Summer 2021

PennState
College of Earth
and Mineral Sciences

Earth and Environmental Systems Institute

EESI Does It

EESI Does It is a publication of the Earth and Environmental Systems Institute in the College of Earth and Mineral Sciences at Penn State.

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Cover Photo: "Curiosity Celebrates 8 Years on the Red Planet." NASA/JPL-Caltech

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In This Issue:

Letter from the Director

Dear EESI community,

I wrote to you last year during a time of great uncertainty and challenges. This year, thankfully, the path to a new normal seems a little clearer, and our community a little more optimistic even as we continue to address the pandemic. I invite you to take a moment to celebrate all that you've accomplished over the last twelve months and to look at what lies on the horizon.

EESI has experienced quite a few changes in appearance and in personnel. The second-floor renovation is finally complete. Some of you have already seen the space in person, some virtually. You can find photos of the suite on page 7 in this edition of *EESI Does It*. I encourage you to stop by during the year and make use of our new collaborative workspaces and conference room.

In terms of people, Doug Miller and Tracy Bernier have moved on to life beyond the academic workforce. We thank them both for their service to EESI, the College of Earth and Mineral Sciences, and Penn State and wish them the best in retirement.

Tam Rankin has joined EESI as the institute's new administrative support coordinator. He brings eighteen years of administrative experience in higher education to the position. I think you'll find him an excellent addition to our community.

We're also welcoming three new faculty members this academic year—Antonia Hadjimichael and Renee Obringer, who will join us in January, and Kimberly Van Meter, who joined us on July 16. They are bringing a wealth of knowledge to EESI in the fields of water resources, energy, land use, and data analytics. In addition, Alan Taylor is serving as acting director of EESI while I'm on sabbatical (July 1 to June 30, 2022). Many of you know Alan, but for those who don't, you can read about his goals for the current academic year in the EESI News Highlights section. I invite all of you to work with Alan on some of his new initiatives for this year.

I'm thrilled to share that Marilyn L. Fogel and Christopher Swarth, who have long donated funds to EESI to facilitate student research experiences, have established the Marilyn L. Fogel Student Research Fund in Biogeosciences. The fund supports research activities in biogeosciences for undergraduate and graduate students affiliated with EESI and EMS and has a particular emphasis on enabling field or laboratory research for students interested in biogeochemistry, biogeology, ecology, biometeorology, biogeography, and aspects of climate science. Learn more about the fund on page 6.

I know many of you are looking forward to seeing one another in person this year. As state and University guidelines allow, we look forward to hosting pizza lunches and other events to bring our community together once again—soon, without masks.

As always, stay safe, keep up the great research you're doing, nurture your students, and, most importantly, take care of one another as we continue to overcome the present challenges.

Sincerely,

Susan L. Brantley
Barnes Professor of Geosciences
Director, Earth and Environmental Systems Institute

EESI Updates

Three faculty associates will join the institute during the 2021-22 academic year:

Kimberly Van Meter, assistant professor of geography, who received her doctorate in earth and environmental science from the University of Waterloo, Canada. Before joining Penn State, she was an assistant professor in the Department of Earth and Environmental Sciences at the University of Illinois Chicago. Her research focuses on the interface of hydrology and biogeochemistry, with a particular emphasis on the human impacts on water under a changing climate and land use.

Antonia Hadjimichael, assistant professor of geosciences, who received her doctorate in water science and technology from the University of Girona, Spain. Before joining Penn State, she was a postdoctoral associate at Cornell University. Her research focuses on developing tools and methods to inform decision-making for complex systems under deep uncertainty and their application for the sustainable and resilient management of water resources systems.

Renee Obringer, assistant professor in understanding land-water-energy systems using machine learning and data analytics, who received her doctorate in environmental and ecological engineering from Purdue University. Before joining Penn State, she was a postdoctoral research fellow at the National Socio-Environmental Synthesis Center in Annapolis, Maryland. She studies systems-oriented environmental engineering, with a focus on the relationship between people, infrastructure, and climate change.

Two faculty associates joined the Laboratory for Isotopes and Metals in the Environment (LIME):

Allie Baczynski, who received her doctorate in earth and planetary sciences from Northwestern University. In addition to joining LIME part-time, she works as a research associate in Kate Freeman's research group. She studies the Paleocene-Eocene Thermal Maximum, carbon isotopes, carbon storage and cycling, and carbon cycle perturbations and the hydrologic cycle in the geologic past.

Dongxiang (Maggie) Wang, who received her doctorate in biomaterials science from the University of Tokyo. Before joining LIME, she was a research associate in the Clean Fuels and Catalysis Program in the EMS Energy Institute. Her research interests include instrumental method development and the application of mass spectrometry on chemical and trace element analysis.

Two faculty associates joined EESI through the Center for Earth System Modeling, Analysis and Data (ES-MAD) run by Chris Forest:

Nachiketa Acharya, assistant research professor, who received his doctorate in statistics from Utkal University, India. Before joining Penn State, he was an associate research scientist at the International Research Institute for Climate and Society at Columbia University. His research interests include subseasonal to seasonal predictions, statistical downscaling, probabilistic multi-model ensembles, general circulation models diagnostics calibration and verification, stochastic weather generators, machine learning modeling for climate forecasts, and extreme value analysis.

Ismaila Diallo, assistant research professor, who received his doctorate in atmospheric sciences from Cheikh Anta Diop University, Senegal. Prior to joining Penn State, he was a staff research associate in the Department of Geography at the University of California, Los Angeles. He studies meteorology and climatology, with specialties in weather and climate modeling, climate dynamics, numerical weather prediction, and aerosol-cloud-climate interactions.

EESI also welcomed seven postdoctoral scholars during the last year:

Erica Barlow, who received her doctorate in geology from the University of New South Wales. Adviser: Christopher House

Courtney Cooper, who received her doctorate in water resource management from the University of Idaho. Adviser: Klaus Keller

Alejandra Domic, who received her doctorate in ecology, evolution, and systematics from Saint Louis University. Adviser: Sarah Ivory

Suhail Mahmud, who received his doctorate in computational science from the University of Texas at El Paso. Adviser: Robert Nicholas

Sampath Rathnayaka, who received his doctorate in geophysics and seismology from the University of Massachusetts Amherst. Adviser: Andrew Nyblade

Iman Hosseini-Shakib, who received his doctorate in civil and environmental engineering from the University of New Hampshire. Adviser: Klaus Keller

Georgia Soares, who received her doctorate in geology from the University of New South Wales. Adviser: Christopher House

EESI welcomes four EESI Environmental Scholars this fall semester:

Shuyu Chang, who is pursuing a doctoral degree in geography under the direction of Kimberly Van Meter, received her bachelor's degree in hydraulic and hydropower engineering from the China Agricultural University, Beijing, and her master's degree in water resources engineering from Johns Hopkins University. In summer 2021, she served as a NASA DEVELOP intern, where she used machine-learning approaches to develop a harmful algal boom detection system. At Penn State, she will combine remote-sensing and deep-learning approaches to identify small, and previously unaccounted for, reservoirs in tributaries across the Chesapeake Bay Watershed, and then extend this methodology to the whole U.S. and create a reservoir dataset with associated information regarding area, volume, residence time, and drainage basins. She will also use computational modeling approaches to simulate water quality dynamics to better understand how dam construction and removal influence downstream water quality, particularly under changing climate dynamics.

