2019

Impact

The Magazine of the College of Earth and Mineral Sciences

PennState
College of Earth
and Mineral Sciences

Contents

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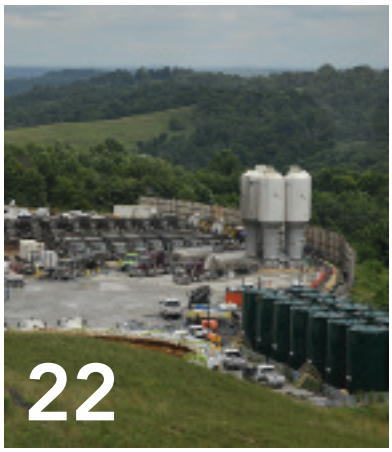

Sections

On the cover...

Troy Ferland, graduate student in geosciences, and Annalee Sekulic, project data manager, collecting samples as part of the Ancient Socio-Ecological Systems in Oman research project.

All photos, unless noted, provided by Penn State.

This publication is available in alternative media on request.

We're back! After many years since the last issue of the college's magazine, we present the first issue of Impact, our way of communicating to you the exciting things our students, faculty, staff, and alumni are doing. And the topics covered are just the tip of the iceberg.

As you might expect, EMS is responding comprehensively to society's need for reliable, safe, affordable, and environmentally responsible energy. Researchers in energy and petroleum and natural gas engineering are working to improve the efficiency and reduce the environmental impact of petroleum and natural gas extraction, goals advanced by our faculty and practiced by our alumni for decades. Accidents do happen, so EMS MatSE faculty member Mike Chung has invented a new polymer that is an amazingly absorptive material for treating oil spills. Our faculty and students are prospecting for critical minerals in coal sequences and related waste materials in support of the need to reduce export reliance for rare earth elements and lithium for high-tech manufacturing in the renewable energy, medical, and defense sectors, while remediating waste and creating opportunities for the idled mining workforce. Utilization and sequestration of carbon dioxide are new directions for the college, and EME associate professor Jeffrey Brownson is helping direct the University's development of utility-scale solar energy projects.

Geoscientist Sarah Ivory and her students are looking to Earth history for insights on how the climate system responds to elevated greenhouse gas levels, digging through hyrax middens for evidence of the types of plants and animals that inhabited remote regions of the world at times past, and what the climate was like. Looking forward, meteorologists, and atmospheric and climate scientists are developing tools to better predict the future. In this issue we highlight the pioneering work of the late Fuqing Zhang, whose data assimilation techniques have revolutionized the fields of severe storm forecasting and global climate model prediction.

Of course, EMS is impacting many fields outside of energy and climate, and is a leader in educational innovation and outreach as well. Geographer Alex Klippel is transforming education at Penn State and beyond, bringing virtual reality and artificial intelligence to the classroom, allowing students to have fully immersive field experiences without getting wet!

I hope you enjoy reading *Impact*. To keep up between issues, you can follow us on Twitter, Facebook and Instagram, and subscribe to our EMS Headlines by going to www.ems.psu.edu/e-news. And as always, stay in touch!

Impact

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Peggy Greb, USDA

Penn State launches Center for Critical Minerals

New technologies from touch-screen displays to batteries to defense applications are increasingly reliant on specific critical minerals not widely used a few decades ago. They are considered critical due to their high economic importance and high supply risk, and because their absence would have significant consequences on the economic and national security of the United States. Since most are imported, researchers are now exploring ways to produce these minerals domestically. The Center for Critical Minerals was launched to build on and expand Penn State's current research examining cost-effective and environmentally friendly technologies to extract critical minerals from clay layers associated with coal, coal waste products, and acid mine drainage. https://bit.ly/2Ty62eM

New family of glass good for lenses

A new composition of germanosilicate glass created by adding zinc oxide has properties good for lens applications. This development marks the discovery of a novel glass family. This glass has a high refractive index, high transparency, ultraviolet shielding properties, and good glass-forming ability. Unlike pure germania or lead oxide germanosilicates, this family of compositions is less costly to produce and requires no toxic raw materials. John Mauro, professor of materials science and engineering, and the research team filed a patent for the composition. https://bit.ly/2FZT0Q4

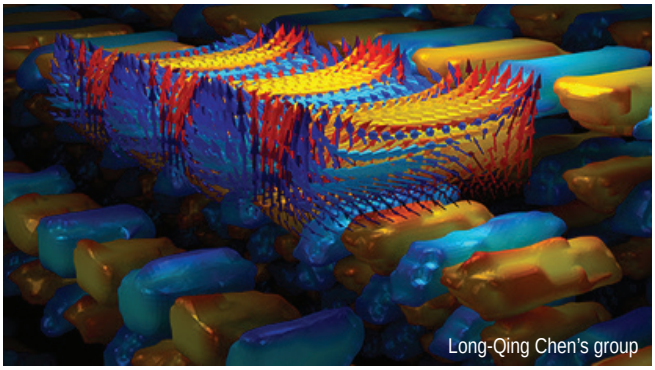

Melissa Gervais

North Atlantic warming hole impacts jet stream

The North Atlantic warming hole (NAWH), a region of reduced warming in the North Atlantic Ocean, significantly affects the North Atlantic jet stream in climate simulations of the future, said Melissa Gervais, assistant professor of meteorology and atmospheric science. Development of the NAWH is thought to be caused by an influx of fresh water resulting from melting Arctic sea ice. This cooling pattern is predicted to become greater and more apparent relative to the internal ocean variability as the twenty-first century progresses. https://bit.ly/2DgUof9

