience for Discovery**, Whistler, British Columbia, Canada. Sponsor: Society of Economic Geologist. (Glenda Freeman, Suite 206, 201 Bewicke Avenue, North Vancouver, BC, V7M 3M7 Canada; Tel.: +1-778-338-4142; Fax: +1-604-984-6439; E-mail: seg2013@seatoskymeetings.com; Web site: http://www.seg2013.org/)

■ 27 September to 1 October 2013 **3rd International Conference on Crystallogenesis and Mineralogy**, Novosibirsk, Russian Federation. Sponsors: Novosibirsk State University; Russian Academy of Sciences; Russian Mineralogical Society. (Tatyana Bekker, 3 Koptyug Avenue, 630090 Novosibirsk, Russian Federation; E-mail: t.b.bekker@gmail.com; Web site: http://km.igm.nsc.ru)

■ 13–15 November 2013 **Third International Conference on Geotechnique, Construction Materials and Environment - GEOMATE 2013**, Nagoya, Japan. Sponsor: Nagoya Institute of Technology. (Teruo Nakai, Nagoya Institute of Technology, Nagoya, Japan; see http://www.geomat-e.com/apps/contactme/sites/show; Web site: http://www.geomat-e.com/). Registration deadline is 15 August 2013.

■ 9–14 February 2014 **Exoclimes III: The Diversity of Planetary Atmospheres**, Davos, Switzerland. Sponsor: University of Exeter. (http://www.exoclimes.org/contact/; Web site: http://www.exoclimes.org/). Abstract deadline is 15 September 2013.

ABOUT AGU

Kim Receives 2012 James R. Holton Junior Scientist Award

Daehyun Kim received the James R. Holton Junior Scientist Award at the 2012 AGU Fall Meeting, held 3–7 December in San Francisco, Calif. The award recognizes outstanding research contributions by a junior atmospheric scientist within 3 years of his or her Ph.D.

Citation

Daehyun Kim, the winner of the James R. Holton Junior Scientist Award, works on intraseasonal variability (especially the Madden-Julian Oscillation (MJO)) and deep convection, including convective parameterization and climate model development. Although only receiving his Ph.D. 2 years ago, he has published 21 papers in high-quality journals.

His accomplishments can best be described by quoting from his nomination letters. "I would argue that Daehyun has done as much as any other single individual (at any career stage) in the last few years to push forward our understanding of the MJO using GCMs." "His work is distinguished from that of others in the field by two things. First, Daehyun is able to get into a model—including into the guts of the parameterizations—and manipulate it with great facility. He is also unparalleled at model diagnosis and analysis." "This kind of deep analysis is needed if we are to learn about the atmosphere from flawed models—and when we study the MJO, all models are flawed."

"Simply put, Daehyun is a scientific phenomenon. He is one of those rare individuals who possess keen scientific insight as well as the boundless enthusiasm and energy to carry out his ideas. We could tell that Daehyun was someone special when he took it upon himself to lead development of the MJO Diagnostics package of the CLIVAR [Climate Variability and Predictability] MJO Working Group as a student. This comprehensive package is considered the gold standard for MJO diagnosis. Amazingly, he did this project on the side while developing a convection parameterization for his Ph.D. research." "I consider Daehyun to be the best young scientist to enter the field of tropical meteorology in the last few years, and I feel fortunate to have interacted with him."

"After arriving at Columbia, Daehyun made it a point to learn the gory details of our GCM [general circulation model] so he could design and implement his own improvements. Almost no one ever has the tenacity and insight to do this successfully with GCMs except the people who build them and run them. To paraphrase the old saying—everyone always complains about climate models but nobody ever does anything about them. Daehyun was the exception—he did something."

"The energy and fundamental insights Daehyun brings to any problem he tackles, combined with his tremendous intellectual curiosity and a humility that too few scientists exhibit, account for the steep arc his career has taken."

"Daehyun Kim is really a prototype for the 21st-century leader in the climate community. There are not many tropical meteorologists (of any age) who can translate theoretical insights into practical approaches that actually make climate models more realistic."

For these reasons, the AGU Atmospheric Sciences section is proud to award the 2012 James R. Holton Junior Scientist Award to Daehyun Kim.

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

Daehyun Kim

Response

It is my great honor to be selected as a recipient of the James R. Holton Junior Scientist Award by AGU. I appreciate AGU and the award committee for the award. I first saw Professor Holton's name on his famous textbook when I was an undergraduate student. I remember his book made me think that atmospheric science was fun. I personally regard the prestigious award given to me as an encouraging message from the society, and I also feel that I have to pay back to the society in any way I can.

I should acknowledge the names of people who have heavily influenced my research career. I know the award would not be mine if I had not met these people: In-Sik Kang, my thesis advisor, who taught me how to live as a scientist; Adam Sobel and Tony Del Genio, my postdoc advisors, who broadened my view on science and provided me with endless opportunity; and Duane Waliser, Ken Sperber, Eric Maloney, Chidong Zhang, and other scientists in the U.S. CLIVAR MJO Working Group, who have continuously helped me and encouraged me since I was a graduate student. Finally, I would like to mention the two women I love the most: my wife Mijung Lim and my daughter Irene Kim. Thank you.