Nicolle Di Domenico, who is pursuing a master's degree in geography under the direction of Shujie Wang. Di Domenico received her bachelor's degree in geology and earth science with a minor in geography information science from Kent State University. She gained research experience at Kent State and as an earth sciences research intern at Oak Ridge National Laboratory, where she worked on identifying Arctic microtopography. She was a co-author on an article published in the May 2020 issue of the journal *Environmental Science: Processes & Impacts*. At Penn State she will use remote sensing and advanced data analytics to study Antarctic ice shelf surface structures.

Alejo Giraldo, who is pursuing a master's degree in geosciences under the direction of Peter Wilf. Giraldo received his bachelor's degree in biology from EAFIT University, Medellín, Colombia. He has research experience in paleobotany and paleoecology, having worked with the laboratory group run by Carlos Jaramillo at the Smithsonian Tropical Research Institute in Ancón, Panama. He was lead author on an article based on his senior thesis research, published in April 2021 in the journal *Ameghiniana*. This work presented the first evidence of intense and varied insect leaf-feeding soon after the end-Cretaceous extinction in the tropics. Giraldo's research on plant-insect associations in the fossil record, with a focus on Patagonian paleofloras and their connections to modern southeast Asian rainforests, will be part of Wilf's NSF project, Origins of Southeast Asian Rainforests from Paleobotany and Machine Learning.

Tengxiang Wang, who is pursuing a doctoral degree in geosciences under the direction of Peter Wilf. Wang received his bachelor's degree in biological sciences from Beijing Forestry University and master's degree in ecology from Xishuangbanna Tropical Botanical Garden, University of Chinese Academy of Sciences. His research experience in paleobotany and paleoecology at the Xishuangbanna Tropical Botanical Garden has resulted in ten publications in the top journals of his field, including the *Proceedings of the National Academy of Sciences* and the *International Journal of Plant Sciences*. At Penn State, Wang will study the deep-time origins of Southeast Asian rainforests in light of past climatic changes and the uplift of the Tibetan Plateau, specifically focusing on a Neogene flora from central Vietnam to reconstruct the past vegetation of the region.

Staff hires:

Tam Rankin joined EESI in May as the institute's new administrative support coordinator. He brings eighteen years of academic administrative experience to the position, including most recently as department manager for the chemistry program at Portland State University. Learn more about Rankin in the Know Your Staff feature on pages 14-16.

The Pennsylvania Space Grant Consortium welcomed two student interns who will work on a Diversity, Equity, and Inclusion Ambassadors program for Space Grant and its affiliates and will work with students and faculty throughout the 2021-22 academic year to provide continuous support for STEM research.

Hope Thatcher is a senior in geography with a focus on human geography. Thatcher would like to work for National Geographic, the National Geographic Society, or an equivalent impact-driven nonprofit after graduation.

Kim Zhu is a senior in materials science and engineering with a minor in polymer science. Zhu plans to travel after graduation then enter research and development in the materials science field.

Taylor serves as interim director of EESI

Alan Taylor, professor of geography and ecology, will serve as interim director of EESI while director Susan Brantley is on sabbatical. His appointment began July 1.

"EESI is lucky that Alan Taylor can take the helm," said Brantley, Barnes Professor of Geosciences. "He has always been an EESI associate who does work for EESI committees and the EESI student cohort. He knows the ins and outs of how EESI operates."

Taylor studies ecological biogeography and vegetation dynamics, focusing on the influences of changes and interactions of land use history and climate on fire disturbance and forest conditions in the western United States. He has several goals and projects for the coming year, including moving forward with the planning phase of a collaboratorium called the Joint Energy-Water-Environment Laboratory and expanding the EESI Environmental Scholars program to include building an interdisciplinary community of graduate students and postdoctoral scholars in the college.

"EESI has a remarkable group of scientists who are working on a set of interesting and pressing environmental problems," Taylor said. "It's a great opportunity to help support this extraordinary group of people and the research enterprise in the college, and is a good way to spend my time. We're going to implement several new ideas over the academic year to build community that should bear fruit in the long term."

125th Anniversary Fellows

Founded in 1896 as the School of Mines, this year, the College of Earth and Mineral Sciences is celebrating its 125th anniversary. The college recognizes that the success and reputation of the college is defined substantially by the achievements of its graduates. To honor their accomplishments, the college has selected a prominent group of 134 alumni whose contributions to the fields of science and engineering have set them apart from their peers and named them 125th Anniversary Fellows. Due to COVID-19, the Fellows will be recognized in October of 2022.

Marilyn L. Fogel Student Research Fund in Biogeosciences

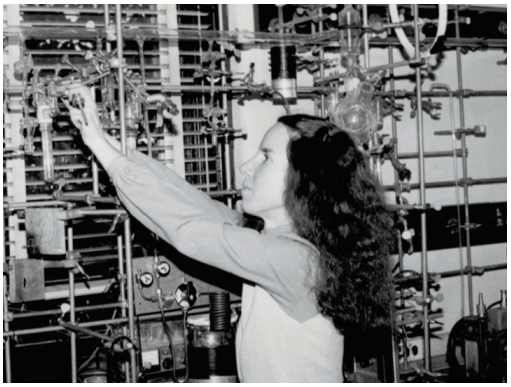
Marilyn Fogel, who graduated in 1973 with a bachelor's degree in biology, may have come to Penn State for the football games, but she left with an appreciation for the interdisciplinary research that would define her career.

Now, she and her husband, Christopher Swarth, aim to get more Penn State students engaged in interdisciplinary research through the establishment of the Marilyn L. Fogel Student Research Fund in Biogeosciences. Biogeosciences combines the fields of geoscience and biological science to answer questions about the modern world and living ecosystems and the beginnings of life on Earth. The couple's $25,000 gift will support research activities for undergraduate and graduate students affiliated with EESI and will have a particular emphasis on enabling field or laboratory research focused on biogeochemistry, geology, ecology, meteorology, climate science, and geography.

"Chris and I are thrilled to have the opportunity to create an endowed fund that promotes biogeosciences in the Earth and Environmental Systems Institute," Fogel said. "We know the importance of providing opportunities for students to experience thinking outside of a traditional scientific field and to open their minds to a new way of critical thinking."

Fogel received her doctorate in botany and marine sciences in 1977 from the University of Texas at Austin and shortly thereafter became a staff scientist in the Geophysical Laboratory at the Carnegie Institution for Science in Washington, D.C. She worked there for thirty-five years, becoming a leading expert in stable isotope chemistry and a pioneer in the emerging biogeosciences field. Her work has led to breakthroughs in multiple disciplines, including paleoecology and climate change, astrobiology, and modern ecosystem studies.

"Marilyn had a bigger field program at the Carnegie Lab than any other staff scientist," Swarth said. Swarth



holds bachelor's and master's degrees in zoology and biology and spent his career directing nature reserves, first as director of the Jug Bay Wetlands Sanctuary in Maryland and then as reserve director of the Merced Vernal Pools and Grassland Reserve in Merced, California, up to his retirement in 2016.