Research predicts size, magnitude, timing of lab earthquakes

Researchers from Penn State and Los Alamos National Laboratory have predicted the time and duration of earthquakes in a laboratory setting for the first time. Machine learning allowed researchers to find patterns for earthquake frequency, which previously posed a significant challenge in laboratories. Movement of an earthlike medium generated acoustic signals, long considered noise early in the earthquake cycle, and these signals taught the machine learning technology to predict earthquake occurrences. Chris Marone, professor of geophysics, and the researchers created two types of earthquakes, slow-slip and fast-slip, ultimately finding that the mechanics and methods for prediction for each are the same. https://bit.ly/2EUGyPz


Long-Qing Chen's group

Supercrystal created by a burst of light

"Frustration" plus a pulse of laser light resulted in a stable "supercrystal" created by a team of researchers led by Venkatraman Gopalan, professor of materials science and engineering. The new hidden state of matter was captured by taking it out of its comfortable state, referred to as the ground state. The team accomplished this by "frustrating the system"—not allowing the material to do what it wants to do, which is to allow it to minimize its energy fully without constraints. This is one of the first examples of a new state of matter with long-term stability transfigured by the energy from a sub-pico-second laser pulse. https://bit.ly/2k4fZBk.

South African forests show pathways to a sustainable future

Native forests make up 1 percent of the landscape in South Africa but could play a key role in reducing atmospheric carbon by acting as a "sponge," and by illustrating how sustainable development practices can be used globally to counter climate change, according to Erica Smithwick, E. Willard and Ruby S. Miller Professor of Geography. Smithwick and her team measured the carbon content of the Dwesa-Cwebe nature reserve in the Eastern Cape Province, finding that the forest stores a moderate to large amount of carbon while allowing for timber and medicinal plants to be harvested by the local communities. The data could help determine the balance between forest productivity and resource extraction so not to degrade the natural system. https://bit.ly/2khQtJ3

North Pacific jet stream, moisture, and fires change with fire suppression

Future conditions in California may include more rain rather than snow during the wet seasons, longer fire seasons, and higher temperatures leading to drier fire seasons, according to a team of researchers, including Alan Taylor, professor of geography, who looked at the historic patterns of the North Pacific Jet, precipitation, and fire. The findings suggest that increased carbon dioxide in the atmosphere will cause temperature increases in California along with decreased snowpack in the mountains and drier summers, whether precipitation increases or decreases. According to the researchers, this warming trend is expected to override historic North Pacific Jet conditions and increase fire potential. https://bit.ly/2jZE0cC

NSF grant aims to enhance resilience of U.S. electricity grids

Society depends on critical infrastructures like the electricity grid. Ensuring that the power grid is able to recover rapidly from disruptions is vital. As the U.S. share of electricity generated from natural gas continues to increase, power systems and gas networks are becoming increasingly intertwined. Chiara Lo Prete, assistant professor of energy economics, is leading a team of researchers to study economic mechanisms for grid resilience against extreme events and natural gas disruptions using a $750,000 grant from the National Science Foundation. Researchers will investigate proposed models and mechanisms on an integrated, natural gas-grid test system with realistic topology for the Northeastern United States — a region that heavily relies on natural gas for power generation. https://bit.ly/2TxyVHS

