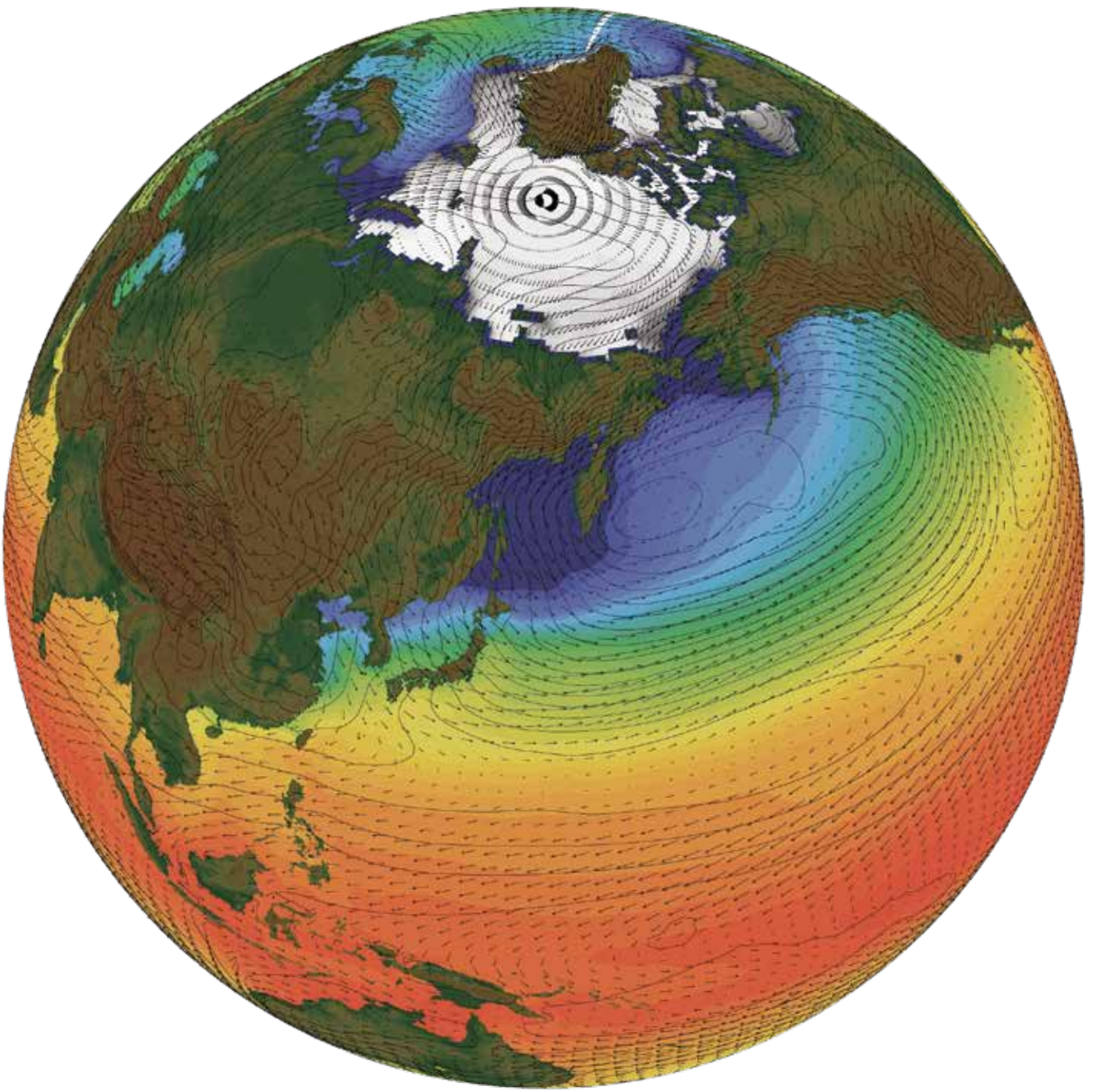
ENVIRONMENTAL SCIENCES
AT THE UNIVERSITY OF VIRGINIA



MODELING, SIMULATION, AND DATA SCIENCE

2022–23 ANNUAL REPORT

A false-color remote sensing image revealing saltwater intrusion on the Virginia coast. Healthy trees are red, and dead trees are dark gray.

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 several 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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COVER: National Center for Atmospheric Research. This image depicts a single month from a simulation of the 20th century by the NCAR-based Community Climate Systems Model (version 4).

XI YANG

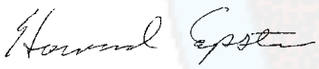
FROM THE CHAIR

In last year's annual report, we celebrated our post-pandemic return to the field. Making observations has always been fundamental to advances in the environmental sciences. Over time, our ability to gather and store data has become increasingly sophisticated. We have seen the introduction of new, more powerful measurement techniques, the proliferation of observational platforms—from towers and drones to airplanes and satellites—and the development of cloud storage capable of holding the vast quantity of digital data that we have generated over the last half century and are producing every day.

The unprecedented scale of these data, combined with unimaginable computing power and the introduction of such tools as machine learning and artificial intelligence, has made modeling, simulation, and data science an essential counterpart of field work.

Data science enables us to pull patterns and relationships from observations that would otherwise be imperceptible. Modeling and simulation enable researchers to build large conceptual frameworks and use them to test hypotheses about how systems work in ways that would be impossible otherwise. For instance, working with models, researchers can change individual or sets of variables in predetermined ways to gauge their effects on an entire system. This kind of manipulation—and the results it provides—often cannot be replicated in the real world.

Together, modeling, simulation, and data science have greatly expanded what we know and how fast we can know it—and have come to the fore at precisely the time when understanding how large, complex environmental systems work has become imperative. I am very proud to announce that we hired four new faculty members last year with expertise across the areas of observational, simulation modeling and data science techniques—and it is equally important to note that essentially all of our faculty use modeling and analytical tools to some degree to complement and amplify the power of their observations.



Howie Epstein, Chair

Retirements

Talent, luck, character, discipline, and drive: the components of every career are also what differentiate one career from another. This year, we note the retirements of three individuals who touched the department in different ways.

Tracking Chemicals Moving Through the Environment

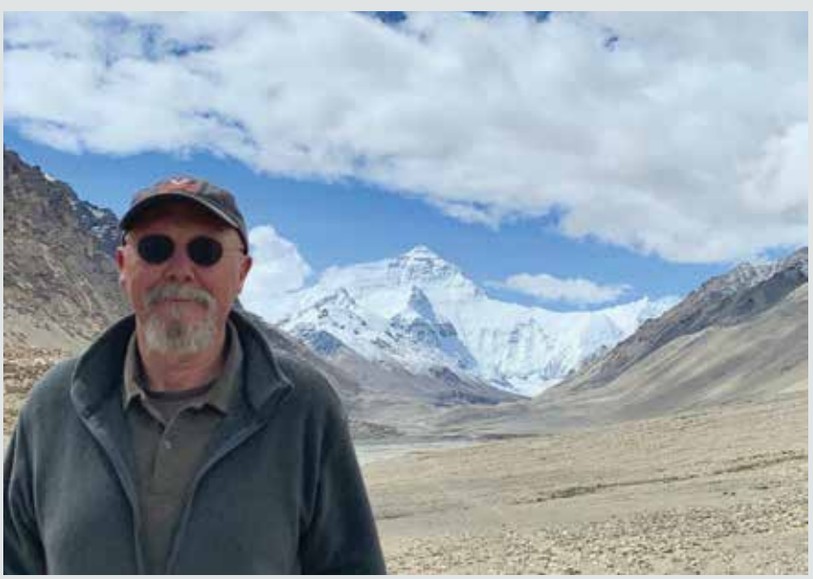
As far as **Jim Galloway** is concerned, there is no better job than a tenured professorship. "You have the freedom to pursue whatever interests you—as long as you do it creatively," says Galloway, the Sidman P. Poole Professor Emeritus. A biogeochemist, Galloway made the most of this opportunity. He focused initially on the trace metal biogeochemistry of the coastal ocean but branched out to include the increasing acidification of the atmosphere, soils, and fresh waters.

Galloway built institutions on the scale necessary to support meaningful research. He modeled the Shenandoah Watershed Study (SWAS)—which he started in 1979 with George Hornberger and Roger Pielke—after Gene Likens' Hubbard Brook Ecosystem Study in New Hampshire. SWAS is now the longest continuously conducted watershed research and monitoring program in the National Park System.

Jim Galloway

In the mid-1990s, Galloway shifted his focus to the biogeochemistry of the nitrogen cycle, following the way nitrogen is converted into multiple chemical forms as it moves through atmospheric, terrestrial, and marine ecosystems. His pioneering research on the nitrogen cascade earned him the

Placing Environmental Science in a Larger Context



Over the course of his career, Associate Professor **Tom Smith** has touched tens of thousands of young people across the world. Through classes like Introduction to Environmental Sciences, he has reached generations of students at UVA, inspiring many to enroll in the major and providing a grounding in the environment for those who did not. He has co-authored two textbooks with his father, Robert Smith: *The Ecology of Field Biology* and *The Elements of Ecology*. The latter, now in its ninth edition, has been translated into eight languages. "When I'm working with scientists from other countries, it's always a pleasure to encounter students who have used my textbooks in their classes."

Tom Smith

prestigious Tyler Prize in 2008, often referred to as the Nobel Prize of environmental science.

Here, too, Galloway was an institution-builder. He founded the International Nitrogen Initiative in 2003, which works to optimize nitrogen's beneficial effects and minimizes its negative ones. In 2014, with the Office of Sustainability, he started the Nitrogen Working Group at the University, which is helping UVA meet its goal of reducing its nitrogen footprint by 30 percent by 2030. In recognition of his collective work, in 2020 he was elected to the US National Academy of Sciences.

Regardless of where Galloway concentrated his research, he always made a point of giving students credit and highlighting their accomplishments. "I get a lot of satisfaction from working with students," he says. "Through their talent and initiative, they have really done a great deal to advance our work." ■

Dave Smith

Keeping the Department on Course

For more than three decades, Professor **Dave Smith** was the critical mainstay of the department. Starting in 1990, he served as associate chair to a succession of leaders—Hank Shugart, Bruce Hayden, Bill Ruddiman, Jim Gallloway, Jay Zieman, Pat Wiberg, Mike Pace, and Howie Epstein—providing an invaluable blend of consistency, institutional knowledge, and flexibility. "Every chair had a different management style," he recalls. "Whenever there was a transition, I adjusted my approach to support how they wanted the department run."

As associate chair, Smith oversaw and planned the construction of projects costing tens of millions of dollars, including the construction of the Anheuser-Busch Coastal Research Center on the Eastern Shore and the addition to and renovation of Clark Hall.

But Smith is even more proud of the diverse staff he assembled over the years and of the reputation they helped the department establish for integrity. "We examined every request carefully, and if we could make a commitment, we always followed through," he says.

