Environmental Sciences

at the University of Virginia

2014–15 ANNUAL REPORT

TAKING THE MEASURE OF *Water*

THE DEPARTMENT OF
ENVIRONMENTAL SCIENCES

Established in 1969, the University of Virginia's Department of Environmental Sciences was one of the first to look at fundamental environmental processes from a multidisciplinary perspective and the first in the nation to offer undergraduate, master's, and doctoral degrees in environmental sciences. Today, the faculty includes winners of the prestigious Tyler and Hutchinson awards as well as five professors who are among the most highly cited researchers in their fields.

Departmental field stations and facilities include the Anheuser-Busch Coastal Research Center in Oyster, Virginia, home of the National Science Foundation–sponsored Virginia Coast Reserve Long-Term Ecological Research program, the Virginia Forest Research Facility in nearby Fluvanna County, and the Blandy Experimental Farm near Front Royal, Virginia.

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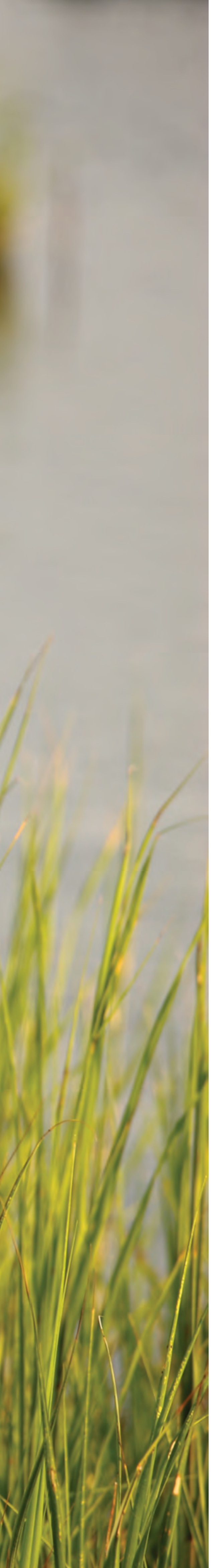


FROM THE **CHAIR**

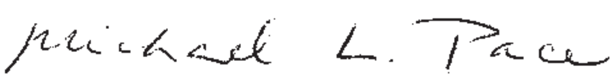
After a century in which citizens in the developed world considered water as an infinite resource, its availability is now becoming a cause for concern. The drought in California, algae blooms in the Great Lakes, and increased flooding in coastal cities like Norfolk are reminders that we can no longer take the availability, purity, and even the level of water for granted.

The challenge is to find sustainable ways to address water issues in a world shaped by population growth and climate change. This will require a fundamental understanding of how water cycles through the environment—as well as the processes that affect this cycle.

The articles in this annual report touch on the ways that water has long been a central theme for the faculty of this department. We have been monitoring water quality in the streams of the Shenandoah Valley and the George Washington National Forest since 1979 and in the bays of Virginia's Eastern Shore since 1992. We have used lakes as test beds for the natural resilience of our inland waters, and we have examined the response of salt water marshes to sea-level rise. Our faculty has also produced pioneering studies at the intersection of the global food trade and local water resources.

Although we can provide the fundamental science needed to address the challenges of sustainable water, solving them also requires expertise in fields like law, business, and public policy. That's why the department is actively forging links with other schools at the University to develop more comprehensive and, accordingly, more effective approaches.

It is fair to say that there is more urgent need for the work we are doing here—both as researchers and educators—than ever before.



Michael L. Pace, Chair

Water IN SYSTEMS

Global Limits on Water Consumption and Redistribution

It takes water—lots of water—to produce the food needed to sustain a single person over a year. With the world population on track to reach 8.5 billion by 2030, countries that lack sufficient water to feed their citizens are using a variety of methods to exert control over the water they need. Hydrologist Paolo D'Odorico, the Ernest H. Ern Professor of Environmental Sciences, has produced a series of pioneering studies that shed light on the mechanisms nations are using to redirect the flow of "virtual" water around the world as well as their consequences.

One method is trade. Countries in regions where water is in short supply can import food produced in areas where water is more abundant. Over the last 25 years, the volume of food trade has increased as the world population has expanded, but improvements in crop yields have plateaued. In other words, we are approaching a tipping point, when reliance on trade will switch from a source of food security to a liability.

D'Odorico has developed a framework that classifies countries by the degree of their dependence on imported food. His research shows that, although some countries are more susceptible than others, the entire system has become increasingly vulnerable to disruptions in trade caused by drought, changes in energy and trade policies, and food price spikes.

These disruptions are only exacerbated by climate change. Working with graduate student Kyle Davis, D'Odorico examines another tactic that countries are using to ensure their food security—purchasing agricultural land overseas. They note that several Middle Eastern nations have effectively doubled the arable land under their control by acquiring African cropland. While these purchases will increase their resilience to climate change, they reduce the ability in targeted countries to respond to climate shocks. In a study they conducted of land concessions in Cambodia, they found this process also contributes to deforestation.

A key element in determining how close we are to a food security crisis is crop yield. One way to close the gap between theoretical and actual yield is to increase irrigation. Recently, D'Odorico has been looking at ways to determine how much water would be required to close the yield gap, whether this water is available in places where it is most needed, and the effect that devoting additional water to agriculture would have on overall water resources. With Professors Jim Galloway, the Sidman P. Poole Professor, and Mike Pace, the department's chair, he has formed a group that is investigating the water, nitrogen, and carbon footprints of crop production to provide a framework for considering potential scenarios of yield gap closure.