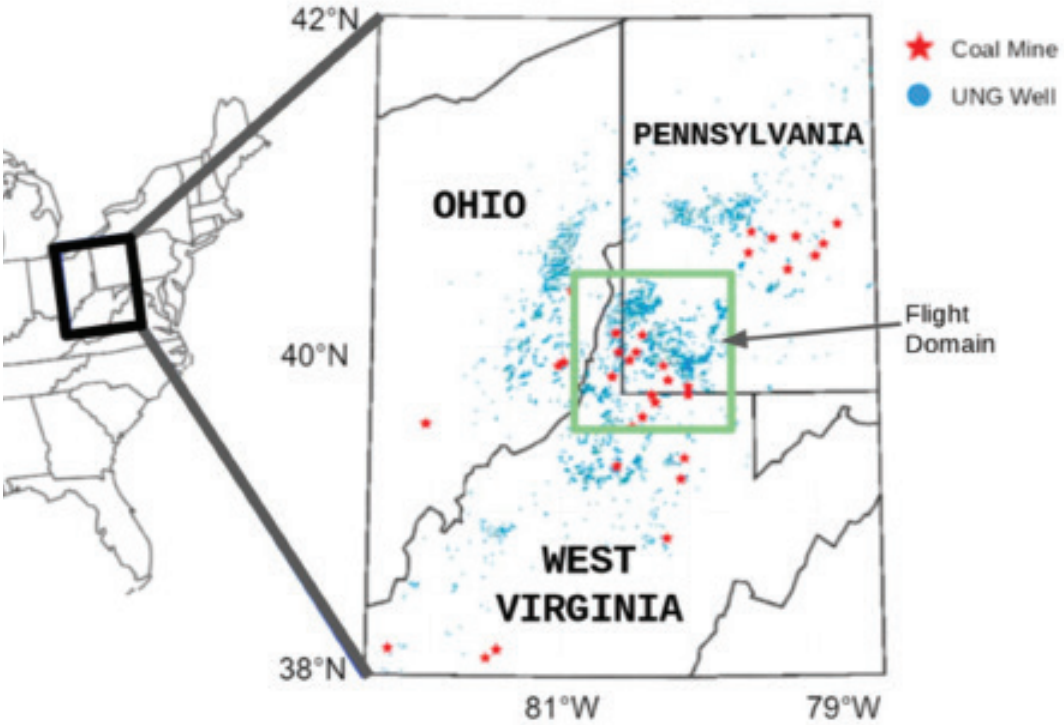
D. Sharon Pruitt

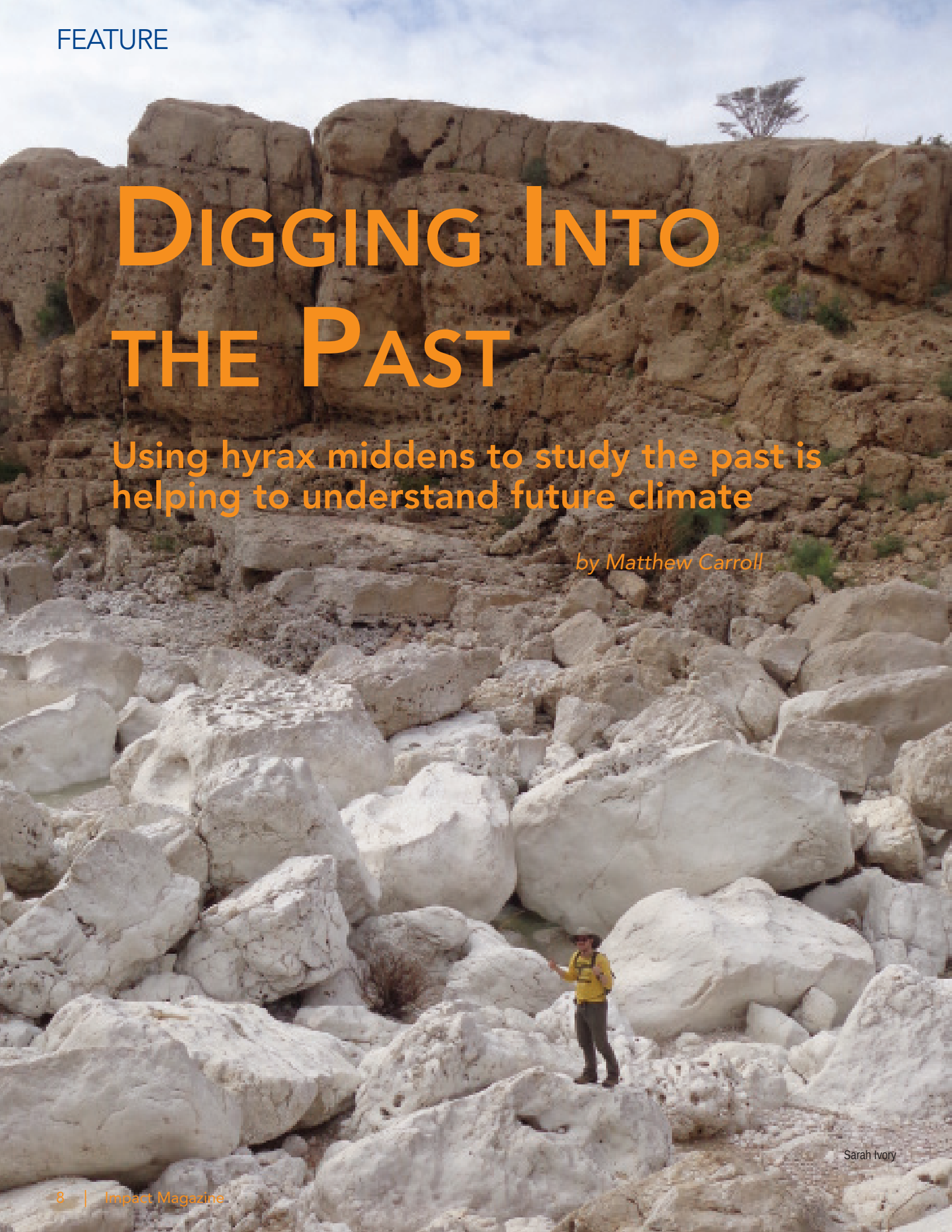
Argentine fossils take oak and beech family history far into Southern Hemisphere