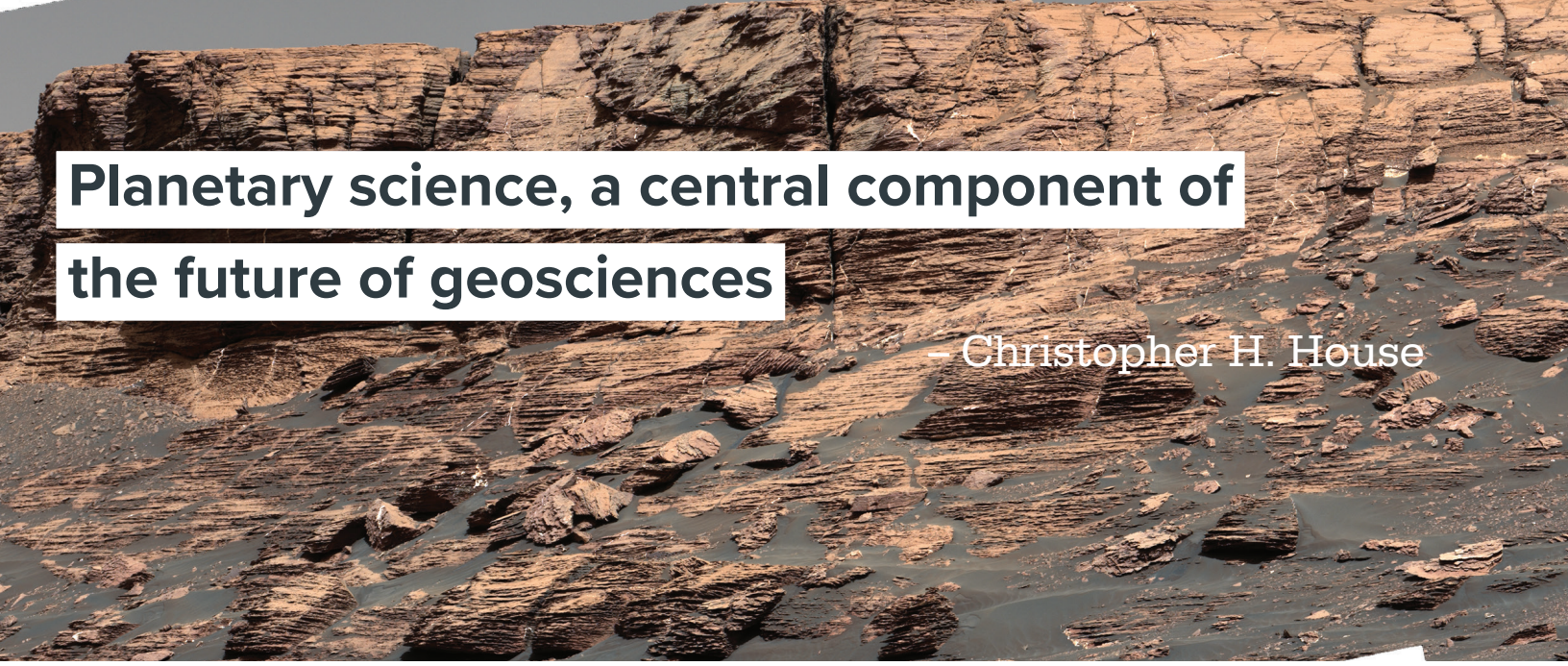
The endowed fund that the couple has established will ensure that students for many years to come will have opportunities to conduct interdisciplinary fieldwork and laboratory research. Such work will help to answer questions about how living organisms, including humans, have adapted to and changed the Earth, questions to which Fogel has dedicated her career.

If interested in helping to grow the impact of the Marilyn L. Fogel Student Research Fund in Biogeosciences, please visit http://raise.psu.edu/FogelFund.

EESI Renovation and JEWEL

The renovation of EESI's second-floor office suite in the Earth and Engineering Sciences Building is now complete. The space includes plenty of tables and seating to encourage and facilitate collaborations; a bright, spacious conference room for meetings; and an open kitchen. EESI looks forward to welcoming you back to the suite and encourages you to take advantage of what the space has to offer. Interim Director Alan Taylor is planning several events that EESI will host in the suite, including the popular pizza lunches, so be on the lookout for those emails.

Meanwhile, the institute is moving ahead with the planning phase for renovating the third-floor office suite into a collaboratorium—the Joint Energy-Water-Environment Laboratory (JEWEL). EESI will share details on JEWEL and solicit feedback as the process moves forward.



Planetary science, a central component of the future of geosciences

– Christopher H. House

Photomosaic of the Pettegrove Point outcrop taken by NASA's Curiosity rover at Gale Crater, Mars. Credit: NASA Mars Science Laboratory / NASA JPL

A large screen of Martian images displayed, virtual private network active, half a dozen chat rooms open, a skeleton-plan filling my third screen, and my dog content on the couch watching for the postal worker. On this day, I am acting as the Mars Science Laboratory (MSL) Curiosity rover's geology and mineralogy theme lead. I have under two hours to have a consensus plan for the science rover actives figured out for the next Martian morning.

My main screen shows a rough surface with a greyish hue where an outcrop lacks the mostly pervasive red Martian dust. The rock is speckled with tiny, elongated jet-black clasts, fragments of rocks or minerals that look like little black "sticks." The team is excited by the clear, chemically altered nature of this outcrop more than 200 million miles from Earth. We suspect that the "sticks" are an iron oxide. Our French colleagues, working late in their day, craft a targeting scheme for the Mars rover's laser to measure the elements present in the small structures. It will be nearly midnight in France–3 p.m. at NASA's Jet Propulsion Laboratory in Pasadena, California, where the project is managed–before the team is ready to transmit the next day's instructions to the rover, but it is worth it to be able to direct science on another world across the emptiness of space.

Science on the Surface of Mars

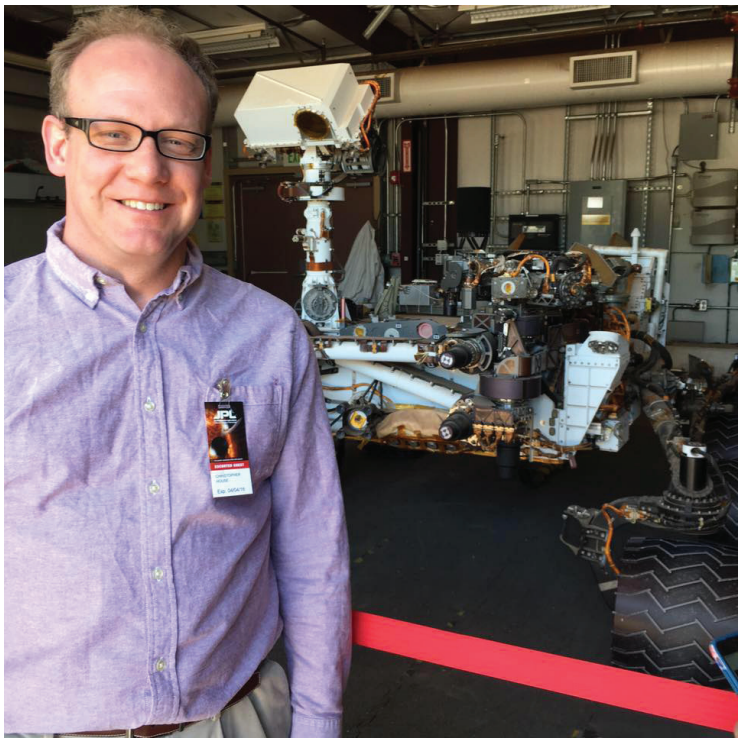
We are currently living through the golden age of planetary science. Since 2010, the international community has successfully launched about twenty-five planetary science probes. For perspective, in the whole of the 1980s, NASA launched only two planetary science spacecraft–Magellan and Galileo. The dawn of the space age, the 1960s, also had a great many planetary launches, but only a handful returned useful results, with mission failures more common than not. In contrast, NASA missions operating in the 2010s have been remarkable in their reliability, sophistication, and ability.