—Daehyun Kim, Columbia University, Palisades, N. Y.

What's on the Web?

Read the latest offerings from the AGU Blogosphere:

Dan's Wild Wild Science Journal: "Fascinating theory on life's origins getting NASA's attention and money" (http://goo.gl/fFlcwJ)

The Landslide Blog: "The Darjeeling landslide disaster of 1950" (http://goo.gl/eDRzbd)

Terra Central: "The ins and outs of fracking and underground waste injection wells" (http://goo.gl/NrZ0sT)

Mountain Beltway: "New Rockies gigapannery" (http://goo.gl/1Bjb6O)

The Trembling Earth: "The jiggling Earth, or, what are all those squiggles?" (http://goo.gl/DGwCmu)

The Plainspoken Scientist: "Breaking news by bicycle: AGU's Mass Media Fellow recounts chasing the news on two wheels" (http://goo.gl/ISyktg)

NASA JPL

The "Lost City" hydrothermal vents, found on the Atlantic seafloor, could hold key evidence supporting the hypothesis that serpentinization provided the energy needed for life to emerge on the planet more than 4 billion years ago, Dan Satterfield reports in Dan's Wild Wild Science Journal blog.

CLASSIFIED

POSITIONS AVAILABLE

Atmospheric Sciences

Carbon Cycle Scientist.

The Jet Propulsion Laboratory invites applications for a full-time position in carbon cycle modeling and analysis, with an emphasis on forward and inverse modeling of greenhouse gas concentrations, surface fluxes and concentration gradients. The applicant will join a broad-based team of researchers within the Lab's Carbon and Climate initiative area working in carbon cycle science, remote sensing and in-situ measurement of greenhouse gases, and development of new missions and carbon cycle science projects. JPL's Carbon and Climate program is integrative and includes urban, terrestrial, oceanic and atmospheric components. The scope of the position includes carbon cycle modeling, inversion techniques, field measurements to support carbon cycle science, interpretation of remote sensing measurements from ground-based, aircraft and satellite instruments, and proposal development. Opportunities will exist for high-resolution analysis and models using data from the imminent flight of OCO-2 synergistically with other missions providing related and correlative data. Expertise is required in inverse modeling, carbon cycle modeling, and/or remote sensing of atmospheric greenhouse gases and tracers. The applicant should also have expertise in network design and optimization as well as broad knowledge of scientific applications of greenhouse gas measurement approaches. The successful applicant must have a PhD in Environmental Science, Applied Physics, Engineering, or a related technical discipline along with an established reputation as evidenced by a significant record of peer-reviewed publications. The incumbent is expected to collaborate with other researchers, analyze and interpret data from an array of instruments, and participate in establishing the science foundation and requirements for future greenhouse gas-related projects and missions.

JPL is a Federally-Funded Research and Development Center operated by the California Institute of Technology for NASA. JPL/Caltech offers a competitive salary and impressive benefits, and provides research opportunities at the leading edge of carbon cycle science. Please apply online at: http://Careerlaunch.jpl.nasa.gov/ (Job ID #11524). Applications will be reviewed as they are received, and should include a curriculum vitae, a career statement with research objectives, and contact information for three professional references. JPL/Caltech is an equal opportunity/affirmative action employer.

Permanent Position available at the National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Maryland Chief, Global Modeling and Assimilation Office.

The Earth Sciences Division (ESD) at NASA's Goddard Space Flight Center in Greenbelt, Maryland is seeking a Senior Scientist to head the Global Modeling and Assimilation Office (GMAO), which is a unit within the ESD. The GMAO is NASA's flagship effort in global data assimilation, climate-focused reanalyses, weather and short-term climate prediction. Organizational goals are to maximize the impact of satellite observations in the analysis and prediction of climate and weather through integrated Earth system modeling and data assimilation systems that support NASA's goal of understanding the Earth as a complete dynamic system. The successful applicant will lead a team of scientists, including NASA civil servants, support scientists and software developers, about 100 staff members in total.

The scope of responsibilities includes: strategic planning, supervision and conduct of research in the broad disciplines of global modeling of the Earth system, and of four-dimensional data assimilation; oversight of the design, development, evaluation, and application of the end-to-end modeling and assimilation system needed to achieve organizational goals; the obtainment and management of resources to achieve the GMAO's core goals; and supervisory management of GMAO's civil service staff. In addition to management responsibilities, the incumbent is expected to conduct independent research and to maintain an active role as a leading scientist in a field that is central to the core of the GMAO's mission.

A successful record of winning proposals in the Earth Science arena is required. Significant publications in prominent Earth Science peer-reviewed journals are expected. Successful candidates must have a breath of knowledge and analysis experience in one or more of the following disciplines: meteorology, atmospheric, oceanic or land surface hydrology science, estimation theory; experience conducting projects that utilize remote sensing data in conjunction with global models in Earth Science applications research; and leadership in modeling and/or data assimilation. PhD desired.

U.S. citizenship required. Position is at the GS-15 grade level (salary $123,758 - $155,500). To view the full vacancy announcement which contains further information, including qualification requirements and how to apply go to http://www.usajobs.gov/GetJob/ViewDetails/348279600. Applications must be received by August 28, 2013. For information about the GMAO and the scope of its activities, please contact Peter Hildebrand, Director, Earth Sciences Division, at 301-614-5635, or by e-mail at Peter.H.Hildebrand@nasa.gov

NASA, GSFC is an Equal Opportunity Employer.