One of the world's significant plant families, *Fagaceae*, has a history extending much farther south than previously recorded. An international research team including Peter Wilf, professor of geosciences, found 52-million-year-old chinquapin fruit and leaf fossils in Patagonia, Argentina. This is the first confirmed evidence that *Fagaceae*, considered restricted to the Northern Hemisphere, was once in the Southern Hemisphere. The findings have implications for understanding extinctions related to climate change, the researchers said, as chinquapin trees in Patagonia originally vanished due to a climatic extinction event in South America. https://bit.ly/2kug1Cv

Methane emissions from coal and natural gas measured

According to an international team of researchers, the U.S. Environmental Protection Agency underestimates methane emissions from natural gas production in Pennsylvania, but natural gas still has half the carbon footprint of underground coal mining. Ken Davis, professor of atmospheric and climate science, and the research team collected data on gases in the atmosphere during flights over southwestern Pennsylvania and portions of West Virginia and Ohio and used the ratio of ethane to methane to estimate the contribution of individual sources to the carbon footprint in areas with multiple sources. https://bit.ly/2kieLCJ





Digging Into the Past

Using hyrax middens to study the past is helping to understand future climate

by Matthew Carroll

Sarah Ivory

High on the craggy cliffs of Oman's rocky desert landscape, Sarah Ivory squeezed into narrow, dark caves in search of a different kind of goldmine.

Shaded away from the desert sun, Ivory tapped a dusty, gray rock with her hammer and heard the dull, hollow sound she'd been waiting for.

She found a special kind of fossil that, when cut open, would reveal smooth golden-brown layers that can help scientists see deep into the past.

This was a fossil of a midden, a communal toilet used by generation after generation of a small, desert-dwelling animal. The same middens are sometimes used for tens of thousands of years.

Ivory recently journeyed to Oman, on the tip of the Arabian Peninsula, to find middens tucked in these caves, dig them out and ship them back to her laboratory at Penn State for analyses.

It's a dirty job.

But in one of the driest places in the world, middens may be the best evidence to understand how the climate changed in the past, and how plants, animals and even humans, responded.

"These unusual fossils are one of the only ways we can look back into the past and see how arid areas changed over time," said Ivory, an assistant professor of geosciences. "That can help us answer important questions about how they will change in the future. These regions are very sensitive to changes in rainfall and are very at risk."

Creatures of habit

The deep, rocky valleys that cut through the Oman desert are home to the rock hyrax, which is, by all accounts, a strange animal.

Hyraxes may look like oversized rodents at first glance, but the tiny tusks that protrude from their jaws hint at their closest living relative—elephants.

For tens of thousands of years, these animals have lived in colonies across sub-Saharan Africa and the Middle East. In Oman, hyraxes pop in and out of small caves that pock the steep valley walls like swiss cheese, going about their daily routine.

Hyraxes are creatures of habit, and many generations of entire colonies have used the same spots to urinate and defecate. Middens discovered in Africa have provided unbroken fossil records dating back as far as 40,000 years.

(Above) The rock hyrax (Procavia capensis) is terrestrial mammal native to Africa and the Middle East. (Bottom) Fossil of a midden collected at the research site.

(Opposite) Troy Ferland, graduate student in geosciences, at the research site in Oman.

Sarah Ivory and Troy Ferland digging for middens at the research site in Oman.
Photos: Courtesy of Sarah Ivory

When hyrax urine meets the arid desert air, it crystalizes, creating a stinky, amber-like substance that provides fossil evidence of past climate change where none had been previously available, making their discovery a cause for celebration.

"The middens have a distinct smell, almost like incense," Ivory said. "I think it's one of those things where you develop associations with smells. Because to me they smell like victory."

A window to the past

Troy Ferland never knew what he would find when he peered into the caves. The Penn State graduate student could come face-to-face with a snake or scorpion seeking shelter from the desert sun. On a good day, he would stumble upon an ancient midden site.

"It's a numbers game," said Ferland, a doctoral candidate in the Department of

Geosciences who traveled with Ivory on a research trip to Oman. "The more holes you poke your head into, the better the chances you'll find a midden."

In Oman, the place to look is between the coast, where wet conditions may prevent middens from being preserved, and the open desert, where food for hyraxes is scarce.

Still, finding middens is not an exact science, especially for researchers more used to working with core samples drilled near lakes and bogs than with crawling through dry, dusty caves.

"This research is really important, because middens are one of our best tools for figuring out how arid and semi-arid areas changed in the past," Ivory said. "There are no lakes or bogs in these areas today, and traditional methods just won't work."

As middens form over long periods, tiny bits of pollen and leaves and traces of animals blow in on the wind and get trapped in new layers of the fossil.

Scientists can split the middens and use them like a core sample, answering questions about what plants grew in the region at different points in the past, and what animals grazed there. Isotopes contained in the urine can even reveal how much rainfall Oman experienced, Ivory said.