My involvement with the Mars Curiosity rover has been rewarding and fun. The most interesting aspect is being directly involved with rover operations. Each working day, a portion of the MSL Science Team from across the globe joins a series of teleconference meetings to plan the rover's next activities. This requires a brief review of the prior day's results to make sure the previous plan was executed properly, inspection of the newest images of the Martian landscape and the rover's workspace, and intense discussion of priorities for limited, and valuable, rover time. The most similar science experience that I have had is when I explored the ocean floor with a robotic vehicle or on an International Ocean Discovery Program expedition. Exploring the seafloor requires making quick decisions so that time and resources are not wasted. In the case of Martian rover science, the movement of celestial bodies–mostly the rotation of the Earth and the orbit of relay satellites around Mars–dictates our deadlines so that the new rover instructions can be transmitted from Earth to Mars before the rover awakes from its nightly energy-saving nap.

While I have been NASA funded most of my career, my experience with NASA missions is limited. I joined the NASA Mars Science Laboratory in early 2016 through the MSL participating scientist program, giving me an opportunity to work as part of the more than 500 person MSL science team. When I wrote that particular proposal, I had little concept

of how NASA missions work, and I certainly did not know that gaining experience with Mars science would change my outlook on the future.

Of all my experiences with MSL, I have most valued getting the opportunity to join the intense rover planning sessions for several reasons. First, they have allowed me to see images of Mars as they first become available. Countless times, the images arrived showing finely laminated sediments with dramatic sulfate-rich veins cutting through the layers. In one location, the images unveiled polygonal mud cracks. In another location, a large rock in the workspace was a conglomerate of stones, some of which were cobbles of a long-ago eroded sediment. Second, my work with the planning sessions has given me satisfaction when I later see the data collected from a plan that I helped craft. Finally, it has given me a new perspective on how difficult it is to make critical decisions with limited data under time pressure.



House alongside the instrumented engineering test model of the Curiosity rover at the NASA Jet Propulsion Laboratory Mars yard testing facility. Credit: Christoher H. House

Our Oasis

My own experience with MSL has emphasized that Mars is a harsh world. Not only is it dusty and cold, but the wind erosion leaves rocks with thin, sharp edges. As was true for the Apollo astronauts, knowing celestial worlds too well makes one long for the lush abundance of the Earth. We may someday colonize worlds, which would help ensure our survival, but in the short-term, planetary science emphasizes the importance of protecting the Earth rather than acting as an open gateway to the heavens.

Recently, EESI coined the catchphrase "Science Informing Solutions." The phrase emphasizes that EESI is a group of scientists aiming to use basic research as a central tool for solving major challenges for the Earth to ensure a more idyllic future–or at least avoid the worst possible futures for our planet. I think that planetary science will continue to be a growing voice supporting EESI's vision. One way or another, the geosciences of 2050 and beyond are going to look quite different than today, with fossil fuels gradually being less of the destination employer for graduates of the Department of Geosciences.

In the simplest terms, the 2050s will, without a doubt, resemble some sort of science fiction movie; EESI's mission right now is an effort to try to have it not resemble a dystopian film such as Bladerunner 2049. Preferably, the geosciences of the 2050s will involve activities such as predicting, avoiding, and mediating climate change; enabling sustainable energy; and exploring the solar system. It is a bold and optimistic view of the future. EESI scientists could be simultaneously ensuring the sustainability of the Earth and gathering the knowledge that places Earth within its cosmic context.

Return to Venus

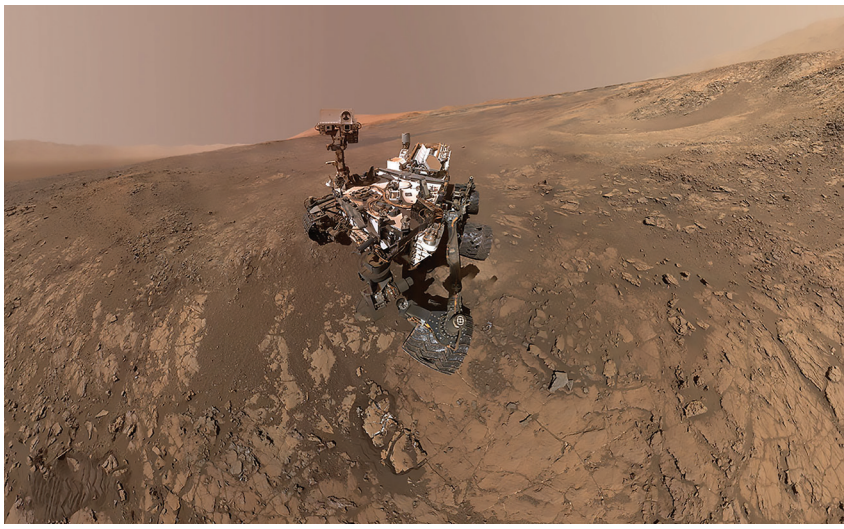
With the golden age of planetary science comes the advent of an era of robust comparative planetary science. With respect to climate change, Mars and Venus are likely to continue in their roles as the most relevant planetary comparisons to Earth. Historically, Venusian science has influenced Earth's climate science community, with the most notable example being Dr. James Hansen. Dr. Hansen's early work focused on the composition of Venusian clouds. His experience with Venus, and its relative inhospitableness, inspired his life-long dedication to investigating human-induced climate change on Earth.

Announced in spring 2021, there are now three different, significant missions to Venus under development. NASA and the European Space Agency both are planning long-lived Venus orbiter missions, and NASA will also send a spacecraft down through the atmosphere of Venus. For perspective, the last time the United States sent a mass spectrometer to sample the Venusian atmosphere was in 1978. In the coming decades, Russia will likely return to Venus with a large lander as well. There is no doubt that such a flurry of scientific investigation of Venus will influence Earth climate science and Earth atmospheric science through direct comparisons never before possible.

Water Worlds Await

When one dreams of science in the mid-twenty-first century, it is the solar system's ocean worlds that perhaps provide the most exciting possibilities. Europa, Ganymede, Titan, and Enceladus all provide deep mysterious oceans that call out to the human spirit, and Ceres has erupting brines freshly deposited on its surface. Each of these worlds has unique aspects that might prove critical to unlocking prebiotic chemistry, triggering an origin of life, or maintaining an ecosystem. When envisaging what it means to have "Science Informing Solutions," imagine how potent such efforts by the scientific community could be when they include a diversity of possible oceans. With my time on the NASA MSL science team nearing its end, I am transitioning my planetary science efforts to the future ocean world spacecraft that need to be developed, launched, and ultimately utilized by scientists to explore all these new worlds.