Smith was also a dedicated teacher. He played a major role in the department's environmental conservation program and taught the capstone conservation seminar, which brought faculty from the department together with those from the Schools of Law and Commerce. He co-directed the UVA in the Bahamas program for over 25 years and the UVA in Belize program for almost a decade. He taught a case-based class for students in the conservation biology program and was one of the principals behind the Chesapeake Bay Game, an award-winning real-world simulation. "At UVA, I've been able to try out new ideas and build new programs," he says. "I'm grateful to have had the opportunity." ■

Several themes run through his teaching as well as his textbooks. Smith is concerned with showing how science combines with a host of ethical, economic, and cultural realities to shape real-world issues. And he is interested in reaching beyond the typical science major to those students interested in building environment-based careers in such fields as law, policy-making, and economics.

For instance, he invited faculty members from around Grounds to lend their expertise and insights to his cased-based Environmental Decisions course. And with former faculty member Vivian Thomson, he founded the Environmental Thought and Practice program, which brings perspectives from the natural and social sciences, the arts, and humanities to create a multidimensional understanding of environmental issues.

Smith notes that teaching and textbook writing are mutually reinforcing in ways that enhance the quality of both. "I always try out new material on my students to make sure I'm presenting it clearly and compellingly," he says. "And the broad-ranging reading I do for the textbooks ensures that my students benefit from the latest science." ■

New Faculty

The arrival of new faculty ensures that the department benefits from new ideas and new perspectives.

Tracking Inorganic Compounds Through the Environment

Rocks and soils contain inorganic nutrients—calcium, magnesium, and potassium, for instance—that are critical to building the structures of life. But rocks and soils also contain toxic metals like arsenic, cobalt, and chromium that can destroy it. A biogeochemist, Assistant Professor **Justin Richardson** uses cutting-edge instrumentation to measure these materials—in plants and animals as well as in soil and rocks—in order to better understand the journey inorganic compounds take as they move from the ground to living organisms.

Richardson studies this process in cities as well as in forests. In urban areas, he has been part of a study examining soils for the presence of toxic metals like lead and determining if they correlate to the socioeconomic status of different neighborhoods. “In my career, I would like to help makes sure that science is available to underrepresented groups who haven’t been able to access it previously,” he says.

In his studies in managed forests, his methods are essentially the same, but his goals are different. In addition to timber, managed forests provide a host of ecosystem services: cleaning air and water of pollutants, sequestering carbon, providing habitat, and generating employment. “I go in and determine if there are sufficient nutrients, in bioavailable forms, required for sustainable forestry, especially in depleted soils,” he says.

Justin Richardson

Richardson is excited by the opportunity to base his work at UVA. “You couldn’t ask for a better set of positive, dynamic colleagues working on cool things I want to be a part of,” he says. He also notes that studying soil in Virginia is particularly meaningful to him. “I’ve traced my enslaved family to Virginia,” he says. “You can still find evidence of the slave system—and the mismanagement of the land that it encouraged—in its soil.” ■

Studying Precipitation Variability and the Tools We Use to Predict It

We can no longer take a reliable supply of water for granted. As the climate changes, precipitation patterns are shifting and becoming more variable and more extreme. Assistant Professor **Antonios Mamalakis** uses a combination of physical models and data science tools to study precipitation variability across spatial and temporal scales in different parts of the world.

“Neither physics-based models that seek to simulate the hydroclimate nor tools that find relationships in the data are sufficient in themselves,” he says. “You need to leverage both.”

Mamalakis is particularly interested in being able to predict precipitation variability on seasonal timescales in the United States and elsewhere in the world. “Being able to look 90 days into the future and determine the risks of drought or flooding is extremely valuable, from both an economic and public safety perspective,” he says.

He also concentrates on shedding light on how sophisticated models that use

Bringing Communities to the Table

Trees in urban parks and curbside plantings, among other urban forest elements, deliver a variety of important ecological, social, health, and well-being benefits for city dwellers. These benefits include heat reduction, air and water quality improvements, water runoff reduction, and carbon sequestration—in addition to providing a more pleasant environment for people to live and work. But tree cover is not evenly distributed in cities, tending to be concentrated in wealthier neighborhoods. This often raises issue of environmental injustice for disadvantaged communities that lack the important benefits trees provide.

Many cities have engaged in extensive tree planting programs intended to address this inequality or have plans to do so. "Most tree planting initiatives have been guided by observations and included models of tree distribution and tools that can help decision-makers prioritize tree cover, but they tend to neglect the human element," says Assistant Professor **Charity Nyelele**. "Using a socio-ecological synthesis approach, I am trying to develop a process that identifies priority areas for tree planting that is grounded in science but also centers the needs and priorities of community members."

Charity Nyelele

This is particularly important because tree-planting initiatives in some underserved and marginalized communities have not always been successful due to lack of meaningful community engagement. Some community members, for instance, have been concerned about increased tree cover potentially encouraging crime. They have also worried about who will assume the costs and responsibilities of maintaining the new trees. "The challenge is to find ways to engage people on the ground in meaningful discussions about the environment they live in," Nyelele says. "They need to have the last word if we are to get the maximum impact from these greening programs."

Nyelele sees Charlottesville as a testbed for actionable research through transdisciplinary science on some of these issues. She is collaborating with her department colleague Professor Lawrence Band, Professor Teresa Culver from the School of Engineering and Applied Science, and Professor Beverly Wilson from the School of Architecture to develop an interdisciplinary approach to the siting of green infrastructure that incorporates the perceptions and priorities of communities. "One of the reasons I came to UVA was the presence of people like Larry, Teresa, and Bev who are already engaged in place-based work and who understand that environmental justice is critical to sustainable urban forest management," she says. ■

Antonios Mamalakis

deep learning AI methodologies make their decisions. "These deep learning models are usually seen as black boxes," he says. "When they're used to influence real-world policymaking, you need to be able to elucidate their decision-making process."

A better understanding of how these models reach their conclusions can help researchers trust them more and/or improve them. It can also help researchers identify otherwise hidden patterns and relationships that the model has discovered in the process of making its predictions.

Mamalakis has a joint appointment in the School of Data Science and the College and Graduate School of Arts & Sciences—and the opportunity to do interdisciplinary research was critical to his decision to join the UVA faculty. "Science is mature enough that we can make exciting discoveries by integrating knowledge across fields," he says. "The leadership at UVA has done a great deal to encourage this kind of cross-disciplinary work." ■

Atmospheric Scien

How Dry Will the Southwest Get?

As the Earth warms, changes in atmospheric circulation are altering long-established weather patterns. In the southwestern United States where water resources are already stretched, global climate models project that the drought will deepen over the course of the 21st century. But disconcertingly for planners, there remains considerable uncertainty about its severity. Associate Professor **Kevin Grise**, an atmospheric scientist, is analyzing climate models in hopes of reducing that uncertainty.

Although models agree that warming air will dry out the soil in the Southwest, there is much less consensus about the amount of precipitation the region can expect and how precipitation might vary from season to season. This is important: increased precipitation in summer would help mitigate drought risk, while decreases in precipitation in winter and spring would exacerbate it. "Right now, the models are inconsistent," Grise says. "Some show the area becoming wetter, while others indicate it will become drier."

Grise likens these precipitation predictions to the different tracks, or storylines, generated by models used to forecast the course of a hurricane. "You see these spaghetti lines tracing the path of the storm," he says. "If more of them cluster in one place, then you know that outcome is more likely, although that doesn't mean the one at the very edge is not possible."

Is that the case in this instance? For the most part, outliers are generated by random internal variability due to the chaotic nature of the atmosphere. But given the broad distribution of storylines for precipitation in the Southwest, Grise wondered if there was a flaw in some of the models.

The Critical Difference

Analysis of previous generations of climate models was limited by the relatively small number of times they could be run. Thanks to constant advances in computing power, researchers now have the ability to run a model with the same data ten to 100 times, producing what are known as large ensemble simulations. The more runs there are, the more confidence researchers have in their ability to separate storylines caused by internal variability from those caused by differences in the models themselves.

All told, Grise analyzed 248 model runs from 18 models. He then examined the climate models to see if they accurately

Kathleen Schiro

Understanding the Impact of Climate Ch

As the ground warms over the course of a day, the warm moist air above it begins to rise. As it moves higher, that moisture condenses into water droplets, forming clouds, releasing heat, and propelling the now lighter air even higher into the atmosphere. This process—called deep convection when it extends far up into the atmosphere—can repeat many times over and eventually generate thunderstorms. The cloud cover and heavy precipitation that characterize these storms are the single most important elements of weather in the tropics, and their outsized influence extends indirectly to higher latitudes.

As the Earth warms, the intensity of these storms will increase because of the relationship between air temperature and moisture capacity. For every degree Celsius of warming, the atmosphere can accommodate up to 7 percent more water vapor. If we are to accurately predict how our climate will change, understanding the impact of a warmer, moister atmosphere on deep convection is essential—and this in turn requires a better sense of deep convection itself, both locally and at more expansive spatial scales.

These challenges are at the heart of Assistant Professor **Kathleen Schiro**'s research. "I combine field campaign observations, satellite observations, and cloud-resolving models to study the physical processes controlling deep convection and heavy precipitation at the

simulated the current configuration of the jet stream over western North America. Not all did. He found that by excluding models that poorly represented the current jet stream, the range of future precipitation storylines for the Southwest could be narrowed to exclude extreme drier weather in the winter and extreme wetter weather during summer.

Grise cautions that a model's ability to accurately portray other factors besides large-scale atmospheric circulation might also affect the reliability of its predictions. These factors might include land surface processes and topography. But he argues that accurate depiction of atmospheric circulation is essential. "By taking atmospheric circulation into account," he says, "we can at least improve our ability to say that some outcomes are more likely to happen than others." ■

Kevin Grise

ange on Tropical Storms

storm-scale," Schiro says. "I also use climate models to study the interactions among deep convection, clouds, and the large-scale atmospheric circulation across scales." While Schiro focuses mostly in the tropics, she maintains collaborations examining regional hydroclimatic changes in the mid-latitudes as well.

The Critical Role of Models

Modeling is a critical tool of climate scientists like Schiro because they enable researchers to anticipate the effects of continued greenhouse gas emissions. They are also critical for understanding processes. Schiro focuses on two classes of models: convection-permitting models and global climate models. Convection permitting models have a fine resolution (on the order of one-to-five kilometers) and are similar to those weather forecasters use. These models are applied to shed light on the physics of convection at the storm scale. "We can, for instance, conduct what we call mechanism denial experiments with the model, doing things like disconnecting the link between clouds and radiation and determining the effect radiation has on thunderstorms," she says. "Are they weaker or stronger, larger or smaller, or do they cluster together more readily?"

This class of models, however, is currently too expensive to run globally for hundreds of years into the future. As a result, climate scientists, including those involved in the Intergovernmental Panel on Climate Change, resort to coarser-resolution models for global warming experiments. Schiro examines the way these models represent clouds and precipitation in present and future climate.