Geochemistry

Assistant Professor of Organic Geochemistry Geosciences Department The University of Tulsa.

The Department of Geosciences at The University of Tulsa invites applications for a tenure-track faculty position in Organic Geochemistry at the Assistant Professor level. A Ph.D. in geochemistry or a related field is required, with demonstrated expertise in Organic or Petroleum-related Geochemistry. We seek an individual who shows the potential for outstanding achievement in research and teaching. The successful candidate will be expected to teach courses at the undergraduate and graduate levels, and establish an externally funded research program. Interdisciplinary and international collaborative research is encouraged. The University of Tulsa is a premier private doctoral-granting research institution committed to excellence in teaching, creative scholarship, and service. The University offers competitive salary and benefits packages. Minorities and women are encouraged to apply.

The city of Tulsa has a vibrant geological and geophysical community. Tulsa is home to the international headquarters of the American Association of Petroleum Geology, Society of Exploration Geophysics, and the Society for Sedimentary Geology. The Department of Geosciences boasts an array of analytical equipment in geochemistry, including new state-of-the-art precision GC units, Soxhlet extraction capability, as well as state-of-the-art x-ray diffraction, SEM, micro-FTIR, UV-Vis and Electron Microprobe. Accessible research equipment in the College includes E-SEM, SEM-FIB, LC-MS/MS, ICP-MS, and a confocal Raman microscope.

Send a letter of application stating research and teaching interests, curriculum vita, and name and contact information for three references to Dr. Bryan Tapp, Chair, Department of Geosciences, The University of Tulsa, 800 South Tucker Drive, Tulsa, OK 74104-9700 or email to beverly-phelps@utulsa.edu. Application review will begin immediately and continue until the position is filled. The University of Tulsa does not discriminate on the basis of personal status or group characteristics including but not limited to the classes protected under federal and state law. The University of Tulsa is an EEO/AA employer.

CHRONOS - Postdoctoral position(s) for Re-Os geochemistry of shales and hydrocarbons.

The AIRIE Program at Colorado State University (CSU) is affiliated with a new Centre of Excellence at University of Oslo (UiO), CEED (Centre for Earth Evolution and Dynamics). Highly motivated applicants are sought to carry out frontier research in the Arctic region funded by the Norwegian petroleum industry under the CHRONOS project. Research directions are guided by results addressing key issues in geoscience while simultaneously enhancing the knowledge base for industry - for example, time scale calibration and correlation, paleoenvironment reconstruction, seawater anoxia, chemistry and correlation in lacustrine systems, sulfide and shale geochronology, and climate change in the deep past. The AIRIE Program is a global leader in development and application of Re-Os technology with a reputation for integrating field science with lab results. Learn more at www.airieprogram.org and www.earthdynamics.org. While the new hires will be based at AIRIE-CSU, they will also interact with CEED-UiO scientists and industry partners. Direct questions to Dr. Holly Stein, Director, AIRIE Program-CSU and Professor, CEED-UiO (holly.stein@colostate.edu).

To apply and view a complete position description, please visit: http://warnercnr.colostate.edu/employment-opportunities.html. For full consideration applications should be submitted by September 2, 2013.

Colorado State University conducts background checks on all final candidates.

CSU is an EO/EA/AA employer.

TEMPLE UNIVERSITY TENURE TRACK POSITION IN STABLE ISOTOPE GEOCHEMISTRY.

The Department of Earth and Environmental Science, with nine tenure track faculty, is entering a period of growth with plans to implement a Ph.D. Toward that goal, the department seeks to fill two tenure-track faculty positions AT ANY RANK to begin in August 2014. One of the positions will be in the area of STABLE ISOTOPE GEOCHEMISTRY. See a separate advertisement for the ECO-HYDROLOGY position. Applicants must have a Ph.D. in a relevant science or engineering discipline. We welcome applicants with interests in the use of stable isotopes to address issues related to climate change, nutrient cycling and ecological tracers, petroleum or ore deposits, and atmospheric/groundwater contaminants.

The successful candidate is expected to establish a stable isotope laboratory and develop a multidisciplinary research program in their specialty supported by internal and external funding. We are seeking individuals who will complement and expand departmental strengths in geochemistry, hydrology, mineralogy, structural geology, sedimentology, and stratigraphy. The new faculty member

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will teach courses in geology and environmental science and be actively involved in undergraduate and graduate (M.S. and Ph.D.) research and mentoring.

Applications should include a CV, statement of teaching goals, a research plan, names and addresses of at least three references, and selected reprints. Instructions for uploading application materials are at: http://ees.cst.temple.edu/. Send a letter of intent and any inquires to David Grandstaff, Chair, Search Committee, grand@temple.edu. We request application material be submitted by September 16, 2013. Temple University is a public, Pennsylvania state-related research-intensive university located in north Philadelphia, with a diverse student community and total enrollment of about 37,000. More information about our department is available at http://www.temple.edu/geology/. Temple University is an equal opportunity, equal access, affirmative action employer committed to achieving a diverse community (AA, EOE, M/F/D/V). The department specifically encourages applications from women and minorities.