"Through middens, we can see how this environment was changing," Ferland said. "We can see how vegetation changed throughout different periods of human occupation, how things like the introduction of grazing animals changed the landscape."

(Left to right) Sarah Ivory, Troy Ferland, and Annalee Sekulic, project data manager on the Ancient Socio-Ecological Systems in Oman, at research site in Oman. Photo: Courtesy of Sarah Ivory

Understanding the impacts of a changing climate is critical in Oman. The dry, rocky country has expanded rapidly over the last several decades, further compounding the country's water scarcity concerns.

"We should care about what's happened to Oman in the past, because we have a changing climate right now," Ivory said.

"This research is really important, because middens are one of our best tools for figuring out how arid and semi-arid areas changed in the past." ~Sarah Ivory

"We don't have observations beyond the last couple of decades to know how Earth's climate will change and how plant communities are likely to respond to that and what changes in our ecosystem there might be. We can answer some of those questions by looking deep into the past, and middens are one way to do that." ⌘

Cleanup on the high seas

Super-absorbent material has potential to reduce the environmental impact of ocean oil spills

by David Kubarek

A new super-absorbent material developed by Penn State scientists could dramatically reduce the environmental impact of ocean oil spills.

The synthetic material, called i-Petrogel, absorbs more than 40 times its weight in crude oil, and effectively stops the oil from spreading after a spill, according to the researchers.

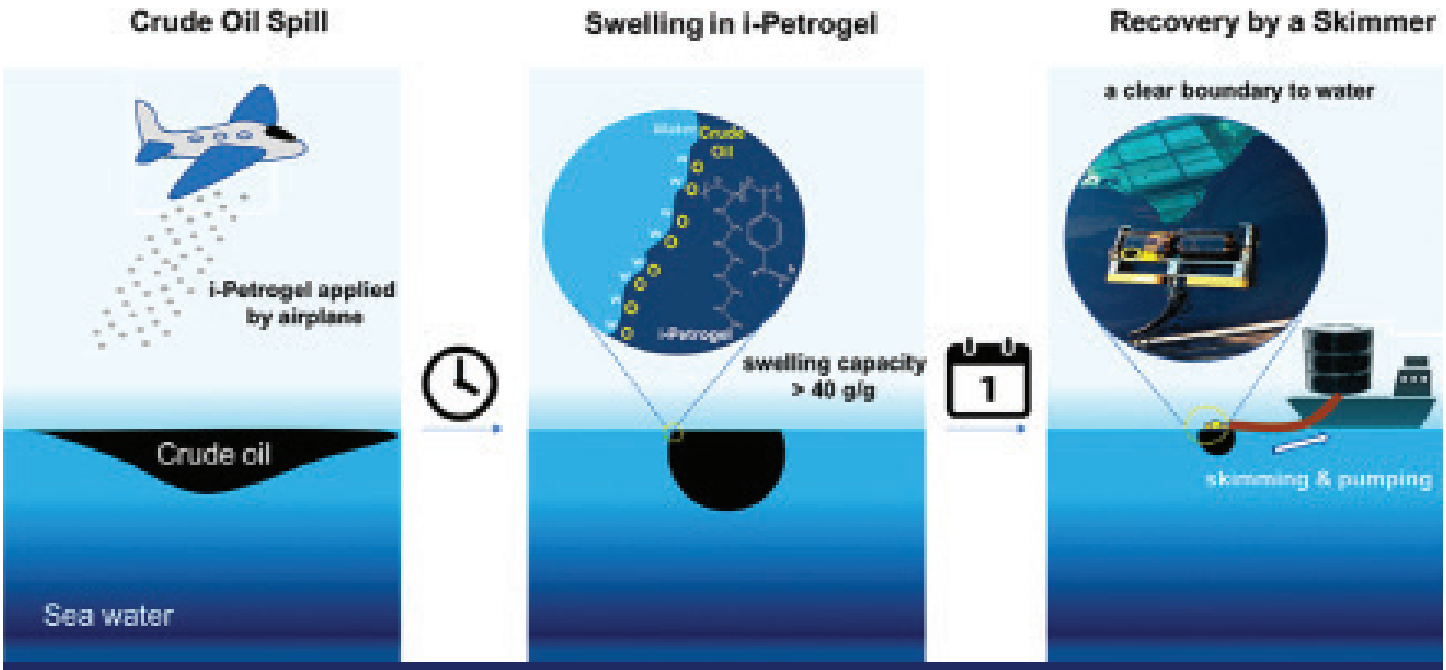
Scientists designed the material to maximize its ability to absorb oil, but not water. The oil collected can then be refined by regular oil refining processes and reused, further reducing environmental waste and pollution associated with other collection methods.

"If the recovered oil can't be reused, it needs to be dumped somewhere. It's useless," said T.C. Mike Chung, professor of materials science and engineering and lead investigator. "That's why we developed a technology that is comprehensive. i-Petrogel is a polymer made from oil. It's a pure hydrocarbon."

The research team created i-Petrogel by mixing two polyolefin polymers in the laboratory, and then scaled up the product for use in large-scale field tests. Because the product is an oil-based polymer, it's strongly bonded to oil and also doesn't need to be removed before being refined.