The critical dependence on global climate models means that they have to be as realistic as possible. This means that atmospheric scientists like Schiro must do more than just study their output: they place a high premium on using observations to refine and validate them. "In our group, we try to use satellite and field observations of convective systems collected over many years to improve the models' physical representation of the statistics of deep convection so we can more accurately simulate precipitation and cloud statistics," she says.

"Our interest is not simply academic," she adds. "We're trying to understand the evolving climate so that people can prepare for the changes in our future." ■

Hydrology

MODELING, SIMULATION, AND DATA

Lawrence Band

The idea is to take natural ecosystem principles and transform them into guidelines to design green infrastructure in urban areas with local residents.

Building More Complex Watershed Models

Lawrence Band, the Ernest H. Ern Professor, has an expansive vision. An ecohydrologist, he operates at the intersection of hydrology, ecosystems, and geomorphology in watersheds—and works across a continuum that includes rural, forested, mixed land use, and urban areas. The breadth of his vision is matched by diversity of the models he employs and his appetite for data.

Band began as a geomorphologist, coming later to hydrology because he realized, as he says, "I needed better plumbing for my geomorphic models." He worked with a NASA team of remote sensing scientists and forest ecologists to develop interdisciplinary models coupling water, carbon and nitrogen cycling in natural to developed landscapes. "I'm an integrator rather than a specialist," he says. "But as a result of these collaborations, my group has some of the most comprehensive models at the watershed scale that I know of."

Heterogeneity and Stability

Having models of this complexity has given Band the opportunity to spotlight the importance of the heterogeneity inherent in landscapes and watersheds. "In a given watershed, soils and vegetation vary and co-evolve with the topography," he says. "We have demonstrated that if we ignore that heterogeneity, our models cannot capture the delicate balances and interactions defining stable ecosystems.

There are good reasons for this. Heterogeneity of both structure and function means that these systems are buffered against extremes and therefore more stable. "Under extreme heat or wet conditions, certain parts of the landscape will shed water or store more water or evaporate more water, and that provides greater stability than we would otherwise see," he says. "Because everything doesn't react the same way, you don't have an ecosystem that lemming-like marches off a cliff."

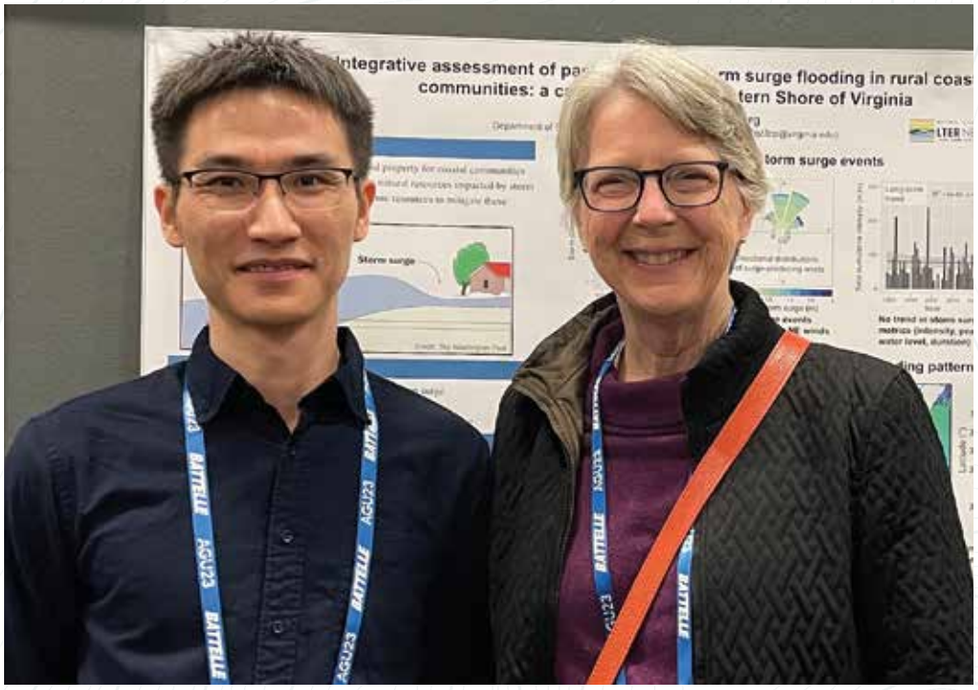
For instance, Band found during the Australian Millennium Drought that spanned the first decade of this century, the limited rain was preferentially shunted to lower riparian regions. This created stability by maintaining healthy riparian ecosystems and regulating the exchange of moisture and carbon with the atmosphere.

Dissolving the Gap Between Urban and Rural

Band refers to himself as a kid from the Bronx, and he has an interest in applying the models developed for rural landscapes to cities. He notes that separate modeling traditions have grown up for natural and urban areas, but his practice is to run the same family of models in both locations, adjusting for different conditions. "In a natural watershed, you still have some roads, culverts, and managed forests," he notes. "And in urban places, impervious surfaces usually make up no more than half of the land area, while the rest is vegetated in some form or another."

The idea is to take natural ecosystem principles and transform them into guidelines to design green infrastructure in urban areas with local residents. Band's goal is to identify ways to develop more diversity in urban areas that suffer from flooding and extreme heat. In this way, he believes, we can create more stable ecosystems that benefit and meet the preferences of communities, resulting in sustainable and equitable change. ■

Modeling Sediment Flow at the VCR-LTER



Qingguang "Bright" Zhu and Patricia Wiberg

Professor **Patricia Wiberg** has studied the transport of sediment in marine systems throughout the world, but she has devoted much of her time to the Virginia Coast Reserve—Long Term Ecological Research (VCR-LTER) site on the Eastern Shore. The VCR-LTER's complex system of 14 barrier islands, punctuated by inlets and backed by a series of bays and marshes, stretches for more than 100 kilometers along the Atlantic coast. Tracking the transport of sediments through this environment is a daunting task but is essential to answering such questions as whether seagrass can be successfully restored to the VCR-LTER's lagoons or whether the salt marshes will be overwhelmed as sea level rises.

To address these issues, Wiberg turned to modeling. "Modeling is really the only way to master this complexity and scale," she says. "You can make only so many field measurements, and remote sensing provides insight primarily into surface conditions."

Creating a Digital Twin

Working with her former graduate student (now research associate) **Qingguang "Bright" Zhu**, Wiberg developed a hydrodynamic model of the bay system using Delft3D, an open-source coastal modeling software suite developed in the Netherlands. By uploading data collected at points across the VCR-LTER over decades, she has developed a digital "twin" that, she says, "works really well for predicting wave conditions, storm-driven flows, sediment resuspension, and turbidity events as well as the effects of vegetation on these processes."

> Her model gives Wiberg the ability to make virtual measurements in areas where there were no field observations.

Wiberg's model gives her the opportunity to ask questions that could not be answered any other way. For instance, she can move back and forth in time. "We can do things like look at a storm in the past and learn more about its effects," she says. "Or we can think about the future when sea level is higher or when storms are more intense and ask how that might change things."

Her model also gives Wiberg the opportunity to expand the spatial domain of her knowledge. In effect, it gives her the ability to make virtual measurements in areas where there were no field observations. Using the model, Wiberg can also control variables in ways that would be impossible otherwise. She might, for example, move a landscape feature to another position and note the impact of that change. And the model helps her pinpoint relationships between different phenomena, for instance between turbidity and waves.

Finally, modeling allows Wiberg to make virtual observations when making real ones would be difficult. Using the model, she and Zhu have found that big nor'easters, which occur relatively infrequently, contribute disproportionately to the delivery of sediments into the marshes. "The likelihood that you would happen to be out during a storm like that—or want to be out there—is slim," she says.

A Tool That Can Be Shared with Others

Wiberg has used her model to understand the way seagrass affects sediment dynamics and to shed light on how sediment flows sustain the salt marshes, but its value transcends her own research. She has been collaborating with colleagues Professor Matthew Reidenbach and Associate Professor Max Castorani, who are interested in learning more about the dispersal of oyster larvae through the bays behind the barrier islands and the implications for the health of the bays' oyster ecosystem. "We are just beginning to tap the potential of models like these," she says. ■

Remote Sensing in

Swapping Secchi Disks for Remote Sensing

Since 1992, researchers at the Virginia Coast Reserve—Long Term Ecological Research (VCR-LTER) site on the Eastern Shore have gone out four times a year to collect water samples from a dozen sites in the bays behind the barrier islands. In addition to measuring water chemistry, they record water clarity using standardized black and white Secchi disks that they lower into the water until they are no longer visible. This simple, reliable method has been used for over 150 years.

In the process, researchers have compiled a remarkable long-term record of the health of the bays. Associate Professor **Max Castorani** realized that the full value of this Secchi dataset, however, had yet to be tapped. He proposed correlating NASA satellite images with these Secchi measurements. If the correlation was successful, researchers could then estimate water clarity much more quickly and frequently and at virtually any location in the bays covered by satellites. "As primarily a field ecologist, I know just enough about remote sensing to be dangerous," he says.

As Castorani notes, remote sensing had already been used to determine water clarity in oceans using color as an indicator. Working in coastal environments is much more difficult because their complicated coastlines and shallow water make it harder to link color with clarity.

Increasing the Value of Satellite Data

Having a detailed, more comprehensive understanding of water clarity could be extremely useful. Cloudy water, for instance, can be a sign of eutrophication, which occurs when run-off containing nutrients such as nitrogen and phosphorous causes

Max Castorani

Counting the Trees in a Ghost Forest

Remote sensing imagery has revolutionized the environmental sciences, but it has also had its drawbacks. Because of their location several hundred miles in space, satellites produced only broad-brush images of the Earth. Lacking detailed information, researchers confined their conclusions to large-scale environmental processes.

In the last decade, the introduction of very-high-resolution remote sensing instruments has opened new avenues for scientific research. Remote sensing instruments now generate images that are so finely grained that researchers can pick out individual trees in a forest—and do so over vast spatial scales. "A forester on the ground might be able to monitor thousands of trees," Associate Professor

Henry Yeung and Xi Yang

algae blooms. At the VCR-LTER, tracking water clarity is essential for monitoring the large-scale seagrass restoration project under way in the lagoons. Murky water can endanger these underwater plants because they need light to survive; clear water is also a sign of a thriving bed, as seagrass reduces suspended sediments.

Castorani sought the help of Professor Scott Doney, an oceanographer with expertise in remote sensing and data analysis. Together they secured funding from the Virginia Space Grant Consortium and enlisted UVA undergraduate **Sarah Lang** to help with the project. "Sarah was a superstar," Castorani says. "She came in with no training in remote sensing or coding. In the span of a summer, she learned scientific programming in MATLAB, how to access Landsat 8 and Sentinel-2 satellite data and adjust them to reflect the unique conditions of coastal waters, and how to apply optical algorithms to extrapolate Secchi depths from the data."