"Thanks to the diversity of expertise within the department," D'Odorico says, "it's possible to create more comprehensive approaches to significant global issues."

PHOTO: TODD SCANLON

PHOTO: MICHAEL SAHA

The Consequences of Fire on Rain

For millennia, subsistence farmers around the world have followed the time-honored practice of periodically burning their fields, a process that returns nutrients to the soil and increases its fertility. Research that Associate Professor Todd Scanlon is conducting in Botswana with Professor Paolo D'Odorico, the Ernest H. Ern Professor of Environmental Sciences, is demonstrating that this approach may be counterproductive in some areas of the world.

"Examining how fires alter atmospheric processes is relatively new."

Using a combination of field data and satellite images, they have found that burning during the dry season can reduce the amount of rain that falls at that spot during the wet season. "There has been a large amount of research about how the land surface affects the energy balance and the recycling of water in the atmosphere, but examining how fires alter atmospheric processes is relatively new," Scanlon says.

The link between fire and reduced rainfall in Botswana, which has a sharply defined seasonal climate, is well established in the satellite record, which goes back to 1998. The team explored two differing hypotheses for this relationship. The first is that fire darkens the ground, which causes it to absorb more energy and, as it warms, to lose moisture. The second is that destruction of vegetation means that there are fewer and smaller plants during the wet season and less water transpiration from their leaves into the atmosphere.

Scanlon, D'Odorico, and graduate student Michael Saha traveled to Botswana, where they conducted a controlled burn over several acres of grassland and installed two 10-meter towers so that they could compare the evaporation, carbon uptake, and energy balance in burnt and unburnt plots. They found the loss of plant cover much more important in reducing wet season rainfall than the darker surface. "Transpiration from these plants is an important source of moisture for the afternoon thunderstorms that blanket the region," Scanlon says. "Reduce the transpiration, and you reduce the magnitude of these storms."

Ironically, they also found that particularly moist wet seasons that produce lush vegetation could lead to drier rainy seasons in the future. As the vegetation withers during the dry season, it becomes fuel for manmade or natural fires and produces hotter and larger burns.

Scanlon, D'Odorico, and Saha are now entering their observations into a large-scale atmospheric model, which will help shed additional light on the underlying processes.

A Better Way to Measure Benthic Fluxes

A little more than a decade ago, Professor Peter Berg had what turned out to be a very, very good idea. Berg is interested in measuring fluxes of carbon, oxygen, and nutrients between the seafloor and the water column so that he can address such issues as how global change affects marine environments. But the device typically used to measure these fluxes—an inverted Plexiglas® cylinder with a paddle—didn't accurately mimic natural ocean currents and light conditions.

With colleagues at the Max Planck Institute for Marine Microbiology in Germany, he invented the aquatic eddy covariance technique. "With aquatic eddy covariance, we can for the first time measure benthic fluxes under realistic conditions and provide definitive answers to questions that researchers have been asking for years," Berg says.

Even the most placid bodies of water have some turbulence at the point where the water meets the sediment. Eddies generated by the turbulence roll across the seafloor—and this rolling motion, for instance, pulls carbon dioxide from the sediment into the water column and pushes oxygen from the water column into the sediment. Berg's instrument has sensors that measure the vertical velocities of the eddies and the concentrations of the material of interest, thus determining the fluxes. "Eddies move fast and turbulence is chaotic, so we need to measure at a very high rate," Berg says. The current version of his instrument takes 16 measurements a second. In addition to oxygen and carbon dioxide fluxes, Berg can also measure heat, salt, and pH fluxes.

As word of the aquatic eddy covariance technique made its way through the scientific community, Berg began collaborating on a wide variety of projects. He has done work on stream metabolism on the Eastern Shore and also compared fluxes on newly restored seagrass beds with bare sand nearby. Members of his team flew to Greenland, where his instruments were suspended upside down under one-meter-thick, algae-covered sea ice to measure oxygen fluxes, and to Japan, where the devices were lowered 1.5 kilometers to the seafloor.

"It's been gratifying developing a technique that has so many different applications," Berg says. "It has been adopted by many other groups throughout the world, producing exponential growth in the number of published scientific papers using the approach."

PHOTO: MARKUS HUETTEL

PHOTO: JON STOCKING

Coral Reefs in Hot Water

The outlook for the world's coral reefs is not encouraging. Corals have evolved a symbiotic relationship with a genus of algae called zooxanthellae that lives in their tissue, serves as a food source, and provides their color. However, the equilibrium of this system is delicate. Pollution and changes in ocean temperature can cause corals to expel the algae, a process known as bleaching. Unless these stressors are removed quickly, the bleached coral will die.

"We know the heat tolerance of the coral species there, and the outlook isn't good."

Associate Professor Matt Reidenbach has demonstrated that coral reefs in shallow coastal bays are particularly susceptible. "If our study site is representative, many of the coral in the world's shallow waters will have completely died off by 2080," he says.

Thanks to connections established through the University's Panama Initiative, led by Associate Professor Vivian Thomson, Reidenbach was able to conduct his research at the Smithsonian's Bocas Del Toro Research Station on the Caribbean coast of Panama. It is operated by the Smithsonian Tropical Research Institute (STRI). The Bocas del Toro archipelago forms a shallow bay that it is almost entirely surrounded by land. Because water circulation in and out of the bay is restricted, it heats up quickly during hot weather. There are several areas in the bay that already show signs of bleaching.