Hydrology

TEMPLE UNIVERSITY TENURE TRACK POSITION IN ECOHYDROLOGY.

The Department of Earth and Environmental Science is entering a period of growth with plans to implement a Ph.D. To move toward that goal, the department seeks to fill two tenure-track faculty positions to begin in August 2014. One of the positions will be in the area of ECOHYDROLOGY. See separate advertisement for ENVIRONMENTAL ISOTOPE GEOCHEMISTRY position. Exceptional candidates holding a Ph.D. are encouraged to apply at any level (assistant, associate, or full professor).

Possible areas of expertise for the ECOHYDROLOGY position include coupled hydrological and ecological processes involving water, energy, carbon, sediment, and nutrient fluxes, as well as the ecological impacts of contamination. Candidates with expertise in urban stormwater management, watersheds, or wetlands are of particular interest. The individual is expected to use a combination of field-based data collection and modeling approaches to quantify ecohydrologic impacts of human development. Mentoring of undergraduate and graduate students and securing external funding are expected. Applicants must have a Ph.D. in a relevant science or engineering discipline, and will be expected to teach courses for majors in Geology and Environmental Science.

Applications should include a CV, statement of teaching goals, a research plan, names and addresses of at least three references, and selected reprints. Instructions for uploading applications materials are at: http://ees.cst.temple.edu/. Send a letter of intention to apply and any inquiries to Laura Toran, Chair, Search Committee, ltoran@temple.edu. We request application material be submitted by September 16, 2013. Temple University is a state-related research intensive university with an undergraduate enrollment of about 28,000. More information on our department is available at http://www.temple.edu/geology/. Temple University is an equal opportunity, equal access, affirmative action employer committed to achieving a diverse community (AA, EOE, M/F/D/V). The department specifically encourages applications from women and minorities.

The Department of Scientific Computing at the Florida State University (http://www.sc.fsu.edu/) has a post-doc position in uncertainty quantification for groundwater reactive transport modeling. The successful candidate will work in an interdisciplinary environment to develop a computational framework for quantification and reduction of predictive uncertainty in groundwater reactive transport modeling. Research experience with computational Bayesian modeling and surrogate modeling are desired. Applicants should send a curriculum vita, statement of research interests, and contact information of three references to Professor Ming Ye (mye@fsu.edu). Applications will be accepted until the position is filled. The applicant should hold a Ph.D. degree at the time of the appointment.

The School of Public and Environmental Affairs (SPEA) at Indiana University-Bloomington (IUB) invites applications for a tenure-track faculty position in water resources. We seek an outstanding individual at the rank of Assistant Professor who will complement existing strengths in the environmental and ecological sciences on the IUB campus (see Integrated Program in the Environment at http://environment.indiana.edu). Preference will be given to candidates with training and research experience in water resources with a focus in hydrology. We are especially interested in someone who focuses on water resources (quantity or quality) and climate change. We expect faculty to establish an independent, externally funded research program and teach environmental science courses related to the candidate's discipline at undergraduate and graduate levels. A Ph.D. or an equivalent terminal degree in a relevant field of science or engineering is required or must be completed by January 2014. Postdoctoral research experience strongly preferred.

Review of applications will begin October 15, 2013 and continue until the position is filled. Please submit an application with complete contact information, statements of research and teaching interests, and a curriculum vita through our online application system https://indiana.peopleadmin.com. Additionally, applicants should have three letters of reference submitted on their behalf via the online system. Inquiries or questions about this job can be sent to: David Reingold, Executive Associate Dean for the Bloomington Campus, SPEA, Room 300, 1315 E. Tenth Street, Indiana University, Bloomington, IN, 47405-1701

Indiana University is an Equal Opportunity/Affirmative Action Employer, Educator and Contractor, and is strongly committed to achieving excellence through cultural diversity. The university actively encourages applications and nominations of women, persons of color, applicants with disabilities and members of other underrepresented groups.

Interdisciplinary/Other

Indiana University - Bloomington. The Department of Geography invites applicants for a Visiting Assistant Professor position in Environmental Change to begin on January 1, 2014. Candidates must have a Ph.D., teaching experience, and research and teaching interests that complement current strengths of the department. The appointee will be expected to teach introductory and advanced courses in physical geography, climatology, computer methods, and environmental topics. Specific teaching duties will be arranged based on candidate background and experience. Instructional responsibilities will be five courses per year (3 in the first semester). Applicants should have or expect to receive the doctoral degree by December 2013. The position will remain open until filled.

Applications received by September 15, 2013 are guaranteed full consideration. Applicants should submit a curriculum vitae, plus concise teaching and research statements (less than two pages each), and contact information for three referees. Apply to Dr. Daniel Knudsen, Chair, Department of Geography, Indiana University, 701 E Kirkwood Ave, Bloomington, IN 47405-6101, USA. Electronic materials are preferred and should be sent as pdf attachments to geog@indiana.edu with the message subject of "VAP in Env Change". Indiana University is an Affirmative Action/Equal Opportunity Institution M/F/D. The university promotes cultural diversity with regard to gender, race, ethnicity, nationality, sexual orientation and religion.