In effect, Lang demonstrated that processed satellite data, validated by field observations, can be used to track water clarity in estuaries and coastal seas. Using her model, researchers can estimate water clarity in areas that were never directly sampled, greatly expanding the spatial footprint of their observations—and determine water clarity for the entire length of time that satellite data are available. This includes during critical events like storms when it would be unsafe to make observations. Finally, having more detailed information about coastal ecosystems in the past provides a better baseline to understand how ecosystems will change in the future.

"This was a valuable project in several ways," Castorani says. "Not only did it advance the science, but the research experience and training proved to be a springboard for Sarah's career." Lang was the lead author of a paper on the project,

Sarah Lang

which was recently published in the journal *Earth and Space Science*. She is now a doctoral candidate at the University of Rhode Island School of Oceanography, where she continues to study ocean color and biogeochemistry by combining field work and remote sensing. ■

Xi Yang says. "We can now track hundreds of millions of trees and revisit them repeatedly. This is a game-changer."

Mapping Ghost Forests

Yet as Yang points out, accessing high-resolution data is just a first step. Researchers must learn how to interpret it. Yang's study of the effects of sea-level rise and saltwater intrusion on coastal forested wetlands is an example of how these data can be processed and combined with other observations to provide a comprehensive yet detailed picture of climate change.

As saltwater invades the marshes, salt-sensitive trees begin to die, leaving behind ghost forests. If researchers can separate dead trees from living ones in satellite imagery, they can determine areas that are more vulnerable to climate change and make informed predictions about the spread of ghost forests and their implications for coastal wetlands. "Tree death is spatially quite heterogeneous and might depend on environmental factors like distance to the coastline or proximity to manmade drainage channels," Yang says. "Correlating the fate of individual trees with environmental and biological drivers is essential to modeling the system and predicting tree mortality."

Yang points out that these models are as important to coastal residents as they are to scientists. "If you're making the investment to build a house on a plot of land, you want to understand the risk of saltwater intrusion killing your trees, polluting your well, and reducing the effectiveness of your septic system," he says.

Applying Machine Learning to Satellite Images

Given the resolution, scale, and quantity of the images satellites now produce, the challenge that Yang and his fellow researchers face is to automate the process of tree characterization. Yang and graduate student **Henry Yeung** turned to machine learning. He recruited a team of students who tagged 100,000 dead trees from remote sensing images and used them to train a machine learning algorithm. It has learned to identify trees by such factors as the color of the canopy, the amount of near-infrared solar radiation they reflect, and the linear patterns caused by dead trees lying on the ground. "The algorithm has been very good at identifying dead trees," Yang says. "We have identified over 4 million dead trees from coastal areas between Virginia and Maine using remote sensing images collected between 2018 and 2022."

Yang's goal is to produce a map of ghost forests in the United States and in other parts of the world and to use these maps to better understand the main drivers of tree death and to help create a model to predict tree mortality at the individual scale. And as part of the Saltwater Intrusion and Sea Level Rise Research Coordination Network, he hopes to bring this information to local communities along the coast to help factor in climate change as they plan for the future. ■

AWARDS, APPOINTMENTS, AND PUBLICATIONS

Undergraduate Students

The department recognizes fourth-year students who have done outstanding work in specific environmental sciences. This year, the Michael Garstang Atmospheric Sciences Award went to **Patrick Roney** and the Mahlon G. Kelly Prize in ecology to **Henry Chin**. The department presented its Hydrology Award to **Ella Heitmeyer** and the Wilbur A. Nelson Award in geosciences to **Medha Prakash**.

The departmental interdisciplinary award for the undergraduate major who has excelled in interdisciplinary environmental sciences research was presented to **Alyssa Underwood**.

Elizabeth Van Metre was selected to receive the Hart Family Award for Undergraduate Research in Environmental Sciences. It provides funds to assist full-time environmental sciences majors who are conducting a supervised research project.

Becca Danese 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.

The Bloomer Scholarship, which provides $1,800 toward tuition, is given to an outstanding undergraduate environmental sciences major with a focus on geology. This year's winner was **Autumn Summers**.

Victoria Thompson received 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.

Carmen Petras was 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 achieve an overall GPA of 3.4 or above. This year, the department selected **Henry Chin**, **Connor Dooren**, **Carmen Petras**, **Medha Prakash**, **Olivia Redding**, **Patrick Roney**, **Olivia Taylor**, **Alyssa Underwood**, and **Tahi Wiggins** as distinguished majors.

Graduate Students

Spencer Tassone was the winner of the Environmental Sciences Student Excellence Award, the department's premier award. Dr. F. Gordon Tice established the award in 1992 to foster environmental research and scholarship; 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.

The department offers a series of awards honoring exceptional graduate students in individual environmental sciences. **Wayne Dawson** earned the Graduate Award in Ecology, **Kelsey O'Donnell** the Graduate Award in Hydrology, **Emma Dawson** the Graduate Award in Atmospheric Sciences, and **Mary Stack** the Arthur A. Pegau Award in Geoscience. **Mirella Shaban** received the Ellison-Edmundson Award in Interdisciplinary Studies.

Mary Stack was also one of 15 students from the College and Graduate School of Arts & Sciences selected to present their research at the 2023 Huskey Graduate Research Exhibition.

Sean Hardison was this year's recipient of the Trout Unlimited Award. Established by the Thomas Jefferson Chapter of Trout Unlimited, this award is presented for "significant contributions to research concerning cold-water fisheries or related ecosystems."

Yuan Li and **Allison Lepp** received the Jay Zieman Research Publication Award, named after the late Jay Zieman, former chair of the department.

The Exploratory Research Awards, based on merit, were initiated to help selected students conduct preliminary research leading to the development of a thesis or dissertation proposal. The recipients this year were **Lauren Brideau**, **David Crowe**, **Luke Groff**, and **Henry Yeung**.

This year, **Jemima Elsherbini**, **Kelcy Kent**, **Rong Li**, and **Madeline Miles** won Moore Research Awards. Based on merit, this award was initiated to help sponsor the dissertation and thesis work of environmental sciences graduate students.

Kylor Kerns received the Thomas Jefferson Conservation Award, which supports basic research related to the conservation of the Earth's resources.

Sayali Kulkarni won the Michael Garstang Award, which supports graduate student research in interdisciplinary atmospheric sciences.

Jemima Elsherbini and **Kelly O'Donnell** won the Graduate Student Association Award, which recognizes members of the department who have been particularly helpful to the graduate student body.

Elise Heffernan won the Fred Holmsley Moore Teaching Award, bestowed on graduate teaching assistants distinguished by their ability to instill excitement, wonder, and confidence in students. An endowment established by Fred H. Moore funds this award, along with matching donations from Mobil Oil Company.

The Jefferson Scholars Foundation awarded **Kayleigh Granville** a two-year Jefferson Fellowship that covers her dissertation completion year and a postdoctoral year. It is the premier graduate fellowship for students in the College and Graduate School of Arts & Sciences.

Marion McKenzie, who completed her PhD this year, received a National Science Foundation Division of Earth Sciences Postdoctoral Fellowship.

Faculty

Lawrence Band, the Ernest H. Ern Professor of Environmental Sciences, was a member of the Editorial Board of Hydrological Processes and was coeditor of a special issue of the *Journal of Hydrology* entitled, "Non-Hortonian Processes in Urban Watershed." He served as an external reviewer for promotion and tenure decisions, including promotion to full professor, and reviewed nominations and recommendations for American Geophysical Union Fellows and other awards, research grants for national and international funding agencies, and manuscripts for journals. At the University, he was a member of the Promotion and Tenure Committees of the School of Data Science and the College and Graduate School of Arts & Sciences and served on the Steering Committee of the Environmental Resilience Institute.

Peter Berg reviewed National Science Foundation (NSF) proposals and manuscripts for peer-reviewed journals. In addition, he arranged for a session on underwater flux measurements at the Association for the Sciences of Limnology and Oceanography meeting.

David Carr was an associate editor of the *American Journal of Botany* and a member of the Board of Directors of the Foundation of the State Arboretum and the Morven Farm Consultation Group. For the UVA College and Graduate School of Arts & Sciences, he served a member of its Chairs and Directors Committee as well as its General Faculty Promotion and Renewal Committee.

Max Castorani served on the Editorial Board of *Ecosphere*, as an external advisor for the Plum Island Ecosystems Long Term Ecological Research project (PIE LTER), and the Diversity, Equity, & Inclusion Steering Committee at the Virginia Coast Reserve LTER. In addition, he was an external thesis reviewer for doctoral students and reviewed articles for a number of professional journals. Professor Castorani was a member of the Ecological Society of America and the Coastal and Estuarine Research Federation. This year, the department awarded him its Tice Prize for research excellence.

Robert Davis chaired the Assembly Group of the Processions Committee at the University and was an at-large faculty representative to the Raven Society and academic advisor to the UVA chapter of the Surfrider Club. He reviewed manuscripts for a number of professional journals. For the second year in a row, Professor Davis was cited by students in the UVA Career Center's Summer Plans Survey as the "individual who helped them the most with their career development."

Stephan De Wekker was the editor of the *Journal of Applied Meteorology and Climatology* as well as an associate editor of *Atmosphere* and was active in a number of scientific initiatives and organizations. He was a member of the Steering Committee for the Transport and Exchange over Mountains–Programme and Experiment (TEAM-X). For the American Meteorological Society (AMS), he served on the Scientific and Technological Activities Commission Committee on Agricultural and Forest Meteorology and represented AMS at the Council for Agricultural Science and Technology. He was also a member of the Observing Facilities Assessment Panel at the National Center for Atmospheric Research. Professor De Wekker reviewed grant proposals for the National Science Foundation, the German Science Foundation, and the Austrian Science Foundation. This year, he had a Sesquicentennial Fellowship from the University and chaired the Faculty Senate Nominating Committee

Scott Doney, the Joe D. and Helen J. Kingston Professor in Environmental Change, is a Web of Science Clarivate Analytics Highly Cited Researcher in Cross-Field research. He served on the Redfield Lifetime Achievement Award Subcommittee of the Association for the Sciences of Limnology and Oceanography (ASLO) and on the Maurice Ewing Medal Selection Committee

for the American Geophysical Union (AGU). He was secretary of the Atmospheric and Hydrospheric Sciences Section of the American Association for the Advancement of Science, chair of the Committee on a Research Strategy for Ocean Carbon Dioxide Removal and Sequestration at the National Academy of Sciences, and a participant in the Australian Centre for Excellence in Antarctic Science. For the National Science Foundation (NSF), he was co-principal investigator and Executive Committee member for the Center for Chemical Currencies of a Microbial Planet, and an RCN Steering Committee Member for the Saltwater Intrusion and Sea Level Rise in Rural Landscapes grant.