I consider myself fortunate to be able to contribute to this golden age of planetary science, and I sincerely hope that planetary science continues to grow and complement the Earth sciences as we build a more idyllic future.

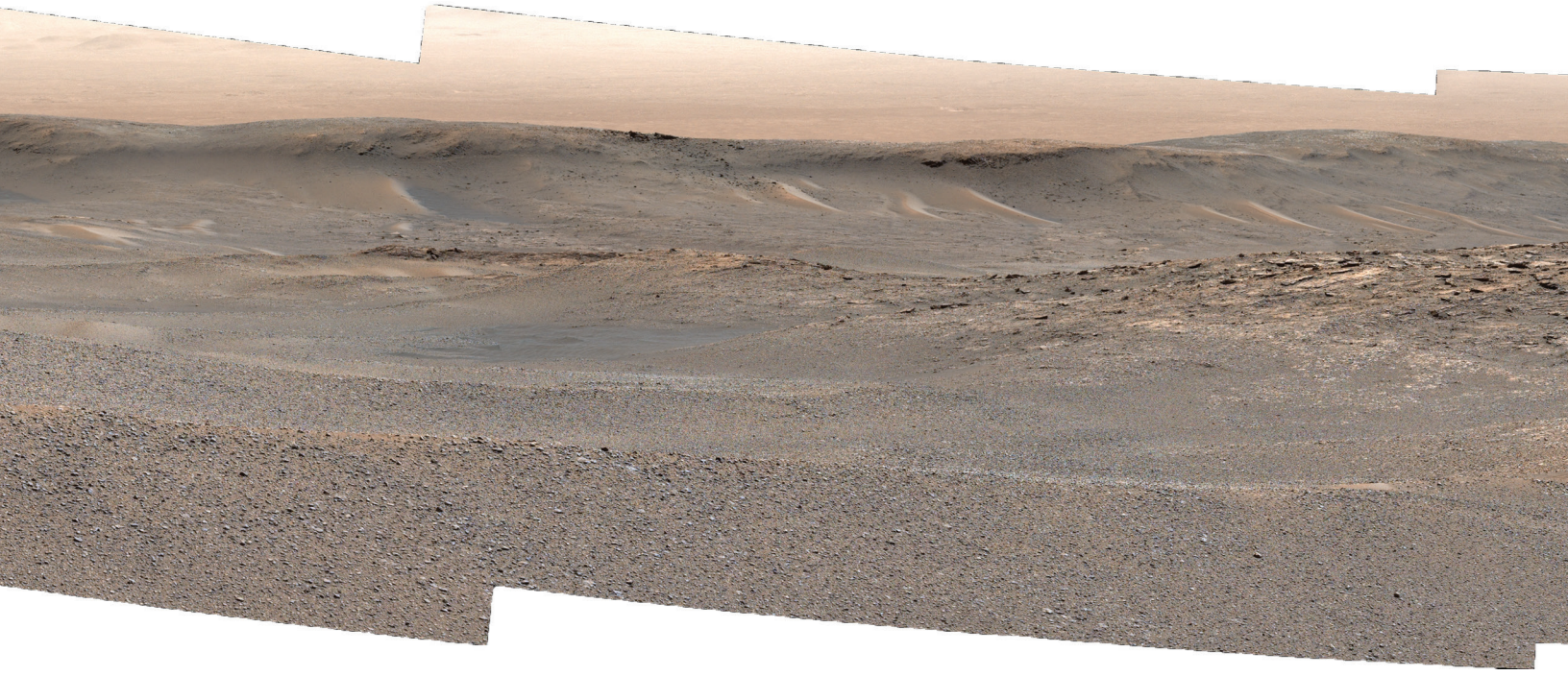


Pictured clockwise, top left to bottom:

Photomosaic of the NASA Curiosity rover's workspace at the Gale Crater location where the team studied the "dark sticks," as discussed in the narrative. Credit: NASA Mars Science Laboratory / NASA JPL

Photomosaic of the Curiosity rover atop Vera Rubin Ridge, Mars.Credit: NASA / JPL-Caltech / MSSS

Photomosaic of the Glen Torridon region of Gale Crater showing aeolian sculpted topology. Credit: NASA Mars Science Laboratory / NASA JPL



EESI News Highlights

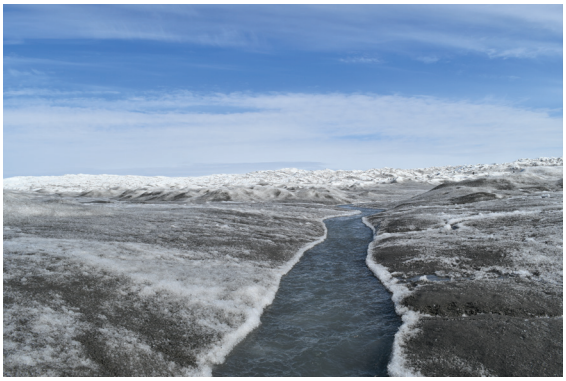
Application of machine learning can optimize hurricane track forecast

When it comes to hurricanes, it's important to know what type of storm you're going to get and when you're going to get it, according to Jenni Evans, professor of meteorology and atmospheric science and director of the Institute for Computational and Data Sciences. Evans and a team of Penn State researchers developed a machine learning technique that can help meteorologists provide more accurate medium-term forecasts and issue timely warnings to communities in the paths of hurricanes. In a study, the researchers used machine learning to remove certain groups of hurricane predictions from ensembles–sets of predictions from weather models that are based on a range of weather possibilities. These groups, called clusters, performed worse than a randomly selected ensemble member. Removing these small clusters reduced errors and improved forecasts four to six days ahead of a storm. https://bit.ly/eesi211

Ice melt projections may underestimate Antarctic contribution to sea level rise

Fluctuations in the weather can have a significant impact on melting Antarctic ice, and models that do not include this factor can underestimate the global impact of sea level rise, according to Penn State scientists. Because modeling how the Antarctic ice sheet will evolve under future climate conditions requires thousands of simulations and large amounts of computing power, modelers use a mean temperature found by averaging the results of climate models. This process smooths out peaks caused by climate variability and reduces the average number of days above temperature thresholds that can impact ice sheet melt. The Penn State team, which includes Chris Forest, professor of climate dynamics, and David Pollard, emeritus research professor, analyzed two large ensembles of climate simulations and fed the atmospheric and oceanic data into a three-dimensional Antarctic ice sheet model. They found that accounting for climate variability caused models to predict an additional 2.7 to 4.3 inches of sea level rise by 2100 and an increase in the rate of ice sheet retreat compared to models that did not account for variability, which delayed the retreat of the ice sheet by up to twenty years. https://bit.ly/eesi212

Ocean color satellites reveal glacier algae, insights for climate models



The brownish-grey algae that darken the Greenland ice sheet in summer absorb solar radiation and warm the ice, causing it to melt faster. Only recently have scientists measured algal blooms in the field, and only at a few sites. Scientists are now turning to satellites to measure these blooms across large regions and understand their effects on melting over time. A team of scientists, including Shujie Wang, assistant professor of geography, used data from the Medium Resolution Imaging Spectrometer (MERIS) on the European Space Agency's Envisat satellite to quantify glacier algal blooms in southwestern Greenland by focusing on a component of the algae called chlorophyll-a, which has a distinct reflected near-infrared radiation signature. They compared the data to measurements taken in the field and by the Moderate Resolution Imaging Spectrometer (MODIS), which measures surface albedo, or how much incoming solar radiation is reflected by a surface. The researchers found that if algae growth doubles, then albedo decreases between 2 percent to 4 percent. Wang plans to quantify how much algae development increases meltwater in subsequent research. https://bit.ly/eesi213