Rock Mechanics/Geomechanics Faculty Position at the University of Wisconsin-Madison. University of Wisconsin-Madison, Geological Engineering (GLE) invites applications for a full-time, tenure-track or tenured position as an assistant, associate, or full professor which is available beginning January 2014. A Ph.D. and background/expertise relevant to Geological Engineering, rock mechanics, and/or geomechanics is required. Geological Engineering is seeking candidates whose primary research interest is in experimental and/or computational approaches to geomechanics as applied to energy, underground construction, and environmental issues such as resource extraction (e.g., mining, oil and gas, geothermal energy, tunneling, etc.) and sequestration (e.g., nuclear waste, CO2, deep well injection, etc.). The successful candidate is expected to develop innovative and internationally recognized research programs, contribute to scholarly work in Geological Engineering, undertake instruction in undergraduate and graduate classes, and engage in professional service. The successful candidate is also expected to develop interactions with other faculty on the University of Wisconsin-Madison campus including those within the College of Engineering, the Department of Geoscience, and the Wisconsin Geological and Natural History Survey. Applications should include a curriculum vitae, research and teaching statements, and the names and contact information for three references. The University of Wisconsin-Madison Madison is an equal opportunity/affirmative action employer that promotes excellence through diversity and encourages all qualified individuals to apply. Unless confidentiality is requested in writing, information regarding the applicants must be released upon request. The application deadline is September 16, 2013 although applications may be considered until the position is filled. Applications should be

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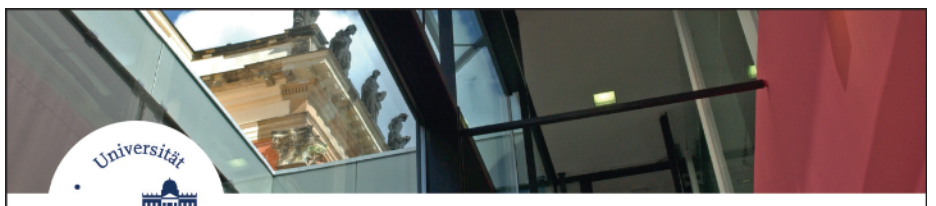

Universität Potsdam

The **University of Potsdam, Institute of Earth and Environmental Sciences,** in a joint appointment with the **German Research Centre for Geosciences (GFZ),** invites applications for a tenured

W3 Professorship for Remote Geoscience Sensing

The position, based at the GFZ, entails leadership of Section 1.4 „Remote Sensing" and involves close cooperation with the Institute of Earth and Environmental Sciences at the University of Potsdam. The successful candidate is required to actively contribute to teaching (2 hours per week) at the Institute of Earth and Environmental Sciences at the University of Potsdam in Geosciences and Geoecology bachelor and master level courses. Establishment of close links with local research initiatives and international research organizations is expected.

The successful candidate shall have an outstanding internationally recognized scientific record in the field of optical and radar (active microwave) remote sensing with special emphasis on imaging spectroscopy. Research focus on sensor technology and methodological development related to interdisciplinary applications in the field of geosciences is highly desired. Ability to lead a larger research group, long-term cooperation with international partners, experience in management of large-scale projects and a proven record of successfully raised third-party funds are also required.

Appointment will be made according to the laws of Brandenburg (Brandenburgisches Hochschulgesetz - BbgHG § 39). Prerequisites for an application are a doctoral degree, teaching skills, scientific excellence and extensive competence in science management. Furthermore, an outstanding record of research proven by the German "Habilitation" or equivalent scientific achievements is required.

The Geo.X platform (www.geo-x.net) coordinates geosciences in the Berlin-Potsdam region in research, education, infrastructure, and promotion of young scientists. The University of Potsdam and the GFZ are partners in Geo.X, thus offering excellent opportunities for cooperation across the partner institutions.

The University of Potsdam and the German Research Center for Geosciences are equal opportunity employers aiming at increasing the number of women in research and teaching and encourage applications from qualified female candidates. Handicapped applicants will be given preference in the case of equal qualifications.

For further information on the position please contact Prof. J. Erzinger (erzinger@uni-potsdam.de) at the University of Potsdam and Prof. H. Schuh (schuh@gfz-potsdam.de) at the GFZ Potsdam.

The University of Potsdam offers dual career support and coaching for newly-appointed professors: http://www.uni-potsdam.de/en/neue-beschaeftigte/information-for-newly-appointed-professors.html.

Send applications within four weeks after publication to Potsdam University, Office of the President, Am Neuen Palais 10, 14469 Potsdam, Germany or per E-Mail to president@uni-potsdam.de.

RESEARCH GEOPHYSICIST

Summary of Position:
Participate in the development of geophysical modeling codes for imaging complex-coupled subsurface processes. Work directly under the senior Lawrence Berkeley National Lab – Earth Sciences Division (LBNL ESD) Scientists to coordinate efforts that will incorporate new capabilities and data types into multi-physics imaging codes. Position requires a person that will implement and over-see the computational workflow and high-performance computing environment.

Responsibilities:
- Develop solutions to multi-physics geophysical inverse problems on high performance computational platforms, independently plan and complete small projects and make significant contribution to larger projects.
- Publish research results in refereed, archival journals.
- Present research results at group meetings, professional meetings, workshops, and conferences.
- Direct the work of technical support staff or students.
- Interact with work group and professional colleagues outside of LBNL.
- Assist in preparing funding proposals.