In addition, Professor Doney was involved in a number of interagency groups. He is a member of the Ocean Carbon Biogeochemistry Scientific Steering Committee (NSF and National Oceanic and Atmospheric Association [NOAA]), the U.S. Biogeochemical Argo Subcommittee (Ocean Carbon Biochemistry, National Aeronautics and Space Administration (NASA), NSF, and NOAA), and the Executive Council of the U.S. Global Ocean Ship-based Hydrographic Investigations Program (NSF and NOAA). He was cochair for two sessions at the 2022 Ocean Sciences Meeting (AGU, ASLO, and the Oceanographic Society).

Professor Doney reviewed manuscripts for scholarly journals, evaluated grant proposals for funding agencies, served as an external reviewer for appointment, promotion, tenure, and awards, and was interviewed by or published articles in publications for general audiences. At the University, he served on the Steering Committee of the Environmental Resilience Institute and was a panelist for a webinar sponsored by the Office of the Vice President for Research on sharing research on social media.

Howard E. Epstein is chair of the Department of Environmental Sciences and the Sidman P. Poole Professor of Environmental Sciences. He is cochair of the Vegetation Dynamics Working Group, part of the National Aeronautics and Space Administration's (NASA's) Arctic Boreal Vulnerability Experiment, as well as of the Environmental Working Group of the Digital Belt and Road Initiative, sponsored by the Chinese Academy of Sciences. At the University, Professor Epstein was codirector of the College Science Scholars program, a member of the EXPAND Fellowship Steering Committee, and a member of the Search Committee for a College Research Administration Director. This year, he was singled out for a Research Achievement Award from UVA's Office of the Vice President for Research.

James N. Galloway, the Sidman P. Poole Emeritus Professor of Environmental Sciences, served on the Steering Committee of the International Nitrogen Initiative. At the University, he was a member of the Committee on Sustainability and a member of its Environmental Stewardship Subcommittee.

Kevin Grise began a four-year term as a member of the U.S. Climate Variability and Predictability Program Process Study and Model Improvement Panel. He served as a peer reviewer for numerous journal articles and for a funding proposal for the National Science Foundation (NSF). In addition, he was a panel reviewer for the National Aeronautics and Space Administration (NASA)/CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation)/CloudSat proposal competition. At the University, Professor Grise was named an Advance Fellow in the College and Graduate School of Arts & Sciences faculty-led STEM Student Success Initiative and served as an internal reviewer for 13 graduate student research proposals submitted to the Virginia Space Grant Consortium Graduate Fellowship Program competition. He represented UVA at the University Corporation for Atmospheric Research.

Kyle Haynes was on the Editorial Boards of *Ecography* and *Oecologia* and was a guest editor for a special edition of *Current Opinion in Insect Science*. He also reviewed manuscripts for a number of professional journals. He and his coauthor received the Best Research Article award from Basic and Applied Ecology for producing the most-cited article three years after publication. At the University, he served on the EXPAND Fellowship Steering Committee, presented at UVA's Universities Studying Slavery Conference, and met with the University's Extinction Club.

Deborah Lawrence directs the Environmental Thought and Practice program, an interdisciplinary major that brings the natural sciences, social sciences, arts, and humanities to bear on understanding and solving environmental challenges such as climate change. She served as secretary of the Board of Trustees of The Nature Conservancy of Virginia and a member of the National Trustee Council of The Nature Conservancy. In addition, she was a member of Climate Strategies, an international research network on climate policy. At the University, Professor Lawrence served on the Advisory Board of the Virginia Environmental Law Review, which is edited by students at the School of Law, and on the Advisory Committee of Wahoos for Sustainability, an alumni advocacy organization.

Manuel Lerdau was an associate editor of *Biology Letters*, *Northeastern Naturalist*, and *Ecology*. He served on the National Science Foundation Graduate Research Fellowship Program panel and reviewed proposals for its Division of Integrative Organismal Systems. In addition, he was a Publications Committee member for the Ecological Society of America and chair of its Data Procedures Subcommittee. He also served as external reviewer for promotion and tenure and promotion to full professor at a number of academic institutions and reviewed manuscripts for several professional journals. At the University, Professor Lerdau chaired the College and Graduate School of Arts & Sciences Faculty Rules Committee. In addition, he was a member of the University's Nelson Fund Committee, the Provost's Working Group on Faculty Evaluation, the Advisory Board of the Global Infectious Disease Institute, Sustainability@UVA Committee, the UVA Food Collaborative Steering Committee, and the Southeast Asia Studies Committee. He is an advisor to the Sexual Misconduct Hearings Board. He was also a faculty mentor for the Grad STAR Faculty Student Mentoring Program.

Ajay Limaye reviewed proposals for the National Science Foundation and the National Aeronautic and Space Administration and manuscripts for a variety of professional journals. For the American Geophysical Union, he served as a judge for its Outstanding Student Presentation Awards. Professor Limaye was a finalist for the David and Lucille Packard Fellowship in Science and Engineering, one of 100 early-career faculty in sciences and engineering nominated for the award.

Stephen A. Macko was a visiting scholar at the Smithsonian Institution. He was editor-in-chief of *Nitrogen*, section editor-in-chief of *Geosciences* (*Biogeosciences*), and served on the Editorial Boards of *Oceanography* (Oxford Research Encyclopedia) and *Minerals*. He was a convener for the Geosciences Information for Teachers and the Science in Tomorrow's Classroom virtual workshops, held in conjunction with the European Geosciences Union (EGU) General Assembly. He served as secretary of the EGU's Committee on Education and a member of the Review Committees for the Crafoord Medal Prize in Geosciences, the Franklin Medal, and the Vernadsky Medal. He was on the Major Instrumentation Panel at the National Science Foundation and served as an external reviewer for a promotion and tenure decision. Professor Macko was included in *American Men and Women in Science*, *Who's Who in America, Science and Engineering*, *Who's Who in America, Science Education*, and *Who's Who in the World, Science and Engineering*. At the University, Professor Macko was a member of the Faculty Senate, the Faculty Senate Policy Committee, the Faculty Advisory Committee to the Honor Committee, the Summer Session Advisory Committee, and the University Libraries Committee. He was a Hereford College Faculty Fellow.

Karen J. McGlathery, the Sherrell J. Aston Chaired Professor in Environmental Sciences, is the lead principal investigator of the Virginia Coast Reserve Long Term Ecological Research (LTER) program and director of UVA's Environmental Resilience Institute. She sat on the LTER National Science Council and LTER National Executive Board as well as the Advisory Committee of the Florida Coastal Everglades LTER. She was a coorganizer of the LTER Network's art-science-humanities collaborations. In addition, she was a member of the National Science Foundation (NSF) Coasts and People (CoPe) Awardee Steering Group and an associate editor of *Ecosystems*.

Professor McGlathery also was active in a number of organizations in the Commonwealth. She served on the Governor's Technical Advisory Committee for Virginia's Coastal Resilience Master Plan, the Advisory Board for the Chesapeake Bay Trust on Modeling Climate Change Impacts on Submerged Aquatic Vegetation, and the Research and Education Advisory Council of Virginia Sea Grant. She reviewed proposals for the NSF and served as an external reviewer for a promotion and tenure decision.

Professor McGlathery serves the University in a number of capacities. She was the UVA representative to the Association of Public and Land-Grant Universities' Board on Oceans, Atmosphere, and Climate's Environmental Futures Forum. In addition to serving as director of the University's Environmental Resilience Institute, she was codirector of its Coastal Conservatory Environmental Humanities Consortium. She also served on the Global Sustainability Pathways Faculty Expert Committee for the Provost's Office and the Extramural Funding and Research Administration Working Group, part of the Strategic Research Infrastructure Initiative under the auspices of the Office of the Vice President for Research. In addition, she was advisor to the provost and vice president of research on Environmental Resilience and Sustainability Grand Challenge Investments and was appointed by the provost to lead the Environmental Grand Challenges Faculty Hiring Coordinating Committee. She was also cochair of the Teaching and Research Subcommittee of the UVA Committee for Sustainability and the lead organizer and a panelist for the College and Graduate School of Arts & Sciences Undergraduate Orientation on the Environment. This year, she was singled out for a Research Achievement Award from UVA's Office of the Vice President for Research.

Lauren Miller served as secretary of the American Geophysical Union Cryospheric Sciences Section and was appointed to the National Academies of Sciences, Engineering and Medicine Polar Research Board. In addition to being a member of the Books Editorial Committee of the Geological Society of London, she served as an associate editor of a *Frontiers of Earth Science* special research topic, "Past Ice Sheet and Ice-Ocean Interactions from Deglaciated Continental Margins" as well as of an Earth Surface Processes and Landforms special research project, "Glaciated landscapes: geomorphology as a tool for understanding past, present, and future glacier and ice sheet behaviour."

Professor Miller was also a member of the Louis Stokes Alliance for Minority Participation (LSAMP) Virginia-North Carolina Alliance Governing Board. In a survey conducted by the UVA Career Center, she was recognized by first- through third-year undergraduate students as "the one individual who helped them the most with their career development." She cochaired the University's Tribal Liaison Search Committee and was the native and indigenous relations community representative to the Chairs Summit and a member of the Indigenous Studies Working Group of the Democracy Initiative. In addition, she served as a faculty mentor at the Mentoring Institute of the Office of Graduate and Postdoctoral Diversity Affairs and was a member of the Native and Indigenous Relations Community.

Michael Pace, the W. W. Corcoran Professor of Natural History and director of graduate studies for the department, served as past president of the Association for the Science of Limnology and Oceanography and was chair of its Nominations Committee and a member of its Executive, Publications, and Finance Committees. In addition, he reviewed articles for numerous scholarly journals. At the University, Professor Pace served on the Biology Department Promotion and Tenure Review Committee and was a member of the Chaired Professors Committee in the College and Graduate School of Arts & Sciences.

John Porter was active in the LTER information management community, particularly in the area of developing new semantic resources for data discovery.

Sally Pusede was awarded the annual Turco Lectureship by the American Geophysical Union, which recognizes significant interdisciplinary scientific research, discoveries, or advancements in climate science. She organized a session at the American Meteorological Society Annual Meeting and was a chapter coauthor on air quality for the Fifth National Climate Assessment. Professor Pusede was a peer reviewer for numerous articles and National Science Foundation proposals.

Matthew Reidenbach was a member of the Diversity, Equity, and Inclusion Committee for the Virginia Coast Reserve-Long Term Ecological Research site. In addition, he was an external reviewer for a promotion and tenure decision and served as a reviewer for several National Science Foundation proposals as well as for manuscripts for professional journals. This year, Professor Reidenbach was the recipient of an Outstanding Researcher Award from the Office of the Vice President for Research.

T'ai Roulston was a subject editor of *Ecosphere* and a member of the Appalachian Regional Working Group on Rusty Patched Bumble Bee Conservation and North American Working Groups on Nut Tree Conservation and Fruit Tree Conservation.