"We already know what kind of polymers can absorb oil," Chung said. "Some oil is very thick

Wikimedia: Kris Krüg

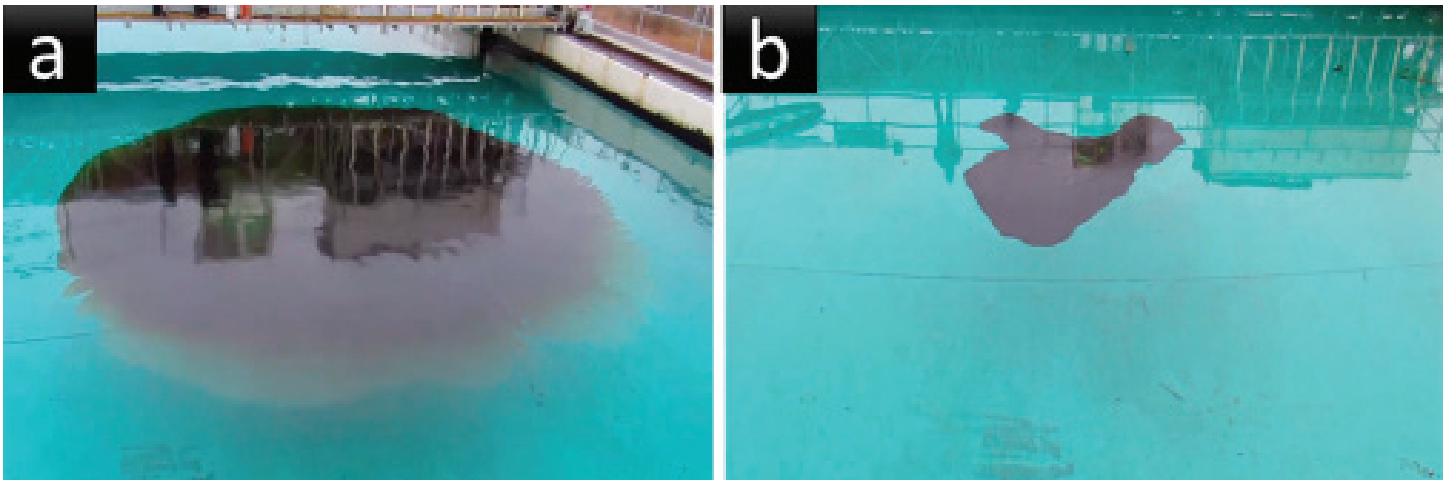


The i-Petrogel technology potentially provides a comprehensive solution for combating crude oil spills in open waters, with dramatic reduction of environmental impact. Illustration: Courtesy Mike Chung

and takes a long time to absorb, so we blended two polymers to provide structure with high surface area. It's a microporous structure. If you look inside there are many small holes. This morphological structure allows the viscous oil to diffuse inside, allowing for more oil to absorb through the surfaces."

The blend of two polymers, called an interpenetrating polymer network of hard and soft polymers, can be optimized for different oil viscosities and other factors. The research has led to three U.S. patents, and i-Petrogel is undergoing steps to become commercially produced. The Penn State technology has been licensed to Polymics, located in State College, Pennsylvania.

During the field tests, researchers found the new polymer absorbed more than forty times its weight in Alaska North Slope (ANS) oil, double the capacity of its predecessor, Petrogel, also developed by the same Penn State researchers. The product takes on a gel-like consistency as it absorbs oil and remains at the surface and can be readily removed using skimmers already used in cleanups.