Qualifications:
- Required are numerical skills in geophysical inverse theory and large-scale optimization, joint inverse modeling methods, techniques for solving boundary value problems for EM and seismic wave propagation problems, knowledge of Maxwell's equations and elastic and acoustic seismology. Also essential are programming skills for distributed/parallel computing environments. Though not required for this position, geophysical data processing and computer graphic skills would be valued.
- PhD in Geophysics with 7+ years experience in geophysical forward and inverse modeling, parallel computation experience and programming, or equivalent combination of the above.
- Experience in the design and implementation of large scale geophysical modeling and imaging software from first-principles
- Extensive experience in coding, maintaining and executing workflow infrastructures handling high-throughput efficient computation
- Knowledge of parallel programming languages, MPI, as well as scientific programming languages; Fortran 90 and C, C++
- Experience with oral and written presentations of scientific work.
- Demonstrated ability to conduct independent research and organize data for publication and presentations.
- Excellent verbal and written communication skills.
- Strong record of scientific publications

For consideration please email your CV to GANewman@lbl.gov

Berkeley Lab is an Affirmative Action/Equal Opportunity Employer dedicated to the development of a diverse workforce.

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submitted electronically to GeoSearch@engr.wisc.edu. Additional information about GLE and the position can be found at gle.wisc.edu and http://www.ohr.wisc.edu/pvl/pv_077029.html.

The Geosciences Department at Hamilton College seeks applicants for a 3-semester, non-tenure-track Visiting Assistant Professor of Geosciences to begin in January 2014 and to extend through the end of spring semester 2015. The successful candidate for the 3-semester term position must have a Ph.D. in the geosciences with a broad background in sedimentary geology and related field experience. Teaching responsibilities will include a required course in sedimentary geology, a topical introductory course in geology, and one or more electives in the candidate's specialty. The candidate will be expected to advise undergraduate research projects.

Our program in sedimentary geology is supported by an isotope ratio mass spectrometer with elemental analyzer, a scanning electron microscope with EDS analytical capabilities, a small research vessel for inland lake studies equipped with a variety of sonar and coring devices, a full-time departmental technician, and by four supportive colleagues with diverse research interests.

A candidate interested in the position and who meets these requirements should submit: 1) a cover letter that addresses his/her qualifications for the position; 2) a statement describing his/her teaching philosophy; 3) a statement of research interests; 4) a complete curriculum vitae; and 5) letters from three professional referees who know the candidate well and understand the expectations of a competitive liberal arts college. Candidates should submit these materials to Associate Professor David Bailey via the Interfolio system at https://secure.interfolio.com/apply/21873. Review of applications will begin on September 15, 2013 and continue until the position is filled.

Hamilton (www.hamilton.edu) is a residential liberal arts college located in upstate New York. Applicants with dual-career considerations can find other Hamilton and nearby academic job listings at www.upstatenyherc.org. Hamilton College is an affirmative action, equal opportunity employer and is committed to diversity in all areas of the campus community. Hamilton provides domestic partner benefits. Candidates from underrepresented groups in higher education are especially encouraged to apply.

THE UNIVERSITY OF NEW BRUNSWICK, FREDERICTON CAMPUS Department of Earth Sciences

http://www.2.unb.ca/earthsciences/.

The Department of Earth Sciences at the University of New Brunswick invites applications for a tenure track Instructor I Curator position to begin January 1, 2014.

The successful applicant will have a minimum of a Masters degree in the Earth Sciences and a record of, or potential for, excellence in teaching Experience in teaching first and second year geoscience courses would be an asset. The applicant will also be responsible for the operation of the Quartermain Earth Sciences Centre museum and the curating of the museum and departmental collections Experience with museum curating and display development would be an asset

Applicants should submit a cover letter, full curriculum vitae, and a statement of teaching experience and philosophy.. Applicants should arrange to have letters of reference submitted by three or more referees familiar with their teaching experience or potential.

Applications may be sent by regular mail or email to: Dr Cliff Shaw,

Chair
Department of Earth Sciences
University of New Brunswick
2 Bailey Drive Fredericton, NB Canada, E3B 5A3
Email: lodge@unb.ca
Fax: 506-453-5055

The deadline to apply is September 15, 2013
Review of applications will begin immediately

All qualified candidates are encouraged to apply; however Canadian citizens and permanent residents will be given priority. Applicants should indicate their current citizenship status.

The University of New Brunswick is committed to the principle of employment equity This position is subject to budgetary approval

Student Opportunities

Available Ph.D. Graduate Assistantship at the Texas A&M University-Corpus Christi in the Coastal and Marine System Science doctoral program in the areas of oceanography; physics or related disciplines (pens.tamucc.edu/boguckilab). The assistantship provides competitive monthly stipend, tuition and health benefits. Fall semester applications are due on 1 October 2013 for priority consideration. More information about the CMSS program and the application procedure can be found at: http://cmss.tamucc.edu/application.html or email: Darek.Bogucki@tamucc.edu.

CHRONOS - PhD position(s) for Re-Os geochemistry of shales and hydrocarbons.