Todd Scanlon is the associate chair of the department and chaired the College and Graduate School of Arts & Sciences Committee on Faculty Rules. He also reviewed manuscripts for a number of professional journals. Professor Scanlon was awarded an ADVANCE Fellowship.

Kathleen Schiro was an associate editor of *Monthly Weather Review* and reviewed manuscripts for a number of professional journals. She chaired the Convection Session at the American Meteorological Society's 34th Conference on Hurricanes and Tropical Meteorology and the Tropical Mesoscale Convection Systems at the AMS's 19th Conference on Mesoscale Processes. This year, Professor Schiro received the department's Environmental Sciences Organization Award, given to a member of the department who has been particularly helpful to undergraduate majors.

Herman H. Shugart, the W. W. Corcoran Emeritus Professor of Natural History, was a member of the Editorial Boards of *Ecological Processes*, *Forest Ecosystems*, and *The Sejm Review*.

Patricia Wiberg was a member of the Fellows Committee of the American Geophysical Union's Earth and Planetary Surface Processes Section as well as the Editorial Committee of the *Annual Review of Marine Science*. In addition, she served on the Steering Committee of the National Science Foundation-sponsored Community Sediment Dynamics Modeling System and on the Advisory Board of the Sediment Workgroup, part of the Regional Monitoring Program for Water Quality in San Francisco Bay. At the University, she was a member of the Graduate Educational Policy and Curriculum Committee. This year, Professor Wiberg won the Department Chair's Award, which recognizes an individual who has performed extraordinary service to the department.

Xi Yang served on the Foliar Sampling Technical Working Group of the National Science Foundation's National Ecological Observatory Network. He was also on the Steering Committee for Flux Course, a two-week educational program for graduate students sponsored by the AmeriFlux Network, and the Guidance Team of the Spectral Ecology Summer School, working to ensure an equitable and inclusive selection process.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PUBLISHED PEER-REVIEWED PAPERS, BOOK CHAPTERS, AND BOOKS BY FACULTY, STAFF, AND GRADUATE STUDENTS FOR SUMMER 2022—SPRING 2023

Barnes, S., Kirssin, L., Needham, E., Baharlou, E., **Carr, D. E.,** & Ma, J. (2022). 3D printing of ecologically active soil structures. *Additive Manufacturing*, *52*, 102670. doi:10.1016/j.addma.2022.102670.

Berg, P., Huettel, M., Glud, R. N., Reimers, C. E., & Attard, K. M. (2022). Aquatic eddy covariance: the method and its contributions to defining oxygen and carbon fluxes in marine environments. *Annual Review of Marine Science*, *14*, 431–455. doi:10.1146/annurev-marine-042121-012329.

Boyd, P. W., **Doney, S. C.**, Eggins, S., Ellwood, M. J., Fourquez, M., Nunn, B. L., ... & Timmins-Schiffman, E. (2022). Transitioning global change experiments on Southern Ocean phytoplankton from lab to field settings: Insights and challenges. *Limnology and Oceanography*, *67*(9), 1911–1930. doi:10.1002/lno.12175.

Brune, W. H., Miller, D. O., Thames, A. B., Brosius, A. L., Barletta, B., Blake, D. R., **Pusede, S. E.**, ... & Wennberg, P. O. (2022). Observations of atmospheric oxidation and ozone production in South Korea. *Atmospheric Environment*, *269*, 118854. doi:10.1016/j.atmosenv.2021.118854.

Buelo, C. D., **Pace, M. L.**, Carpenter, S. R., Stanley, E. H., Ortiz, D. A., & Ha, D. T. (2022). Evaluating the performance of temporal and spatial early warning statistics of algal blooms. *Ecological Applications*, *32*(5), e2616. doi:10.1002/eap.2616.

Cannon, C. H., & **Lerdau, M.** (2022). Asking half the question in explaining tropical diversity. *Trends in Ecology & Evolution*. doi:10.1016/j.tree.2022.01.006.

Carpenter, S. R., **Pace, M. L.**, & Wilkinson, G. M. (2022). DOC, grazers, and resilience of phytoplankton to enrichment. *Limnology and Oceanography Letters*, *7*(6), 466–474. doi:10.1002/lol2.10280.

Castorani, M. C., Bell, T. W., Walter, J. A., Reuman, D. C., Cavanaugh, K. C., & Sheppard, L. W. (2022). Disturbance and nutrients synchronise kelp forests across scales through interacting Moran effects. *Ecology Letters*, *25*(8), 1854–1868. doi:10.1111/ele.14066.

Cheng, S. L., **Tedford, K. N.**, **Smith, R. S.**, **Hardison, S.**, **Cornish, M. R.**, & **Castorani, M. C.** (2022). Coastal vegetation and bathymetry influence blue crab abundance across spatial scales. *Estuaries and Coasts*, *45*(6), 1701–1715. doi:10.1007/s12237-021-01039-5.

Davis, R. E., Driskill, E. K., & Novicoff, W. M. (2022). The association between weather and emergency department visitation for diabetes in Roanoke, Virginia. *International Journal of Biometeorology*, *66*(8), 1589–1597. doi:10.1007/s00484-022-02303-4.

Delesantro, J. M., Duncan, J. M., Riveros-Iregui, D., Blaszczak, J. R., Bernhardt, E. S., Urban, D. L., & **Band, L. E.** (2022). The Nonpoint Sources and Transport of Baseflow Nitrogen Loading Across a Developed Rural-Urban Gradient. *Water Resources Research*, *58*(7), e2021WR031533. doi:10.1029/2021WR031533.

Dinauer, A., Laufkötter, C., **Doney, S. C.**, & Joos, F. (2022). What Controls the Large-Scale Efficiency of Carbon Transfer Through the Ocean's Mesopelagic Zone? Insights from a New, Mechanistic Model (MSPACMAM). *Global biogeochemical cycles*, *36*(10), e2021GB007131. doi:10.1029/2021GB007131.

Dressel, I. M., Demetillo, M. A. G., Judd, L. M., Janz, S. J., Fields, K. P., Sun, K., ... & **Pusede, S. E.** (2022). Daily satellite observations of nitrogen dioxide air pollution inequality in New York City, New York and Newark, New Jersey: Evaluation and application. *Environmental Science & Technology*, *56*(22), 15298–15311. doi:10.1021/acs.est.2c02828.

Duce, R. A., Dickerson, R. R., Galbally, I. E., **Galloway, J. N.**, Jaenicke, R., Keene, W. C., ... & Winkler, P. (2022). Christian Junge—a pioneer in global atmospheric chemistry. *Journal of Atmospheric Chemistry*, *79*(4), 219–256. doi:10.1007/s10874-022-09437-0.

Fagherazzi, S., FitzGerald, D. M., Fulweiler, R. W., Hughes, Z., **Wiberg, P. L.**, **McGlathery, K. J.**, ... & Johnson, D. S. (2013). Ecogeomorphology of salt marshes. doi:10.1016/B978-0-12-818234-5.00194-2.

Fang, J., Liu, F., **Shugart, H. H.**, & Yan, X. (2022). Using a Simple Representation of Non-Structural Carbohydrates Allocation to Predict Wood Growth in Temperate Forests. *Journal of Geophysical Research: Biogeosciences*, *127*(12), e2022JG007085. doi:10.1029/2022JG007085.

Fang, J., **Shugart, H.**, Liu, F., Yan, X., Song, Y., & Lv, F. (2022). FORCCHN V2. 0: An individual tree-based model for predicting multiscale forest carbon dynamics. *EGUsphere*, 1–26. doi:org/10.5194/egusphere-2022-49.

Fang, J., Lutz, J. A., **Shugart, H. H.**, Liu, F., & Yan, X. (2022). Predicting soil mineralized nitrogen dynamics with fine root growth and microbial processes in temperate forests. *Biogeochemistry, 158*(1), 21–37. doi:10.1007/s10533-021-00883-8.

Fang, J., Lutz, J. A., **Shugart, H. H.**, Wang, L., Liu, F., & Yan, X. (2022). Continental-scale parameterization and prediction of leaf phenology for the North American forests. *Global Ecology and Biogeography, 31*(8), 1603–1615. doi:10.1111/geb.13533.

Fang, J., Lutz, J. A., **Shugart, H. H.**, Yan, X., Xie, W., & Liu, F. (2021). Improving intra- and inter-annual GPP predictions by using individual tree inventories and leaf growth dynamics. *Journal of Applied Ecology, 58*(10), 2315–2328. doi:10.1111/1365-2664.13960.

Fennel, K., Mattern, J. P., **Doney, S. C.**, Bopp, L., Moore, A. M., Wang, B., & Yu, L. (2022). Ocean biogeochemical modelling. *Nature Reviews Methods Primers, 2*(1), 76. doi:10.1038/s43586-022-00154-2.

Foster, A. C., Wang, J. A., Frost, G. V., Davidson, S. J., Hoy, E., Turner, K. W., **Epstein, H.**, ... & Goetz, S. (2022). Disturbances in North American boreal forest and Arctic tundra: impacts, interactions, and responses. *Environmental Research Letters, 17*(11), 113001. doi:10.1088/1748-9326/ac98d7.

Fowler, K., Peel, M., Saft, M., Peterson, T. J., Western, A., **Band, L.**, ... & Nathan, R. (2022). Explaining changes in rainfall–runoff relationships during and after Australia's Millennium Drought: a community perspective. *Hydrology and Earth System Sciences, 26*(23), 6073–6120. doi:10.5194/hess-2022-147.

Frazier, G., McGlynn, D. F., Barry, L. E., **Lerdau, M.**, **Pusede, S. E.**, & Isaacman-VanWertz, G. (2022). Composition, concentration, and oxidant reactivity of sesquiterpenes in the southeastern US. *Environmental Science: Atmospheres, 2*(5), 1208–1220. doi:10.1039/d2ea00059h.

Frost, G. V., Macander, M. J., Bhatt, U. S., Berner, L. T., Bjerke, J. W., **Epstein, H. E.**, Forbes, B. C., et. al. 2022. Tundra greenness [in "State of the Climate in 2021"]. *Bulletin of the American Meteorological Society,103*(8), S291–S293. doi:10.1175/BAMS-D-22-0082.1.

Frost, G. V., Macander, M. J., Bhatt, U. S., Berner, L. T., Bjerke, J. W., **Epstein, H. E.**, Forbes, B. C., et. al. 2022. *Arctic Report Card 2022: Tundra Greenness*. M. L. Druckenmiller, R. L. Thoman, and T. A. Moon (eds.). https://doi.org/10.25923/g8w3-6v31.

Graham, A. G. C., Wåhlin, A., Hogan, K. A., Nitsche, F. O., Heywood, K. J., Minzoni, R., **Simkins, L. M.**, ... & Larter, R. D. (2022). Rapid retreat of Thwaites Glacier in the pre-satellite era, *Nature Geoscience, 15*, 706–713. doi.org/10.1038/s41561-022-01019-9.