Reidenbach and his students surveyed the bay, measuring the flow environment, the coral distribution, and the currently bleached areas. They also used long-term monitoring data that STRI scientists collected on surface water temperature and bleaching. They loaded this data along with climate change scenarios for the 2020s, 2050s, and 2080s into numerical models to understand the effect of global warming on surface temperatures in the bay. "It is possible that the coral might be able to adapt to rising temperatures over time," Reidenbach says. "But right now, we know the heat tolerance of the coral species there, and the outlook isn't good."

Reidenbach is quick to point out that the collapse of the coral reefs would be an economic as well as ecological disaster. "The reefs support tourism and subsistence fishing," he says. "As the reefs degrade, food and financial instability will rise."

Water IN STREAMS

PHOTO: SIDNEY BUSH

Mercury Flowing through Our Streams

The phrase “mad as a hatter” describes the occupational consequences of working with mercury, a highly dangerous neurotoxin. Hatters using mercuric nitrate to prepare felt for hats breathed mercury vapor, eventually developing tremors and becoming pathologically shy, irritable, and occasionally delirious.

Today, exposure to this deadly element is through mercury released into the environment by coal-burning power plants and incinerators. Deposited on the ground and in our waterways, it eventually works its way up the food chain, becoming more concentrated and dangerous as it goes. It is increasingly found in high doses in shellfish and large predator fish.

Graduate student Olivia Stoken, working with Professor Todd Scanlon, is studying the processes by which airborne mercury is deposited on land and enters our streams after moving through the terrestrial environment. “Mercury entering the headwaters of our streams is the ultimate source of mercury reaching the oceans,” she says. “If we can understand the process in headwater watersheds, we can understand why we are seeing increased concentrations downstream.”

Stoken is pursuing an answer from two perspectives. She tracked the association of the more bioavailable form of mercury—dissolved mercury—with dissolved organic carbon, which is co-transported with mercury into streams. Using data collected by the National Soil Survey, she examined the mercury-to-dissolved-organic-carbon ratio in 19 geographically distinct watersheds across the continental United States. She found that the factor that most influenced the ratio was the amount of organic carbon in the soil. This allowed her to propose a method for estimating mercury in a stream that could be used in place of the painstaking mercury sampling process. “If you know the soil organic carbon and measured the dissolved organic carbon in a stream, you can predict the concentration of mercury your stream is carrying,” she says.

In addition, Stoken studied the relationship of stream acidity to its ability to transport mercury. After establishing baseline levels in a small, low-relief watershed at the department’s Virginia Forest Research Facility, she injected the stream with acid, lowering its pH, and measured the levels of mercury and dissolved carbon. “We found that as the pH decreased, the mercury and carbon moved out of the stream and into the stream sediment,” she says. “As a result, the mercury-to-carbon ratio dropped.”

Stoken’s work is attracting notice. Her meta-analysis of 19 streams won an outstanding student paper award at the 2014 American Geophysical Union meeting.

Self-Cleaning Streams—and Their Limits

Thanks to fertilizer runoff from upland farms, nitrogen levels in the groundwater entering the Eastern Shore's Virginia Coast Reserve average between 15 and 30 parts/million. When the streams draining the upland reach the coastal bays, however, much of this nitrogen is gone. The level is just 1 to 2 parts/million, far below the Environmental Protection Agency's 10 parts/million recommendation for drinking water.

The purity of these waters is an important reason why researchers at the Long-Term Ecological Research (LTER) site have been successful in reestablishing seagrass beds in these lagoons. "The water in the bays at the LTER is some of the cleanest that can be found on the East Coast," says Professor Karen McGlathery, the LTER's lead principal investigator.

Since 2001, Professors Janet Herman and Aaron Mills have made a priority of accounting for the missing nitrogen. They have discovered that a thin zone of sediment—in places no more than 30 centimeters thick—is responsible for removing most of the nitrogen. "In the presence of organic matter filtering into the sediment from the surrounding riparian forests, bacteria in this layer convert reactive nitrogen in the groundwater into nonreactive nitrogen gas and release it into the atmosphere," Mills says. The process is known as denitrification.

In addition to this nitrogen removal, there are a number of factors that contribute to the high water quality at the LTER. The watersheds that contribute nitrogen-rich groundwater are relatively small. The area is lightly populated and so far has been spared the commercial poultry farms that have been introduced further up the peninsula. And water in the lagoons exchanges readily with lower-nitrogen water from the ocean.

There are signs, however, that the system is reaching its limits. "The fact that some nitrogen is coming out of the sediments suggests that they are working at full capacity," Mills says. "If we increase nitrate supply, we will see an increase in denitrification, but we will also see an increase in nitrogen that is not denitrified."

Associate Professor Linda Blum started measuring water quality in the coastal bays at the LTER in 1992. "Having such long-term data sets is a prerequisite for the research that Aaron, Janet, and their students have conducted," McGlathery says. "Our knowledge of how the system works also gives us a basis for working with local groups to keep the lagoons clean."