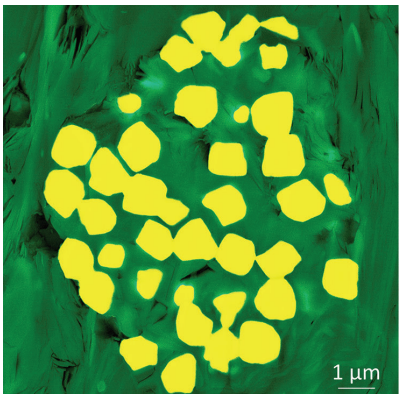
Uncertainties key to balancing flood risk and cost in elevating houses

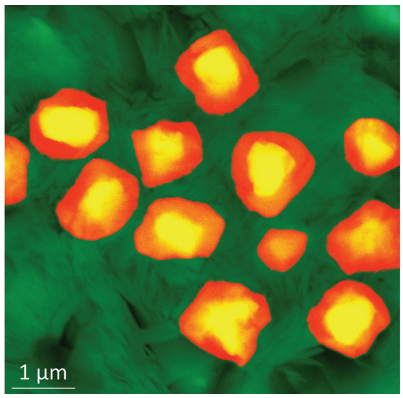
Considering uncertainties when weighing the risks and costs of elevating a house in a flood zone can help improve homeowners' decisions, according to a research team led by Klaus Keller, professor of geosciences, and former Penn State researchers Vivek Srikrishnan and Mahkameh Zarekarizi. The Federal Emergency Management Agency (FEMA) recommends elevating houses to the height of a flood that has a 1 percent chance to occur in a given year, also known as the one-hundred-year flood, plus at least one foot. The researchers investigated if they might improve on this suggested elevation by factoring in uncertainties surrounding future flooding, the future value of money, and the vulnerability of a house to flooding, among other considerations. "Looking at the range of possible outcomes can help to improve decisions on how high to elevate a house," Zarekarizi said. https://bit.ly/eesi214

Researchers use minerals from ancient soils to reconstruct past climate

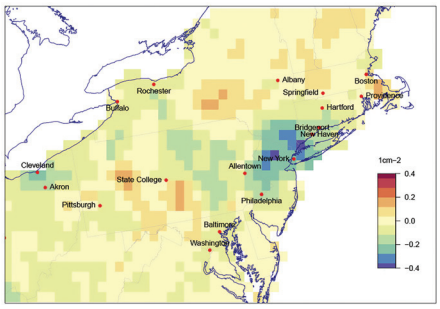
When the Paleocene ended and the Eocene began nearly fifty-six million years ago, high atmospheric carbon dioxide levels gave rise to sauna-like conditions across the earth. An international team of scientists, including Tim White, EESI research professor, used tiny minerals called siderites to measure just how hot and wet the world was. Siderites only form in totally saturated, oxygen-free soils during warm greenhouse episodes, and soil temperatures influence which carbon and oxygen isotopes become embedded in the crystal lattice. The researchers used a new method called clumped isotope thermometry to measure the concentration of heavy oxygen-18 and carbon-13 isotopes in the minerals, which they used to determine the mean air temperature and the amount of moisture in the atmosphere at the time the siderites formed. The team found that the global moisture content in the atmosphere was much higher at the Paleocene-Eocene boundary than it is today. Earth was much warmer, too, with the mean annual air temperature at the equator where Colombia lies today hovering around 106 degrees Fahrenheit, and summer temperatures in Arctic Siberia averaging 73 degrees Fahrenheit. https://bit.ly/eesi215

Landscape to atomic scales: Researchers apply new approach to pyrite oxidation





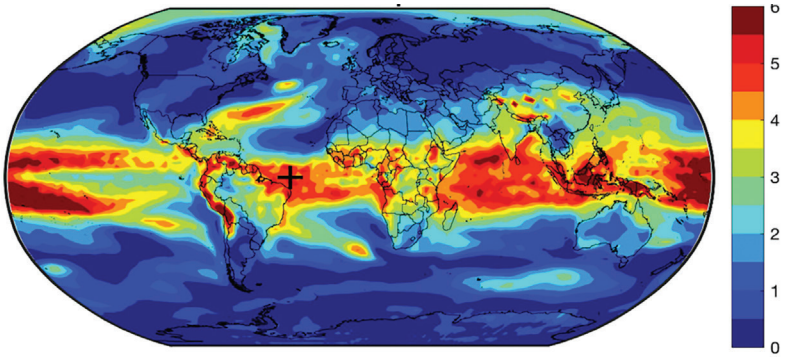
When exposed to water or air, pyrite reacts quickly with oxygen and can lead to hazards like acid mine drainage, but little is known about pyrite oxidation in unmined rock deep underground. A Penn State-led team of researchers used a new, multi-scale approach to studying pyrite oxidation deep underground to shed light on the process. The research team, which includes Xin Gu, assistant research professor, and Susan Brantley, Barnes Professor of Geosciences and director of EESI, lowered geophysical logging tools down boreholes three-inches wide and recovered rocks from more than one-hundred-feet deep to examine the shale bedrock and identify how deep or shallow pyrite weathers and fractures underground. They studied the grains of pyrite using scanning electron microscopes to image their microstructures. They found that the erosion rate of the shale controlled the rate of pyrite oxidation at depth, and that the slow oxidation of pyrite over millennia prevents harmful acids from accumulating, instead leaving behind "fossils" that retain pyrite's raspberry-like shape even though chemically it has transformed from iron sulfide to iron oxide. The researchers used their findings to develop a model to calculate pyrite oxidation levels across the globe. https://bit.ly/eesi216



Air quality data during COVID-19 may help improve models, guide interventions

The measures instituted in April 2020 to help curb the spread of COVID-19 across the United States may hold clues for improving air quality, according to a team of researchers that includes Penn State's Guido Cervone, professor of geography and meteorology and atmospheric science. The researchers examined the pandemic's effects on two key pollutants–nitrogen dioxide and fine particulate matter–and human mobility. They found that as individuals limited their travel, nitrogen dioxide levels fell significantly because fewer passenger vehicles hit the road. Levels of fine particulate matter remained mostly unchanged but rose in certain parts of the country as the demand for diesel-fueled traffic, mainly comprised of business and home delivery trucks, and home heating and electricity use rose. "One of the big uncertainties with trying to forecast future air quality is how the atmosphere will respond to lower emissions of certain pollutants," Cervone said. "COVID-19 gave us some insights into the effects of lower emission rates on the environment. We had this unique situation that showed us what happens if people stop driving." https://bit.ly/eesi217