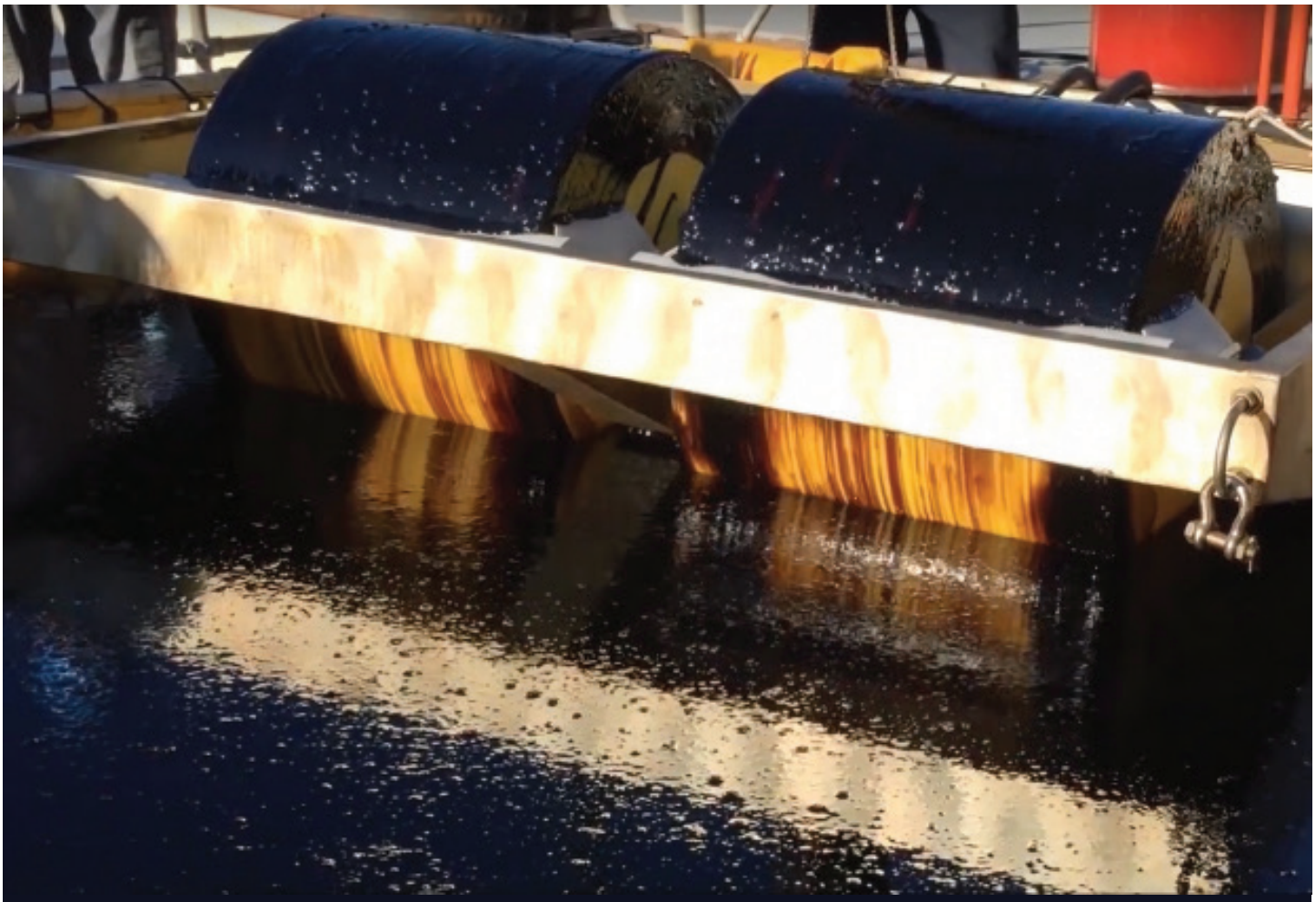
Two gallons of fresh Alaska North Slope oil released into tank (a) diffused quickly from the spill site. The same Alaska North Slope oil, treated with i-Petrogel before releasing (b), showed no significant spreading, The oil/i-Petrogel solution formed a clear boundary to water, indicating no free oil. Photos: Mike Chung

Techniques used to clean up disasters like the Deepwater Horizon incident in 2010 recovered about 10 percent of the oil spilled, and the recovered oil was unusable. That generated about 80,000 tons of solid waste from soiled booms, and additional liquid oil waste mixed with salt water as responders struggled to contain the estimated 200 million gallons of spilled oil.