PHOTO: KATE SANDERS

Tracking the Future of the Jet Stream

Climate change will not simply bring changes in temperature but will also alter the distribution of rain around the globe. Climate models show subtropical desert regions expanding toward the poles and wetter, temperate zone regions also shifting to higher latitudes. Assistant Professor Kevin Grise analyzes observational data to improve the predictive precision of the computer models used to forecast global climate and, on a more fundamental level, to better understand the interplay of factors that shape climate variability and change.

The midlatitude jet streams will play a key role in this poleward shift, thus determining our water future. "I study wind patterns in the atmosphere because ultimately they help determine where rain is going to fall," Grise says. The observational record, of course, is limited, measured in decades rather than millennia, but jet stream movement from year to year can serve as a proxy for longer-term processes. If he can identify the drivers of observed variability in the jet stream, Grise can examine whether these relationships are properly represented in global climate models, and thus can provide guidance about which models might yield more accurate predictions of future climate change.

One factor that may affect the positioning of the jet stream in models is a proper representation of the Earth's radiation balance. Clouds are critical to an accurate analysis because they reflect radiant energy from the sun that would otherwise heat the earth's surface. The issue is one of scale. "Clouds are small-scale phenomena," Grise says, "while most current climate models represent the Earth's surface in large boxes that are 100 kilometers or greater on each side." As a result, modelers depend on statistical approximations to represent cloud cover.

To determine which statistical approaches are more valid, Grise analyzed the way 20 of the global climate models from phase 5 of the Coupled Model Intercomparison Project (CMIP5) approach cloud formation and radiant heating. He concentrated on the interannual variability in the midlatitude jet stream over the Southern Ocean, a proxy for the shift in the jet stream that many models predict will occur during the 21st century. He identified a subset of CMIP5 models that behaves most similarly to observations, suggesting that those models might prove more skillful in 21st-century predictions.

"Refining the models is critical," Grise says. "Small changes can have huge impacts on our image of local precipitation patterns in the future."

RE

The Effects of Water on the Boundary Layer

Although Associate Professor Stephan De Wekker emphatically considers himself "a dry-land, fair-weather, boundary layer meteorologist" who tries to avoid anything to do with water, his work has inevitably drawn him to consider the effects of water in the atmosphere. "Whether it's a question of humidity or cloud formation, water is an inescapable part of my research," De Wekker says.

De Wekker's preference for dry conditions reflects the exacting nature of the atmospheric niche in which he works. He studies the boundary layer above complex, mountainous terrain, documenting the way this terrain affects the mixing and transport of aerosols, gases, and particles from the boundary layer into the free atmosphere above it. "We can account for water in vapor form very well, but as soon as condensation occurs, understanding the thermodynamic processes that occur in the boundary layer becomes much more difficult," he says.

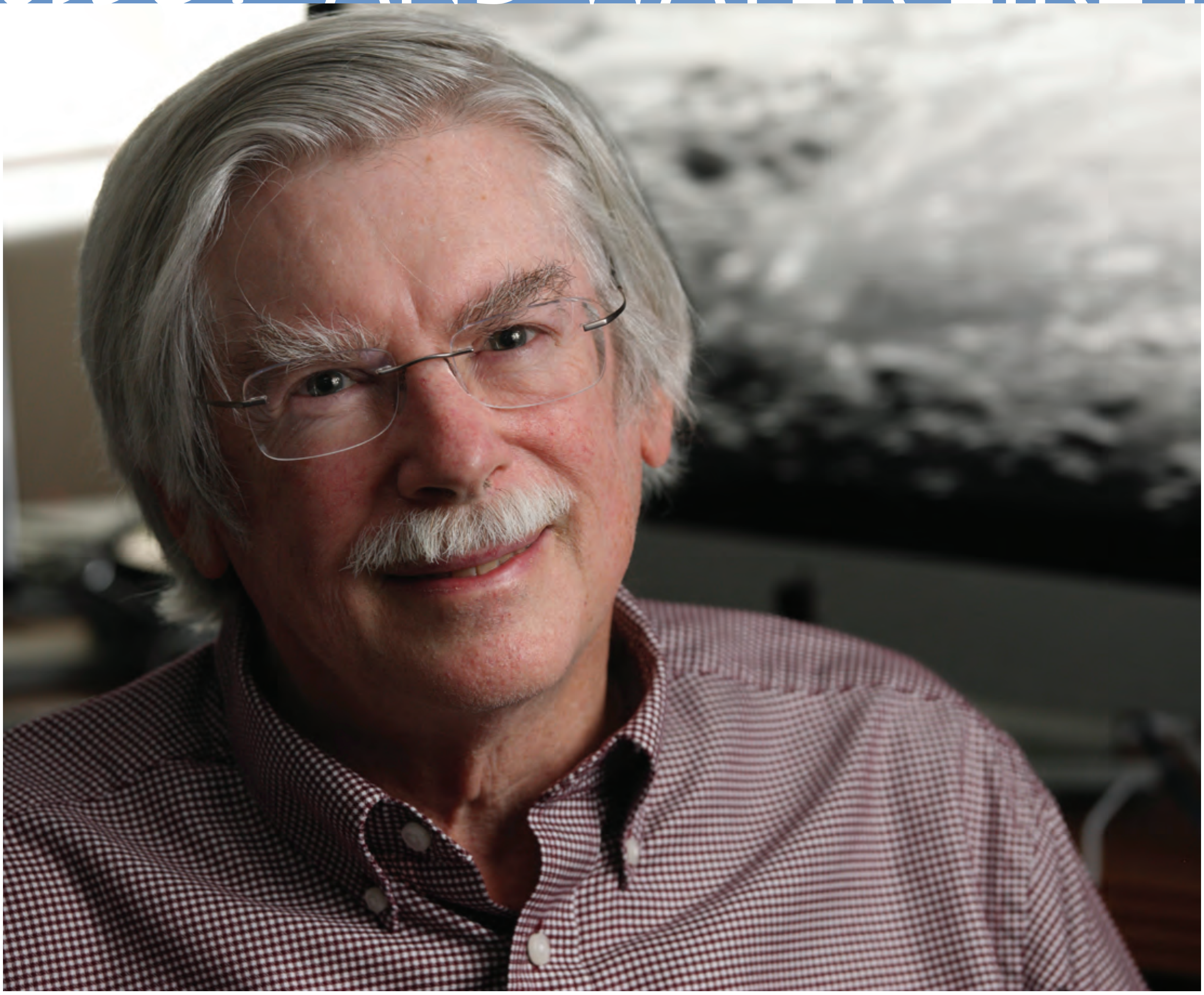
De Wekker does, however, pay close attention to humidity, which can have important effects on the radiation balance in the atmosphere and the energy balance at the surface. It also skews the results of instruments that measure air pollution. "We need to know what the humidity is in order to interpret our air pollution readings correctly," he says. "Measuring humidity with the precision we need can be difficult."