Apparent Atlantic warming cycle likely an artifact of climate forcing

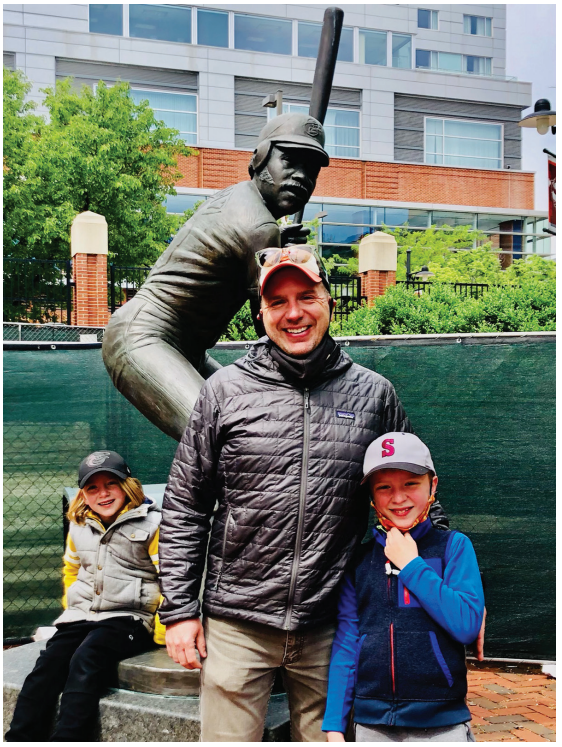


Volcanic eruptions, not natural variability, were the cause of an apparent "Atlantic Multidecadal Oscillation," a purported cycle of warming thought to have occurred on a timescale of forty to sixty years during the pre-industrial era, according to a team of climate scientists that includes Michael Mann, distinguished professor of atmospheric science. The researchers looked at state-of-the-art climate models for preindustrial times over the past thousand years where external factors like solar and volcanic drivers were used, and unforced, "control" simulations where no external drivers were applied and any changes that happen are internally generated. When they looked for the AMO, it did not occur in the unforced model and only appeared in modern times using climate change variables as forcing and in preindustrial times with forcing by volcanic eruptions. The study appears to be the final nail in the coffin of the AMO theory. "What has in the past been attributed to an internal AMO oscillation is instead the result of external drivers, including human forcing during the industrial era and natural volcanic forcing during the pre-industrial era," said Mann. https://bit.ly/eesi218

Landscape shows earliest effects of modern humans using fire to shape ecosystem

New archaeological and paleoenvironmental evidence from Lake Malawi, Africa, shows that the effects on the landscape of humans' use of fire is tens of thousands of years older than previously thought, according to an international team of researchers that includes Sarah Ivory, assistant professor of geosciences at Penn State. The researchers studied dense clusters of stone artifacts, some dating as far back as 92,000 years, collected from the northern shores of the lake, and fossil pollen and charcoal samples taken from a sediment core drilled from the lakebed. The evidence, when analyzed separately, raises more questions than answers, but combined it tells a story of early modern humans using fire in a way that prevented regrowth of the region's forests and created the sprawling bushland that exists today. "Fire clearly has been an important component in our evolutionary story, and this research identifies an interesting turning point," Ivory said. "Humans, through their use of fire and being able to ignite their own fires, are shaping the landscape to benefit themselves ... and the timing is right as modern humans are moving out of southern Africa." https://bit.ly/eesi219

Know Your Staff:
Q&A with Tam Rankin



Tam Ranking with his children standing next to the Eddie Murray statue at Oriole Park at Camden Yards, Baltimore. Photo courtesy of Tam Rankin.

Tam Rankin joined EESI in June as the institute's new administrative support coordinator. Rankin, who hails from southern Pennsylvania, brings eighteen years of academic administrative experience to the position. He received his bachelor of fine arts from Tulane University and a master of music from the Peabody Institute of the Johns Hopkins University. Here we talk to him about work, music, and the time he found himself surrounded by orcas.

I think the number one question on everyone's mind is, who is Tam Rankin?

Tam Rankin is an aging father who says his joints hurt. (Laughs.) No, so, I'm a career academic administrator coming to Penn State having spent eighteen years working in academic administration, first at Yale University and, most recently, Portland State University, with a brief sojourn at Imperial College London.

I have a history of supporting interdisciplinary institutions, first with the Institute of Sacred Music at Yale University–which is a unit that engages with faculty and students who have affiliations with the Yale School of Music and the Yale Divinity School–and then at Yale's Council on Middle Eastern Studies and at Portland State's Middle East Studies Center. The latter centers involved multi-disciplinary undertakings with faculty who have shared research interests in the Middle East. I spent the last five years in science administration as the department manager for the chemistry program at Portland State. I had a team of five people, including a department administrator and four chemistry stockroom staff who were responsible for teaching laboratory preparation and providing chemistry research lab support at a couple locations on the Portland State campus. I supervised their work and served as our graduate program coordinator, which meant that I supported admissions and graduate assistantship appointments. I also provided general faculty support, including staffing faculty meetings and searches. Working directly with our department chair, I managed our annual budget and coordinated our sponsored project support.

Even though you've been in academic administration for the last eighteen years, your background is in music. How has your background in composition, which requires great attention to detail and creativity and other sought-after skills, prepared you for your current role at EESI?

I think you're right about those specific skills that I brought from my experience as a musician to my work as an administrator. When I worked for the Institute of Sacred Music, I was able to relate directly with our music faculty, having been in that milieu prior to transitioning to an administrative role. I think a strength that I bring to my work is an understanding of the work of the scholar. My spouse, Laura Robson, is a member of the Penn State faculty, and I have lots of friends who are researchers and scholars. I think that my interactions with them and my understanding of their lifestyle really informs my work and expectations as an administrator and my approach to providing faculty support.

You took full control of the reins after Tracy Bernier retired at the beginning of June. How has your work and that transition been?

It's been going well so far. I was able to sit at Tracy's side for a few weeks. She had graciously devised a comprehensive plan for orienting me to EESI's work and to the work of the position. She was really strategic and careful, and she had a sequential strategy.

Since then, I have been relying on the expertise of our excellent staff. Shelly McCall and Abby Benkiran have been sharing what they know about my position's responsibilities. I've also had the good fortune to speak with staff colleagues within the dean's office and University administration.

What are some of the major goals that you are hoping to accomplish at EESI?

I'm interested in playing a leadership role and continuing EESI's tradition of providing excellent faculty support. In the more immediate term, I'm interested in participating actively in the University's plans to return to work on campus. I'd like to capitalize on the opportunities that being in-person will provide to support and encourage our researchers' multidisciplinary collaborations.

You've moved from Portland, Oregon, to State College with your spouse and two young children during the COVID-19 pandemic. How has that transition been going, and what's your favorite part of State College so far?

It has been a really, really weird time to show up in a new place. State College is different from Portland, of course, but also the restrictions of the pandemic have made it difficult in some respects to feel like we have a clear picture of the community. I think my family has really benefited from the excellent public school system. And I'm certainly excited to be at such an excellent research institution. I think my favorite part of being here has been working at Penn State and learning about the exciting work that's happening at the University.

If you don't mind me delving into your background a bit more, can you talk about your music?

I studied classical composition as an undergraduate and graduate student, but my plan all along was to be a rock star. I have had a number of bands every place I've lived. Probably my most ambitious group in terms of performing was The Masses when I lived in New Haven, Connecticut. I played guitar in a five-piece band that played a lot from Boston to New York and up and down that stretch of the eastern seaboard. More recently, in Portland I played in a four-piece group called Aquavit. I was actively gigging with the group until just a few months after my son was born.