The AIRIE Program at Colorado State University (CSU) is affiliated with a new Centre of Excellence at University of Oslo (UiO), CEED (Centre for Earth Evolution and Dynamics). Highly motivated PhD student(s) are sought to carry out frontier research in the Arctic region funded by the Norwegian petroleum industry under the CHRONOS project. Research directions are guided by results addressing key issues in geoscience while simultaneously enhancing the knowledge base for industry - for example, time scale calibration and correlation, paleoenvironment reconstruction, seawater anoxia, chemistry and correlation in lacustrine systems, sulfide and shale geochronology, and climate change in the deep past. The AIRIE Program is a global leader in development and application of Re-Os technology with a reputation for integrating field science with lab results. Learn more at www.airieprogram.org and www.earthdynamics.org. Students will be based at AIRIE-CSU, but also interact with CEED-UiO scientists and industry partners. Direct questions to Dr. Holly Stein, Director, AIRIE Program-CSU and Professor, CEED-UiO (holly.stein@colostate.edu). Apply to the graduate program at http://graduateschool.colostate.edu

RESEARCH SPOTLIGHT

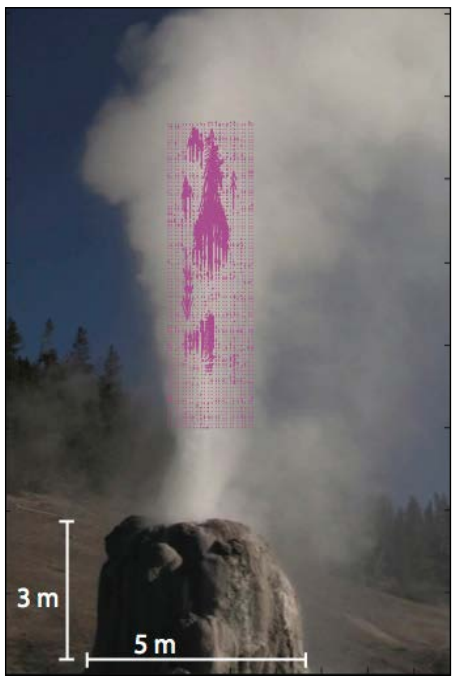
Highlighting exciting new research from AGU journals

Characterizing the dynamics of geyser eruptions

Some geysers have predictable eruptions that make them ideal for study. Understanding geyser eruption dynamics can provide insight into other intermittent natural processes, such as volcanic eruptions, but most studies of geysers have focused on the processes that trigger geyser eruption. The eruption jet dynamics are less well characterized.

In one of the most comprehensive studies of geyser eruption dynamics to date, over the course of a 4-day experiment at Lone Star Geyser in Yellowstone National Park, *Karlstrom et al.* measured water discharge, acoustic emissions, and infrared intensity and recorded visible and infrared video of the geyser. They selected Lone Star Geyser because it has relatively frequent and vigorous eruptions, about every 3 hours.

They found that the eruption cycle had four distinct phases: first, a main eruptive phase with liquid and steam fountaining and maximum jet velocities of 16 to 28 meters per second, concluded by a period in which the ratio of erupting steam to liquid increases; second, a posteruption phase with no discharge but periodic acoustic and infrared emissions; third, a recharge period during which the geyser cone refills; and fourth, a "preplay" period characterized by a series of 5- to 10-minute pulses of steam, periodic acoustic emissions, and small volumes of liquid water discharge. The authors also estimate the total heat output from the geyser to be about 1.4 megawatts, which is less than 0.1% of the total heat output from Yellowstone caldera. (*Journal of Geophysical Research-Solid Earth,* doi:10.1002/jgrb.50251, 2013) —EB



Video captured during a Lone Star Geyser eruption with calculated velocity field overlay; maximum calculated velocity shown is 18.36 meters per second.

Marcellus Shale fracking waste caused earthquakes in Ohio

Before January 2011, Youngstown, Ohio, had never had an earthquake since observations began in 1776. In December 2010 the Northstar 1 injection well came online; this well was built to pump wastewater produced by hydraulic fracturing projects in Pennsylvania into storage deep underground. In the year that followed, seismometers in and around Youngstown recorded 109 earthquakes—the strongest of the set being a magnitude 3.9 earthquake on 31 December 2011.

In a new study analyzing the Youngstown earthquakes, *Kim* found that the earthquakes' onset, cessation, and even temporary dips in activity were all tied to the activity at the Northstar 1 well. The first earthquake recorded in the city occurred 13 days after pumping began, and the tremors ceased shortly after the Ohio Department of Natural Resources shut down the well. Also, the author found that dips in earthquake activity correlated with Memorial Day, the Fourth of July, Labor Day, and Thanksgiving, as well as other periods when the injection at the well was temporarily stopped.

Further, the author found that the earthquakes were centered in an ancient fault near the Northstar 1 well. The author suggests that the increase in pressure from the deep wastewater injection caused the existing fault to slip. Throughout the year the earthquakes crept from east to west down the length of the fault away from the well—indicative of the earthquakes being caused by a traveling pressure front.