His expertise measuring humidity has led him to collaborate with wildlife biologists in the Shenandoah National Park. They are interested in knowing how climate change will affect the mountaintop habitat for an endangered species of salamander that requires humid conditions. He entered temperature and humidity data for a variety of elevations on the east and west slopes of the Blue Ridge into a high-resolution atmospheric model, calibrated the model so that it matched his observations, and extrapolated into the future. The outlook for this species is not hopeful.

Over time, De Wekker has also become more interested in clouds. For years, the assumption has been that the top of a dry convective boundary layer over a flat surface acts as a lid, which prevents transfer of water vapor and pollutants into the free atmosphere above it. The lid opens, however, in the presence of clouds. In the complex terrain where De Wekker studies clouds, the boundary layer lid is always open. "We may be able to apply what we know about cloud-enabled transport over flat areas to mountainous terrain," he says.

In fact, De Wekker used to reflexively turn off a parameterization in atmospheric models that represented cloud formation, assuming it was irrelevant to his work in dry areas. Now he is experimenting with keeping the parameterization enabled.

Water AND WATER-LIKE FLO



Nitrogen Glaciers on Pluto

No matter how far into the solar system Professor Alan Howard's research has taken him, Earth has always his reference point. Over the last 40 years, Howard has been celebrated for his investigations into the way winds, fluids, and ice floes shape the surface of bodies in the solar system, most notably Mars and Titan, Saturn's largest moon. Now, as a member of the team supporting NASA's New Horizons mission to Pluto, he has found valleys that seem similar to those carved by glaciers on Earth. In this case, however, the glaciers were most likely composed of frozen nitrogen, emptying out onto an immense smooth expanse 1,200 kilometers across dubbed Sputnik Planum.

"As we go through the solar system, there's always a process that modifies the surface, but it varies as you move away from the sun," Howard says. On Earth and Mars, it's water, but on Titan, 1.5 billion kilometers from the Sun, water is replaced by liquid methane. Titan even has a hydrological cycle. Methane evaporating from polar methane lakes falls back to the moon's surface as rain during regular thunderstorms.

Thanks to the many Mars missions and the Cassini-Huygens mission to Saturn, Howard has had sufficient data to build computer models describing how landforms on Mars and Titan develop over time and shedding light on their long-term climate history. It is far too early in the exploration of Pluto to do something similar. "We're still cataloguing and coming up with conceptual frameworks," Howard says. "For instance, it is unlikely that Pluto ever had an atmosphere thick enough to provide the right conditions for nitrogen rain."

Although he has been studying the forces shaping landforms in the solar system since the early 1970s, this is the first time Howard has participated in a NASA mission. He spent a month during the encounter with Pluto at the Johns Hopkins Applied Physics Laboratory, which oversees the science portion of the mission for NASA. "It was very exciting being there as larger and larger images of Pluto started coming in," he says. "And it was fantastic working with 100 of the best scientists in the world. Now we're going to try to make sense of some of the surprising data we're collecting."

An Interplanetary Detective

Graduate student Alex Morgan describes his research as detective work. He is trying to account for the conditions that created alluvial fans in Mars's southern hemisphere, in the process shedding light on the red planet's history and climate. The difficulty is that he can't conduct his investigations at the crime scene. Instead, Morgan uses data and observations from similar areas on Earth, looking at alluvial fans in such dry regions as Death Valley and Chile's Atacama Desert as well as in places where the soil approximates that on Mars, such as the island of Hawaii.

"When you look on Mars, you see alluvial fans, which on Earth are formed by rivers depositing sediments," Morgan says. "We are trying to figure out when the Martian fans formed, whether they formed in short bursts or over long periods of time, and what that might mean for Mars's former climate." Morgan is working under the direction of Professor Alan Howard.

Morgan has access to a number of data sources from Mars, including images from NASA orbiters and the *Curiosity* rover. His task is to collect analogous data on Earth, create and test models of alluvial fan formation that use this data, insert data from Mars, and draw his conclusions.