I continue to play around the house and to support my children's musical education and exposure. We listen to a lot of music and make a lot of music at home.

What instruments do you play?

I'm most interested in guitar. I have gigged a lot on bass and keyboard, and I have a drum set prominently set up in my home office.

What's this I hear about you finding yourself surrounded by orcas?

I recounted a trip to a couple of our colleagues that my wife and I took in the San Juan Islands in Washington state. We were on a sea kayaking day trip just to the west of San Juan Island. That island is an especially prime hunting ground for orca whales. They run salmon up against a sheer face of the island and trap and eat them there. That body of water is home to three different pods that migrate to and from the space. The day we were out, having been told that we had a 50 percent chance of seeing an orca, we found ourselves surrounded by all three pods. More than seventy orcas were swimming underneath the kayak. They were jumping and doing the Free Willy breach.

We were pretty terrified. (Laughs.)

But our expert guide got us out of the water and back home safely. He took us out for a beer afterward. We walked into his local watering hole and they said, "Hey, Tim, did you hear there were some crazy people out there kayaking with the orcas today?"

Would you do it again?

Never. That's my punch line. I always say it was the best sea kayaking and whale watching experience, and that I would never ever do it again.

Rankin prepares to serve a crawfish boil, a dish he learned to cook while living in New Orleans.

Last question: If you could be a superhero or have a superpower, what would it be?

I don't know much about superheroes, but I struggle with having enough time, so if there's a superhero who has the power to slow down time, I'd be interested in having that power. I don't want to have to fly around the world a million times to turn back time. That sounds like a lot of work. Something that's more straightforwardly slowing things down would work well for me.

Rankin at David's Vista on the Jackson Trail, near State College.

EESI Community News

Sanjib Sharma, a former EESI postdoc, began an appointment as an assistant research professor with EESI. Sharma's research focuses on hydrometeorological ensemble predictions, climate risk management, integrated infrastructure design, and decision-making under uncertainty.

Kim Lau received the Pre-tenure Award from the Geobiology and Geomicrobiology Division of the Geological Society of America.

Roman DiBiase received a promotion to associate professor with tenure.

Timothy White was elected as a Fellow of the Geological Society of America.

Doug Miller received the Wilson Award for Outstanding Service at the college's 2021 Wilson Awards Banquet.

Brandon Forsythe received a promotion to assistant research professor.

Jenni Evans was elected as a Fellow of the American Association for the Advancement of Science.

The Manual of Leaf Architecture, co-authored by **Peter Wilf**, is now available as an open access document. The manual provides a comprehensive description of leaf characteristics to aid in the identification and classification of modern and fossil leaves.

Michael Mann was co-recipient of the 2020 World Sustainability Award. The award recognizes individuals or research teams for an outstanding academic or societal contribution to sustainability or a particular sustainability-relevant issue.

Susan L. Brantley was inducted into the American Academy of Arts and Sciences and became the first recipient of the Dr. Hubert L. Barnes and Dr. Mary Barnes Professorship in Geosciences.

Erica Smithwick was named a distinguished professor. She was also named a Penn State Administrative Fellow and will shadow Lora Weiss in the Office of the Senior Vice President for Research during the 2021-22 academic year.

Guido Cervone was elected to a two-year term as president-elect of the Natural Hazards Section of the American Geophysical Union. He will serve a two-year term as president beginning on January 1, 2023.

Kelly Núñez Ocasio successfully defended her doctoral dissertation, "Tropical cyclogenesis and its relation to interactions between African easterly waves and Mesoscale convective systems," in the Department of Meteorology and Atmospheric Science. She received her degree at Penn State's summer commencement on August 14 and in the fall started as an Advanced Study Program Postdoctoral Fellow at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado.

Jamie Peeler successfully defended her doctoral dissertation, "Fire, forests, and spatial resilience: the role of landscapes in post-fire tree recovery," in the Department of Geography. She received her degree at Penn State's summer commencement on August 14 and in the fall started as a NatureNet Science Fellow with The Nature Conservancy in Missoula, Montana.

Retirees

Douglas Miller, research professor emeritus, retired on June 30 after thirty-three years at the University. He worked for the colleges of Earth and Mineral Sciences and Agricultural Sciences, and the John A. Dutton e-Education Institute. Throughout his career, Doug served as an educator, a researcher, an expert in Geographic Information Systems (GIS), and most recently as the leader on campus for use of unmanned aerial systems (drones) in research and education. He directed the Center for Environmental Informatics for twenty years and led teams of researchers who developed high-quality web and mobile applications and other technology solutions for entities such as the U.S. Department of Agriculture, American Bird Conservancy, and the Pennsylvania Geological Survey, to name a few. "We will miss Doug very much for his willingness to always, always give to Penn State students and to complete his work with the highest integrity and excellence," Brantley said.

Tracy Bernier, administrative support coordinator, retired on June 2 after eleven years with EESI and thirty-seven years at Penn State. One word was used consistently to describe Tracy: irreplaceable. Tracy kept EESI running smoothly and ensured that the institute provided exceptional support to our student and faculty researchers, even through trying times. Many faculty have commented on how much easier she made their jobs. EESI will miss her ability to keep track of the myriad details that are important for research, education, and outreach to proceed at a big, bustling university. Tracy was able to keep everything running smoothly, and at the same time she had a great sense of humor, the highest level of integrity, and a willingness to always work for Penn State and the EESI faculty and staff.

Passings

Robert Brooks

EESI mourns the passing of Robert P. Brooks, emeritus professor of geography, who will be remembered as a terrific colleague, mentor, and friend.

Born in Baltimore, Maryland, Brooks loved exploring the woods and waters in his backyard, canoeing, camping, and becoming an Eagle Scout Master. He received his bachelor's degree in biology from Muhlenberg College, where he honed his rock-climbing skills scaling along the sides of dormitories and classroom buildings. He completed his master's and doctoral degrees in wildlife biology at the University of Massachusetts, where his preferred method of inventorying muskrat populations was to reach blindly into submerged burrows with his bare hands.

Throughout his thirty-eight-year career at Penn State, he helped countless students along their journeys. His leadership of the EESI-funded center Riparia, which he founded in 1993 as the Penn State Cooperative Wetlands Center, encouraged many undergraduate and graduate students to pursue careers in water sciences, and his example nudged them to help the planet in many small and large ways.

Beyond Penn State, Brooks enjoyed a combination of good scotch, classic rock, and collecting antique tools, all while talking about wildlife and his list of ever-growing house and Maine projects.

When it came to helping others, no one was ever "out of the way" for Brooks. People were the way, and he always made others feel included and helped those who asked–including those who didn't know they needed help.

Friends recall Brooks as being the kind of person they wanted to emulate, and also the kind of person they wanted to sit down and have a beer with. He will be sorely missed.

Support EESI

The Earth and Environmental Systems Institute brings together scientists studying environmental science that crosses human to geologic timescales and transcends from fundamental to applied science. Its diverse and world-renowned faculty members are engaged in innovative and collaborative transdisciplinary research on questions related to our environment and how humans interact with the environment. To help support our mission (and help EESI do it), please consider donating to the Institute at raise.psu.edu/eesi.

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