The author notes that of the 177 wastewater disposal wells of this size active in Ohio during 2011, only the Northstar 1 well was associated with such induced seismicity. (*Journal of Geophysical Research-Solid Earth,* doi:10.1002/jgrb.50247, 2013) —CS

Why freshwater organisms survived the asteroid that killed the dinosaurs

Roughly 65.5 million years ago, a massive asteroid smashed into present-day Chicxulub, Mexico. The impact set fire to Earth's surface. Dust and ash darkened the sky, sending the planet into an "impact winter" that lasted months to years and caused the extinction of nonavian dinosaurs and half of ocean-dwelling species. However, life in inland freshwater ecosystems largely escaped this fate. To try to understand why freshwater organisms held on while ocean life failed, *Robertson et al.* surveyed relevant research to understand how the mechanisms of extinction would have operated differently in the two environments.

Life in rivers and lakes, as well as the oceans, would have been protected from the initial blast of heat from the asteroid impact. Previous research suggests that the heat would have evaporated the upper half-centimeter of water but that temperatures at depth would have been largely unaffected. In the impact winter that followed, however, a lack of sunlight would have stalled photosynthetic production. Without photosynthesis, the decomposition of existing organic matter could have caused widespread hypoxia. In addition, the veil of dust and ash would have caused temperatures to drop.

Although all of these mechanisms would have operated in both the oceans and inland waterways, the authors propose that biological adaptations and differing physical processes could have made freshwater ecosystems more resilient—an argument supported by fossil evidence previously gathered in Montana's Hell Creek formation. The scientists hypothesize that freshwater organisms, often accustomed to annual freeze-thaw cycles and periodic hypoxia, would have held up better to the impact winter conditions. Fast-flowing river water could have reoxygenated inland waterways. Furthermore, groundwater seeps could have kept freshwater ecosystems warm and supplied with organic matter. Also, even in normal conditions, many freshwater organisms have dormant stages, including eggs or adults buried in mud, that allow them to await the return of more clement conditions. Because the Chicxulub impact winter only lasted from 6 months to 2 years, the authors suggest that these differences could have helped freshwater species hold on until the sky cleared. (*Journal of Geophysical Research-Biogeosciences,* doi:10.1002/jgrg.20086, 2013) —CS

Understanding the complexities of volcanoes that erupt just once

Most of the world's volcanoes erupt only once and, often, only for a short time—a few days to a couple of weeks. Because of the brevity of the eruptions and possibly because of a presumed docility, singly erupting volcanoes, known as monogenetic volcanoes, are not nearly as well studied as their polygenetic fellows. Traditionally, researchers have assumed that monogenetic volcanic eruptions are simple in their dynamics. A new investigation by *Barde-Cabusson et al.,* however, reveals that these volcanic eruptions can be highly complex, sometimes incorporating multiple phases and magma vents.

Using high-resolution electrical resistivity tomography, the authors retrospectively investigated the dynamics of the eruptions of three monogenetic volcanoes—Pujalós, Montsacopa, and Puig d'Adri—all located in the Garrotxa volcanic field of northern Spain. The materials produced by different types of eruptions, such as mildly explosive Strombolian eruptions or hydromagmatic eruptions (when magma interacts with water), have different electrical resistivities. By studying how the electrical resistivity of the material layered on the outside of the volcanoes changed with depth, the researchers could reconstruct the volcanoes' eruptive styles.

Stéphanie Barde-Cabusson

Volcanologist Anthony Finizola overlooks a monogenetic volcano on Reunion Island.

The authors found that their application of electrical resistivity tomography enabled them to identify not only different eruptive styles but also shifts in eruptive dynamics. They also discovered a second, previously unknown vent in one of the volcanoes. Further, the authors report what they suggest is the first observation of the eruptive conduit inside a monogenetic volcano. (*Geophysical Research Letters,* doi:10.1002/grl.50538, 2013) —CS

Warming climate increases rainfall extremes

In recent years there have been a number of prolonged heat waves and heavy rain events, and studies are showing that global climate warming is increasing the risk of extreme rainfall and drought. To add to the evidence linking climate warming and extreme precipitation and provide a regional as well as global perspective, *Lau et al.* analyzed projections from 14 different climate models that are part of the CMIP5 project, which is organized by the Intergovernmental Panel on Climate Change in preparation for its upcoming fifth assessment report.

The authors examined not only total rain but also changes in heavy, moderate, and light rain, as well as drought, on global and regional scales. They found that under a 1% per year increase in carbon dioxide (CO_2) emissions, which is comparable to a business-as-usual scenario, the ensemble of models predicts that by the time CO_2 emissions triple, globally extremely heavy rain would increase by 100% to 250%, moderate rain would decrease by 5% to 10%, and light rain would increase by 10% to 15%. There would also be a global increase in dry months of up to 16%, with the largest risk of drought in areas that are already dry, including northern Africa, southern Africa, and southern Europe as well as the southwestern United States and Mexico and northeastern Brazil. The increased heavy precipitation would likely be concentrated in wet regions, including the equatorial Pacific Ocean and Asian monsoon areas.

The results add to growing evidence that increased CO_2 emissions will change global precipitation patterns. The increased risk of severe floods and droughts globally is associated with an adjustment in the large-scale circulation in response to the heat imbalance induced by global warming. (*Geophysical Research Letters,* doi: 10.1002/grl.50420, 2013) —EB

—Ernie Balcerak, Staff Writer, and Colin Schultz, Writer