In the field, Morgan has used a number of different tools to gather data. He employs differential GPS, which is accurate to a centimeter, to survey river channels, ground-penetrating radar to determine the lateral extent of flows, and luminescence dating, which provides a measure of the age of exposed rocks. He also measured sediment size in different locations, which can give him a sense of the velocity of the flow.

Morgan is now concentrating on the modeling phase of his project. "We start with an initial topographic surface and then mathematically simulate a number of processes that modify the landscape," he says. "Alluvial fan modeling is in its infancy because it requires computing power that wasn't readily available until a decade ago." His tentative conclusion is that Mars's alluvial fans were formed over relatively long periods of time, tens of thousands of years if not longer, during a period in Mars's history long believed to be too cold and dry for long-term surface water flow.

One possible explanation is that because of extreme variations in Mars's axial tilt, ice could have formed in these regions when the southern half of the planet was far from the sun. As the planet tilted back in the other direction, this snow would have melted, creating the alluvial fans. Another possibility is that increased volcanism warmed the planet, allowing water to flow on the surface.

PHOTO: MARISA PALUCIS

Awards, Appointments, and Publications

UNDERGRADUATE STUDENTS

Lia Cattaneo, an environmental sciences and civil and environmental engineering double major, was awarded a Harry S. Truman Scholarship for 2015–16, designed to support the next generation of public service leaders. Ms. Cattaneo was one of 58 winners nationwide. Her work addresses climate and energy policy and creation of solutions to climate change.

The department recognizes fourth-year students who have done outstanding work in each of the environmental sciences. This year, the Michael Garstang Atmospheric Sciences Award went to **Erin M. Dougherty**, and the Mahlon G. Kelly Prize in ecology went to **Janet K. Walker** and **Rebecca H. Walker**. **Cassandra L. Cosans** won the Hydrology Award, and **Benjamin A. Pickus** received the Wilbur A. Nelson Award in geosciences.

The Departmental Interdisciplinary Award, for the undergraduate major who has excelled in interdisciplinary environmental sciences research, was presented to **Jennifer E. Ren**.

Thomas J. Sherman received the Wallace-Poole Prize, awarded each year to the graduating student majoring in environmental sciences who has at least a 3.8 GPA and who is judged the most outstanding student in the class.

Staige E. Davis and **Janice G. Zhuang** were honored for making the best undergraduate student presentations at the 31st annual Environmental Sciences Student Research Symposium.

The Bloomer Scholarship awards $1,800 to an outstanding undergraduate environmental sciences major with a focus on geology. This year's winner was **Cassandra L. Cosans**. Ms. Cosans was also this year's winner of the Joseph K. Roberts Award, given to a student who presents the most meritorious research paper at a national meeting.

To be chosen for the College's distinguished majors program, students must have an overall GPA of 3.4 or above. Once admitted, they must complete a significant research project, write a thesis, and defend their work. This year, the department selected **Cassandra L. Cosans**, **Erin M. Dougherty**, **Kelsey A. Everard**, **Benjamin A. Pickus**, **Jennifer E. Ren**, **Janet K. Walker**, and **Rebecca H. Walker** as distinguished majors.

Established by the Thomas Jefferson Chapter of Trout Unlimited, the Trout Unlimited Award is for "significant contributions to research concerning cold-water fisheries or related ecosystems." This year's recipient was **Bridget F. Shayka**.

Double Hoo Research Awards pair an undergraduate student with a graduate student mentor to pursue an independent research project. This year, the University presented six Double Hoo awards, including one to undergraduate **Declan P. McCarthy** and graduate student **Sonja K. Long**.

Jessica L. Hawkins was this year's recipient of the Richard Scott Mitchell Scholarship, which provides $1,800 to a rising fourth-year student who is focusing on geoscience and has completed Fundamentals of Geology and two other advanced courses in geoscience, preferably including mineralogy or petrology.

Each year, the University of Virginia's Harrison Undergraduate Research Awards program funds approximately 40 outstanding undergraduate research projects. In 2015, environmental science major **Hayes B. Fountain** was selected for this prestigious program.

Phi Beta Kappa, the most distinguished honor society in the country, offers membership to less than 1 percent of all undergraduates. The society inducted five environmental sciences majors from UVA this year: **Panayes Dikeou**, **Isabel Greenberg**, **Benjamin Pickus**, **Jennifer Ren**, and **Katherine Travis**.

GRADUATE STUDENTS

Grace M. Wilkinson was the winner of the Maury Environmental Sciences Prize, the department's premier award, established by Dr. F. Gordon Tice in 1992. It recognizes and honors outstanding undergraduate or graduate students for their contributions to environmental sciences, their ability to communicate their findings, and their efforts to promote a better understanding of the environment.

Jeffrey W. Atkins won the Graduate Student Association Award, which recognizes members of the department who have been particularly helpful to the graduate student body.

The department offers a series of awards honoring outstanding graduate students in environmental sciences specialties. **Lillian R. Aoki** earned the Graduate Award in Ecology; **Olivia M. Stoken** won the Graduate Award in Hydrology; and **Stephanie P. Phelps** won the Graduate Award in Atmospheric Sciences. **Erin E. Swails** received the Ellison-Edmundson Award for Interdisciplinary Studies.

Alexandra L. Bijak received the Thomas Jefferson Conservation Award, which supports basic research related to the conservation of the earth's resources.