Grise, K. M. (2022). Atmospheric circulation constraints on 21st century seasonal precipitation storylines for the southwestern United States. *Geophysical Research Letters*, *49*(17), e2022GL099443. doi:10.1029/2022GL099443.

Gross, C. P., Duffy, J. E., Hovel, K. A., Kardish, M. R., **McGlathery, K. J.**, Reynolds, P. L., Boström, C., ... & Stachowicz, J. J. (2022). The biogeography of community assembly: latitude and predation drive variation in community trait distribution in a guild of epifaunal crustaceans. *Proceedings of the Royal Society B, 289*(1969), 20211762. doi:10.1098/rspb.2021.1762.

Gutierrez, G. M., LeCroy, K. A., **Roulston, T. A. H.**, Biddinger, D. J., & López-Uribe, M. M. (2023). Osmia taurus (Hymenoptera: Megachilidae): A non-native bee species with invasiveness potential in North America. *Environmental entomology, 52*(2), 149–156. doi:10.1093/ee/nvad005

Halpern, B. S., Boettiger, C., **Castorani, M. C. N.**, Dietze, M. C., Gephart, J. A., Gonzalez, P., Grimm, N. B., ... & Youngflesh, C. (2023). Priorities for synthesis research in ecology and environmental science. *Ecosphere, 14*(1), e4342. doi:10.1002/ecs2.4342.

Haynes, K. J., Liebhold, A. M., Lefcheck, J. S., Morin, R., & Wang, G. (2022). Climate affects the outbreaks of a forest defoliator indirectly through its tree hosts. *Oecologia, 198*(2). doi:10.1007/s00442-022-05123-w.

Haynes, K. J., & Walter, J. A. (2022). Advances in understanding the drivers of population spatial synchrony. *Current Opinion in Insect Science*, 100959. doi:10.1016/j.cois.2022.100959.

Heijmans, M. M., Magnússon, R. Í., Lara, M. J., Frost, G. V., Myers-Smith, I. H., van Huissteden, J., **Epstein, H.**, **Lawrence, D.**, ... & Limpens, J. (2022). Tundra vegetation change and impacts on permafrost. *Nature Reviews Earth & Environment, 3*(1), 68–84. doi:10.1038/s43017-021-00233-0.

Hogan, S., Murphy, E. A., Volaric, M. P., **Castorani, M. C.**, **Berg, P.**, & **Reidenbach, M. A.** (2022). Influence of oyster reefs on infauna and sediment spatial distributions within intertidal mudflats. *Marine Ecology Progress Series, 686*, 91–106. doi:10.3354/meps13983.

Hojnacki, V., **Lepp, A.**, Horowitz Castaldo, J., States, A., Li, X., & Passchier, S. (2022). Impact of - Antarctic Glaciation on the Paleoceanography of the Weddell Sea. *Paleoceanography and Paleoclimatology, 37*(12), e2022PA004440. doi:10.1029/2022PA004440.

Jorgenson, M. T., Kanevskiy, M. Z., Jorgenson, J. C., Liljedahl, A., Shur, Y., **Epstein, H.**, **Kent, K.**, ... & Jones, B. M. (2022). Rapid transformation of tundra ecosystems from ice-wedge degradation. *Global and Planetary Change, 216*, 103921. doi:10.1016/j.gloplacha.2022.103921.

Juska, I., & **Berg, P.** (2022). Variation in seagrass meadow respiration measured by aquatic eddy covariance. *Limnology and Oceanography Letters, 7*(5), 410–418. doi:10.1002/lol2.10276.

Kadakia, N., Demir, M., Michaelis, B. T., DeAngelis, B. D., **Reidenbach, M. A.**, Clark, D. A., & Emonet, T. (2022). Odour motion sensing enhances navigation of complex plumes. *Nature, 611*(7937), 754–761. doi:10.1038/s41586-022- 05423-4.

Kaushal, Sujay S., **Pace, M. L.**, et al. "Five state factors control progressive stages of freshwater salinization syndrome." *Limnology and Oceanography Letters 8.1* (2023): 190–211. doi:10.1002/lol2.10248.

Kelleher, M. K., & **Grise, K. M.** (2022). Varied midlatitude shortwave cloud radiative responses to Southern Hemisphere circulation shifts. *Atmospheric Science Letters, 23*(1), e1068. doi:10.1002/asl.1068.

Kim, D., Cho, C., Jeong, S., Lee, S., Nault, B. A., Campuzano-Jost, P., ... & **Pusede, S. E.** (2022). Field observational constraints on the controllers in glyoxal (CHOCHO) reactive uptake to aerosol. *Atmospheric Chemistry and Physics, 22*(2), 805–821. doi:10.5194/acp-22-805-2022.

Kim, H. H., Bowman, J. S., Luo, Y. W., Ducklow, H. W., Schofield, O. M., Steinberg, D. K., & **Doney, S. C.** (2022). Modeling polar marine ecosystem functions guided by bacterial physiological and taxonomic traits. *Biogeosciences, 19*(1), 117–136. doi:10.5194/bg-19-117-2022.

Lane, M. A., Walawender, M., Brownsword, E. A., Pu, S., Saikawa, E., Kraft, C. S., & **Davis, R. E.** (2022). The impact of cold weather on respiratory morbidity at Emory Healthcare in Atlanta. *Science of The Total Environment, 813*, 152612. doi:10.1016/j.scitotenv.2021.152612.

Lawrence, D., Coe, M., Walker, W., Verchot, L., & Vandecar, K. (2022). The Unseen Effects of Deforestation: Biophysical Effects on Climate, *Frontiers in Forests and Global Change, 5*, 1–13. doi:10.3389/ffgc.2022.756115. doi:10.3389/ffgc.2022.756115.

Lepp, A. P., **Simkins, L. M.**, Anderson, J. B., Clark, R. W., Wellner, J. S., Hillenbrand, C. D., ... & Wacker, L. (2022). Sedimentary signatures of persistent subglacial meltwater drainage from Thwaites Glacier, Antarctica. *Frontiers in Earth Science, 10*, 863200. doi:10.3389/feart.2022.863200.

Lerdau, M. (2022). The complicated legacy of E. O. Wilson with respect to genetics and human behavior. *BioEssays, 44*(5), 2200034. doi:10.1002/bies.202200034.

Lerdau, M. (2022). The challenge of open access incentives. *Science, 378*(6617), 256–256. DOI:10.1126/science.ade7288. doi:10.1126/science.ade7288.

Li, R., Lombardozzi, D., Shi, M., Frankenberg, C., Parazoo, N. C., Köhler, P., ... & Yang, X. (2022). Representation of leaf-to-canopy radiative transfer processes improves simulation of far-red solar-induced chlorophyll fluorescence in the community land model version 5. *Journal of Advances in Modeling Earth Systems, 14*(3), e2021MS002747. doi:10.1029/2021MS002747.

Li, Y., & **Limaye, A. B.** (2022). Testing Predictions for Migration of Meandering Rivers: Fit for a Curvature-Based Model Depends on Streamwise Location and Timescale. *Journal of Geophysical Research: Earth Surface, 127*(12), e2022JF006776. doi:10.1029/2022JF006776.

Liebhold, A. M., Hajek, A. E., Walter, J. A., **Haynes, K. J.**, Elkinton, J., & Muzika, R. M. (2022). Historical change in the outbreak dynamics of an invading forest insect. *Biological Invasions, 24*(3), 879–889. doi:10.1007/s10530-021-02682-6.

Manley, K., **Nyelele, C.**, & Egoh, B. N. (2022). A review of machine learning and big data applications in addressing ecosystem service research gaps. *Ecosystem Services, 57*, 101478. doi:10.1016/j.ecoser.2022.101478.

McGlathery, K. J., Sundbäck, K., & Fong, P. (2012). Estuarine benthic algae. *Estuarine Ecology*, 203–234. doi:10.1002/9781118412787.ch8.

McGlynn, D. F., Frazier, G., Barry, L. E., **Lerdau, M. T.**, **Pusede, S. E.**, & Isaacman-VanWertz, G. (2023). Minor contributions of daytime monoterpenes are major contributors to atmospheric reactivity. *Biogeosciences, 20*(1), 45–55. doi:10.5194/bg-20-45-2023.

McKee, D. C., **Doney, S. C.**, Della Penna, A., Boss, E. S., Gaube, P., Behrenfeld, M. J., & Glover, D. M. (2022). Lagrangian and Eulerian time and length scales of mesoscale ocean chlorophyll from Bio-Argo floats and satellites. *Biogeosciences, 19*(24), 5927–5952. doi:10.5194/bg-19-5927-2022.

McKenzie, M. A., **Simkins, L. M.**, Principato, S. M., & **Munevar Garcia, S.** (2022). Streamlined subglacial bedform sensitivity to bed characteristics across the deglaciated Northern Hemisphere. *Earth Surface Processes and Landforms, 47*(9), 2341–2356. doi:10.1002/esp.5382.

Mercaldi, B., **Brideau, L. E.**, Tait, J. F., & Griggs, G. (2022). Seasonal Morphological Variability on Estuarine Beaches and Implications for Low-Energy Beach Management. *Journal of Coastal Research, 38*(6), 1135–1147. doi:10.2112/JCOASTRES-D-22-00018.1.

Moran, M. A., Kujawinski, E. B., Schroer, W. F., Amin, S. A., Bates, N. R., **Doney, S. C.**, Bertrand, E. M., ... & Vardi, A. (2022). Microbial metabolites in the marine carbon cycle. *Nature Microbiology, 7*(4), 508–523. doi:10.1038/s41564-022-01090-3.

Murphy, E. A., Barros, J. M., Schultz, M. P., Flack, K. A., Steppe, C. N., & **Reidenbach, M. A.** (2022). Boundary layer hydrodynamics of patchy biofilms. *Biofouling, 38*(7), 696–714. doi:10.1080/08927014.2022.2117033

National Academies of Sciences, Engineering, and Medicine (**S.C. Doney**, Committee Chair) 2022. A Research Strategy for Ocean-based Carbon Dioxide Removal and Sequestration, Washington, DC, The National Academies Press, https://doi.org/10.17226/26278

Nelson, P. R., Maguire, A. J., Pierrat, Z., Orcutt, E. L., Yang, D., Serbin, S., **Epstein, H. E.**, ... & Huemmrich, K. F., ...(2022). Remote sensing of tundra ecosystems using high spectral resolution reflectance: opportunities and challenges. *Journal of Geophysical Research: Biogeosciences, 127*(2), e2021JG006697. doi:10.1029/2021JG006697.

Nyelele, C., Kroll, C. N., & Nowak, D. J. (2022). A comparison of tree planting prioritization frameworks: i-Tree Landscape versus spatial decision support tool. *Urban Forestry & Urban Greening, 75*, 127703. doi:10.1016/j.ufug.2022.127703.