Olivia M. Stoken and **Ariel L. Firebaugh** were honored for making the best graduate student presentations at the 31st annual Environmental Sciences Student Research Symposium. Ms. Stoken also received an Outstanding Student Presentation Award at the American Geophysical Union meeting in San Francisco this past December.

Nevio Babic won the Michael Garstang Award, used to support graduate student research in interdisciplinary atmospheric sciences.

This year, **Alexander M. Morgan** and **Matthew P. J. Oreska** won Moore Research Awards. Based on merit, these awards were initiated to help sponsor the dissertation and thesis work of environmental sciences graduate students. **Alice F. Besterman**, **Laura C. Cattell Noll**, **Gina B. Digiantonio**, and **Michael V. Saha** received Exploratory Research Awards, meant to support preliminary research leading to a thesis or dissertation proposal.

Jeffrey W. Atkins was awarded first place in the Biological and Biomedical Sciences Poster session at the 15th Annual Robert J. Huskey Graduate Research Exhibition held in March 2015. **Alexander M. Morgan** placed second in the Physical Sciences and Math Oral Presentation session; he also won the Department Chair's Award, which recognizes an individual who has performed extraordinary service to the department.

Itiya Aneece and **Ksenia Brazhnik** were two of the 15 students to receive a University Graduate Teaching Assistant Award. Each year, the Office of Graduate and Postdoctoral Affairs invites departments to submit nominations for teaching awards, honoring the University's graduate students for their commitment to and excellence in undergraduate instruction. Ms. Aneece also received the department's Fred Holmsley Moore Teaching Award, bestowed on a graduate teaching assistant distinguished by the ability to instill excitement, wonder, and confidence in students. An endowment set up by Fred H. Moore funds this award, along with matching donations from Mobil Oil Company.

FACULTY

Linda Blum is associate editor of *Estuaries and Coasts* and a board member of the Chesapeake Bay Sentinel Site Cooperative, sponsored by the National Oceanographic and Atmospheric Administration. At the University, Professor Blum served as chair of the Committee on Faculty Rules.

David Carr is an associate editor of the *American Journal of Botany*. He serves on the Domain Science and Education Coordination Committee of the National Ecological Observatory Network.

Robert Davis won the Figure of the Year Award from the *American Journal of Epidemiology*. The figure was contained in an article he wrote jointly with graduate students Michael Saha and David Hondula. At the University, Professor Davis is a Jefferson Scholars Program advisor.

Stephan De Wekker is an associate editor of the *Journal of Applied Meteorology and Applied Climatology* as well as an associate editor of *Atmosphere*. He is a co-organizer of the Conference on Mountain Meteorology (to be held in summer 2016), sponsored by the American Meteorological Society. This year, he was one of 12 Mead Grant winners at the University of Virginia. The Mead Endowment was established in 2002 to provide faculty members with $3,000 grants to pursue opportunities to inspire students academically while building personal relationships in a setting that the traditional classroom cannot provide.

Paolo D'Odorico, the Ernest H. Ern Professor of Environmental Sciences, serves as editor in chief of *Advances in Water Resources* and associate editor of the *Oxford Encyclopedia of Environmental Sciences*. He is a member of the Provost's Promotion and Tenure Committee and was organizer of the University's 2015 Water Week Forum.

Howard E. Epstein is an associate editor of *Ecosphere* and a member of the board of directors of the Arctic Research Consortium. At the University, he is a faculty advisor, co-directs the College Science Scholars program, and serves as a mentor for the Excellence in Diversity Fellowship Program. He also is an advisor to the Jefferson Scholars Foundation Graduate Selection Committee and a codirector of the Committee on Graduate Educational Policy and Curriculum. He won the department's Environmental Sciences Organization Award, given to a member of the department who has been particularly helpful to undergraduate majors.

James N. Galloway, the Sidman P. Poole Professor of Environmental Sciences, is a trustee of the Marine Biological Laboratory at Woods Hole, Massachusetts, and continues to serve as a member of the Board of Trustees of the Bermuda Biological Station. He is an associate editor of *Environmental Development*.

Kevin Grise was an Excellence in Diversity Fellow at UVA's Teaching Resource Center.

Kyle Haynes is an associate editor of *Ecosphere*.

Janet S. Herman is president of the Karst Water Institute and a councilor and member of the Executive Committee of the Geological Society of America. This year, she served as an Intergovernmental Personnel Act appointee at the National Science Foundation's hydrology program.

Alan D. Howard was elected a fellow of the Geological Society of America. Professor Howard serves as president of the Earth and Planetary Surface Processes Focus Group of the American Geophysical Union.

William Keene serves as the department's representative to the UVA Faculty Senate.

Deborah Lawrence is an advisor to the U.S. Agency for International Development on SilvaCarbon, the U.S. contribution to the GEO Forest Carbon Tracking Task, and a trustee of the Virginia Chapter of The Nature Conservancy. At the University, Professor Lawrence serves as a member of the Dean's Promotion and Tenure Committee for the College and Graduate School of Arts & Sciences.

Manuel Lerdau serves as an associate editor of *Biology Letters* (British Royal Society) and is on the editorial board of *Oecologia*. In 2015, he won the Kavli Foundation Science-Writer Award. At the University, he is a member of the academic board of the University's Morven Summer Institute and a member of the Sexual Misconduct Board.

Stephen A. Macko serves as an associate editor of *Amino Acids and Science of the Total Environment*. He is an associate editor of the *Oxford Research Encyclopedia of Oceanography*. In addition, Professor Macko is a member of the Program Committee of the American Geophysical Union as well as the Committee on Education of the European Geoscience Union. This year, he served on the Graduate Program Review Committee for the University of New Hampshire Program in Earth Sciences. In addition, he served on National Science Foundation panels. At the University, he is a member of the Faculty Advisory Committee to the Honor Committee.

Karen J. McGlathery is the University's associate vice president for research, sustainability, and the environment. She serves as the lead principal investigator of the Virginia Coast Reserve Long-Term Ecological Research (LTER) program and sits on the national LTER Executive Council and the Science Council. Professor McGlathery is also a member of the steering committee of the Mid-Atlantic Coastal Resilience Institute, served on National Science Foundation review panels, and is an associate editor of *Ecosystems*. At the University, she is also a member of the Committee on Sustainability.

Aaron L. Mills serves on the National Aeronautics and Space Administration Microbial Observatory Science Advisory Team. He is chair of the Faculty Steering Committee, a member of the Dean's Committee on Academic Priorities and the Dean's Committee on Budget and Development in the College and Graduate School of Arts & Sciences.

Michael Pace serves as chair of the department. He is an associate editor of *Ecosystems* and was a co-organizer of the 2015 annual meeting of the Association for the Sciences of Limnology and Oceanography, held in Granada, Spain.

John Porter is a member of the national LTER Network Information System Advisory Committee. He serves as a member of the Organization of Tropical Studies' Science Advisory Committee.

G. Carleton Ray is a member of the Board of Trustees of the Bahamas National Trust.

Matthew Reidenbach reviews proposals for the University's Harrison Awards and is a member of the Jefferson Scholars Foundation's Undergraduate Selection Committee. He is an associate editor of *Advances in Water Research*.

T'ai Roulston is an associate editor of *Ecosphere*.

Todd Scanlon serves as chair of the Horton Grant Selection Committee of the American Geophysical Union. At the University, he was chair of the Committee on Personnel Policy in the College and Graduate School of Arts & Sciences.

Arthur Schwarzchild is a member of the national LTER Executive Committee.

Herman H. Shugart, the W. W. Corcoran Professor of Environmental Sciences, is an associate editor of *Research Letters in Ecology* and a member of the editorial boards of *Ecosystems*, the *Eurasian Journal of Forest Research*, *PeerJ*, and *Forest Ecosystems*. He is also the chief scientist for the Northern Eurasia Earth Science Partnership Initiative and a member of the Defense Intelligence Agency's Special Advisory Committee on the Environment. At the University, Professor Shugart serves as a member of the Educational Policy and Curriculum Committee and the Curriculum Planning Committee. This year, the department awarded Professor Shugart its Maury-Tice Prize for research excellence.

David E. Smith serves the University as a member of the Executive Leadership Network, the Facilities Management Advisory Board, the Process Simplification Advisory Committee, and the Committee on Undergraduate Admission.

Robert Swap was an Intergovernmental Personnel Act assignee at the National Aeronautics and Space Administration. This year, he was chosen to join UVA's University Academy of Teaching. He is the first member from the department to receive this honor.

Vivian Thomson is director of the Environmental Thought and Practice interdisciplinary major.

Patricia Wiberg serves as the steering committee chair of the National Science Foundation's Community Surface Dynamics Modeling System (CSDMS), a National Science Foundation–funded modeling community of approximately 1,100 members. CSDMS presented her with its Lifetime Achievement Award in Earth System Modeling. Professor Wiberg serves on the executive committee of the American Geophysical Union's Earth and Planetary Surface Processes Focus Group.

PEER-REVIEWED PAPERS, BOOK CHAPTERS, AND BOOKS

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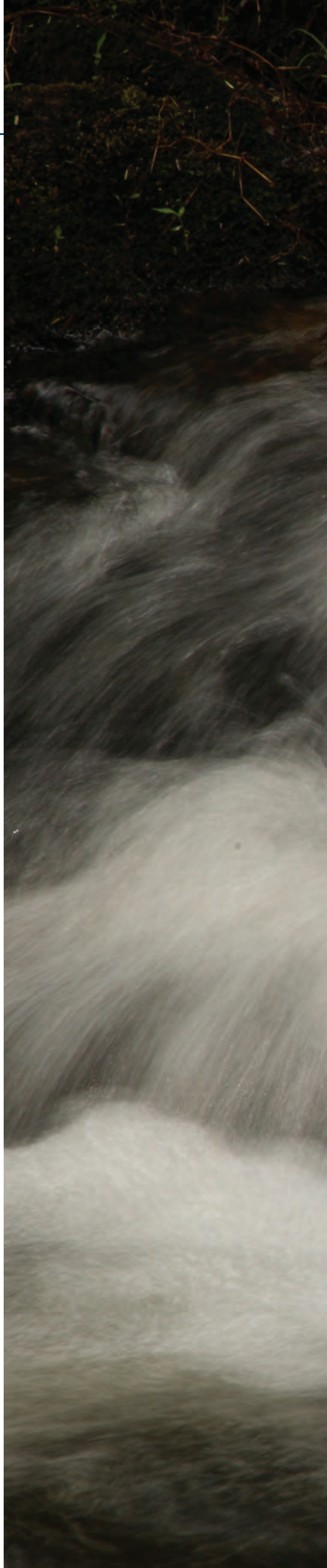

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