Oguri, K., Masqué, P., Zabel, M., Stewart, H. A., MacKinnon, G., Rowden, A. A., **Berg, P.**, ... & Glud, R. N. (2022). Sediment accumulation and carbon burial in four hadal trench systems. *Journal of Geophysical Research: Biogeosciences, 127*(10), e2022JG006814. doi:10.1029/2022JG006814.

Olff, H., Aerts, R., Bobbink, R., Cornelissen, J. H. C., Erisman, J. W., **Galloway, J. N.**, ... & Wardle, D. A. (2022). Explanations for nitrogen decline. *Science, 376*(6598), 1169–1170. doi:10.1126/science.abq7575.

Porter, J. H. 2022. Using the LTERHub Directory API to Perform Site Tasks, LTER Databits newsletter, April 13, 2022 (https://lternet.edu/stories/using-the-lterhub-directory-api-to-perform-site-tasks/)

Porter, J. H. and An Nguyen. 2022. Reasons to Archive and Share Data. LTER Databits newsletter, February 24.2022 (https://lternet.edu/stories/reasons-to-archive-and-share-data)

Reed, D. C., Schmitt, R. J., Burd, A. B., Burkepile, D. E., Kominoski, J. S., **McGlathery, K. J.**, ... & Zinnert, J. C. (2022). Responses of coastal ecosystems to climate change: Insights from long-term ecological research. *BioScience, 72*(9), 871–888. doi:10.1093/biosci/biac006.

Robel, A. A., Pegler, S. S., Catania, G., Felikson, D., & **Simkins, L. M.** (2022). Ambiguous stability of glaciers at bed peaks. *Journal of Glaciology, 68*(272), 1177–1184. doi:10.1017/jog.2022.31.

Rotach, M. W., Serafin, S., Ward, H. C., Arpagaus, M., Colfescu, I., Cuxart, J., **De Wekker, S. F.**, ... & Zardi, D. (2022). A collaborative effort to better understand, measure, and model atmospheric exchange processes over mountains. *Bulletin of the American Meteorological Society, 103*(5), E1282–E1295. doi:10.1175/BAMS-D-21-0232.1.

Schiro, K. A., Su, H., Ahmed, F., Dai, N., Singer, C. E., Gentine, P., ... & David Neelin, J. (2022). Model spread in tropical low cloud feedback tied to overturning circulation response to warming. *Nature Communications, 13*(1), 7119. doi:10.1038/s41467-022-34787-4.

Seekell, D. A., **Pace, M. L.**, Heffernan, J. B., & Holbrook, S. J. (2022). Nonlinear dynamics, resilience, and regime shifts in aquatic communities and ecosystems: an overview. *Limnology and Oceanography, 67*, S1. doi:10.1002/lno.12072.

Shimabukuro, M., Zeppilli, D., Leduc, D., Wenzhöfer, F., **Berg, P.**, Rowden, A. A., & Glud, R. N. (2022). Intra-and inter-spatial variability of meiofauna in hadal trenches is linked to microbial activity and food availability. *Scientific Reports, 12*(1), 4338. doi:10.1038/s41598-022-08088-1.

Shugart, H., **White, P.**, **Saatchi, S.**, & **Chave, J.** (2022). *The World Atlas of Trees and Forests: Exploring Earth's Forest Ecosystems*. Princeton University Press.

Smith, R. S., Hogan, S., **Tedford, K. N.**, Lusk, B., **Reidenbach, M. A.**, & **Castorani, M. C.** (2022). Long-term data reveal greater intertidal oyster biomass in predicted suitable habitat. *Marine Ecology Progress Series, 683*, 221–226. doi:10.3354/meps139349.

Smith, J. D., Lin, L., Quinn, J. D., & **Band, L. E.** (2021). Guidance on evaluating parametric model uncertainty at decision-relevant scales. *Hydrology and Earth System Sciences Discussions, 2021*, 1–30. doi:10.5194/hess-26-2519-2022.

Smith, R. S., Lusk, B., & **Castorani, M. C.** (2022). Restored oyster reefs match multiple functions of natural reefs within a decade. *Conservation Letters, 15*(4), e12883. doi:10.1111/conl.12883.

Smith, R. S., Cheng, S. L., & **Castorani, M. C.** (2023). Meta-analysis of ecosystem services associated with oyster restoration. *Conservation Biology, 37*(1), e13966. doi:10.1111/cobi.13966.

Stephens, C. M., Marshall, L. A., Johnson, F. M., Ajami, H., Lin, L., & **Band, L. E.** (2022). Spatial variation in catchment response to climate change depends on lateral moisture transport and nutrient dynamics. *Water Resources Research, 58*(10), e2021WR030577. doi:10.1029/2021WR030577.

Sun, P., Farley, R. N., Li, L., Srivastava, D., Niedek, C. R., Li, J., **Pusede, S. E.**, ... & Zhang, Q. (2022). PM2. 5 composition and sources in the San Joaquin Valley of California: A long-term study using ToF-ACSM with the capture vaporizer. *Environmental Pollution, 292*, 118254. doi:10.1016/j.envpol.2021.118254.

Tassone, S. J., Besterman, A. F., Buelo, C. D., Ha, D. T., Walter, J. A., & **Pace, M. L.** (2023). Increasing heatwave frequency in streams and rivers of the United States. *Limnology and Oceanography Letters, 8*(2), 295–304. doi:10.1002/lol2.10284.

Tassone, S. J., Besterman, A. F., Buelo, C. D., Walter, J. A., & **Pace, M. L.** (2022). Co-occurrence of aquatic heatwaves with atmospheric heatwaves, low dissolved oxygen, and low pH events in estuarine ecosystems. *Estuaries and Coasts, 45*(3), 707–720. doi:10.1007/s12237-021-01009-x.

Tedford, K. N., & **Castorani, M. C.** (2022). Meta-analysis reveals controls on oyster predation. *Frontiers in Marine Science, 9*, 1055240. doi:10.3389/fmars.2022.1055240

Tejedor, A., Schwenk, J., Kleinhans, M., **Limaye, A. B.**, Vulis, L., Carling, P., ... & Foufoula-Georgiou, E. (2022). The Entropic Braiding Index (eBI): A Robust Metric to Account for the Diversity of Channel Scales in Multi-Thread Rivers. *Geophysical Research Letters, 49*(16), e2022GL099681. doi:10.1029/2022GL099681.

Walter, J. A., Buelo, C. D., Besterman, A. F., **Tassone, S. J.**, Atkins, J. W., & **Pace, M. L.** (2022). An algorithm for detecting and quantifying disturbance and recovery in high-frequency time series. *Limnology and Oceanography: Methods, 20*(6), 338–349. doi:10.1002/lom3.10490.

Walter, J. A., **Castorani, M. C.**, Bell, T. W., Sheppard, L. W., Cavanaugh, K. C., & Reuman, D. C. (2022). Tail-dependent spatial synchrony arises from nonlinear driver–response relationships. *Ecology Letters, 25*(5), 1189–1201. doi:10.1111/ele.13991.

Wang, J., Song, G., Liddell, M., Morellato, P., Lee, C. K., Yang, D., **Yeung, H. C.**, ... & Wu, J. (2023). An ecologically constrained deep learning model for tropical leaf phenology monitoring using PlanetScope satellites. *Remote Sensing of Environment, 286*, 113429. doi:10.1016/j.rse.2022.113429.

Wu, G., Jiang, C., Kimm, H., Wang, S., Bernacchi, C., Moore, C. E., **Yang, X.**, ... & Guan, K. (2022). Difference in seasonal peak timing of soybean far-red SIF and GPP explained by canopy structure and chlorophyll content. *Remote Sensing of Environment*, 279, 113104. doi:10.1016/j.rse.2022.113104.

Wu, H., MacDonald, G. K., **Galloway, J. N.**, Geng, Y., Liu, X., Zhang, L., & Jiang, S. (2022). A new dietary guideline balancing sustainability and nutrition for China's rural and urban residents. *Iscience, 25*(10). doi:10.1016/j.rse.2022.113104.

Zeng, Y., Chen, M., Hao, D., Damm, A., Badgley, G., Rascher, U., **Yang, X.**, ... & Berry, J. A. (2022). Combining near-infrared radiance of vegetation and fluorescence spectroscopy to detect effects of abiotic changes and stresses. *Remote Sensing of Environment, 270*, 112856. doi:10.1016/j.rse.2021.112856.

Zhan, W., **Yang, X.**, Ryu, Y., Dechant, B., Huang, Y., Goulas, Y., ... & Gentine, P. (2022). Two for one: Partitioning CO2 fluxes and understanding the relationship between solar-induced chlorophyll fluorescence and gross primary productivity using machine learning. *Agricultural and Forest Meteorology, 321*, 108980. doi:10.1016/j.agrformet.2022.108980.

Zhang, R., Newburn, D., Rosenberg, A., Lin, L., Groffman, P., Duncan, J., & **Band, L.** (2022). Spatial asynchrony in environmental and economic benefits of stream restoration. *Environmental Research Letters, 17*(5), 054004. doi:10.1088/1748-9326/ac61c6.

Zhang, Z., Flora, K., Kang, S., **Limaye, A. B.**, & Khosronejad, A. (2022). Data-Driven Prediction of Turbulent Flow Statistics Past Bridge Piers in Large-Scale Rivers Using Convolutional Neural Networks. *Water Resources Research, 58*(1), e2021WR030163. doi:10.1029/2021WR030163.

Zhang, Z., **Limaye, A. B.**, & Khosronejad, A. (2022). Three-dimensional realizations of flood flow in large-scale rivers using the neural fuzzy-based machine-learning algorithms. *Computers & Fluids, 246*, 105611. doi:10.1016/j.compfluid.2022.105611.

Zhao, Y., Lee, C. K., Wang, Z., Wang, J., Gu, Y., Xie, J., **Yang, X.**, ... & Wu, J. (2022). Evaluating fine-scale phenology from PlanetScope satellites with ground observations across temperate forests in eastern North America. *Remote Sensing of Environment, 283*, 113310. doi:10.1016/j.rse.2022.113310

Zhu, Q., & **Wiberg, P. L.** (2022). The importance of storm surge for sediment delivery to microtidal marshes. *Journal of Geophysical Research: Earth Surface, 127*(9), e2022JF006612. doi:10.1029/2022JF006612.

Zhu, Q., **Wiberg, P. L.**, & **McGlathery, K. J.** (2022). Seasonal growth and senescence of seagrass alters sediment accumulation rates and carbon burial in a coastal lagoon. *Limnology and Oceanography, 67*(9), 1931–1942. doi:10.1002/lno.12178.

Zhu, Q., **Wiberg, P. L.**, & **McGlathery, K. J.** (2022). Seasonal growth and senescence of seagrass alters sediment accumulation rates and carbon burial in a coastal lagoon. *Limnology and Oceanography, 67*(9), 1931-1942. doi:10.1002/lno.12178.

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