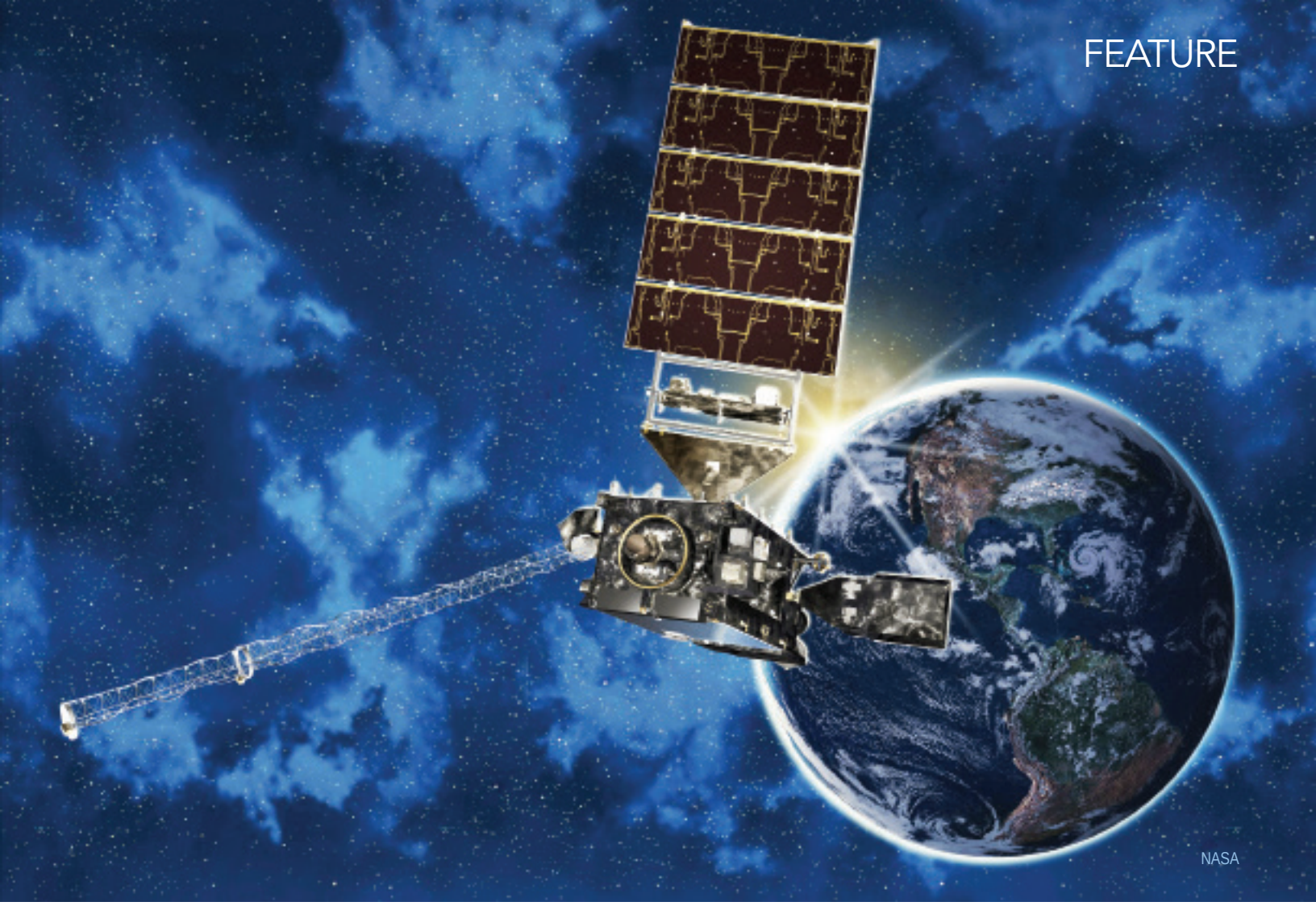
BP used dispersants and underwater oil-eating microorganisms to mitigate damage from the worst oil spill in history, yet roughly 60 percent was never accounted for. For Arctic incidents such as the Exxon-Valdez spill in 1989, Chung said fewer recovery options exist because microorganisms are ineffective in that colder climate. Because of the lack of methods for dealing with cold water spills, researchers tailored i-Petrogel for Alaskan crude oil, where 20 percent of all U.S. oil was extracted at the time of the Exxon-Valdez spill.

Chung said i-Petrogel works in any climate and pays for itself in recovered oil alone. For example, one barrel of crude oil could be recovered using less than eight pounds of i-Petrogel, which costs $2 per pound to manufacture. Using today's crude oil prices, it would cost $16 to recover about $80 worth of oil.

Chung's research team is exploring similar technologies for use in natural gas transportation and delivery. Chung hopes this new research could find solutions to replace expensive and limited compressed and liquified gas storage methods used in transportation and elsewhere. ⌘



Alaska North Slope crude oil/i-Petrogel solution is recovered by an Elastec TDS 118 oleophilic drum skimmer. The recovered oil/i-Petrogel solution contains almost no water and can be refined using regular refining processes. Overall, i-Petrogel technology potentially provides a comprehensive solution for combating crude oil spills in open waters, with dramatic reduction in environmental impacts. Photo: Courtesy Mike Chung


NASA

More data: better Forecasts

Assimilating data from next-generation satellites to improve severe weather prediction models

by Matthew Carroll

Speeding through the stratosphere, some twenty-two miles above the Earth, the United States' next generation weather satellite watched as storm clouds churned over the Midwest.

On the ground, more than 200 tornadoes from New Jersey to Texas devastated communities during a two-week period in May 2019, marking one of the largest tornadic outbreaks in recent history.

High above the storms, the Geostationary Operational Environmental Satellite-16 (GOES-16) captured dramatic, high-resolution images every thirty seconds and beamed the information back to Earth.

Data like these could someday improve our understanding of severe weather and increase warning times, but only if scientists can help forecast models ingest the massive amounts of information.

Back on Earth, researchers with Penn State's Department of Meteorology and Atmospheric Science and the Center for Advanced Data Assimilation and Predictability Techniques (ADAPT) are doing just that.

Improving warning times

About forty years ago, people in the path of potentially deadly storms like those that ripped through the United States in May could expect little warning—three minutes on average. That number is about fourteen minutes today, thanks to improvements in numerical weather prediction.

Forecasting models better simulate the physics behind prevailing westerlies, storms and fronts that make up Earth's climate, and new satellites provide better images than ever. Advanced data assimilation techniques, like those Zhang and his laboratory have developed, help combine these models and data.

"If you want to get weather right, you need to know what is going on now, and what has been occurring recently," said Richard Alley, Evan Pugh University Professor of Geosciences, who has collaborated with Zhang on previous research.

Data assimilation helps feed forecast models the most accurate picture of current conditions, important because even small changes to the atmosphere can lead to divergent forecasts after time, a phenomenon sometimes called the "butterfly effect."

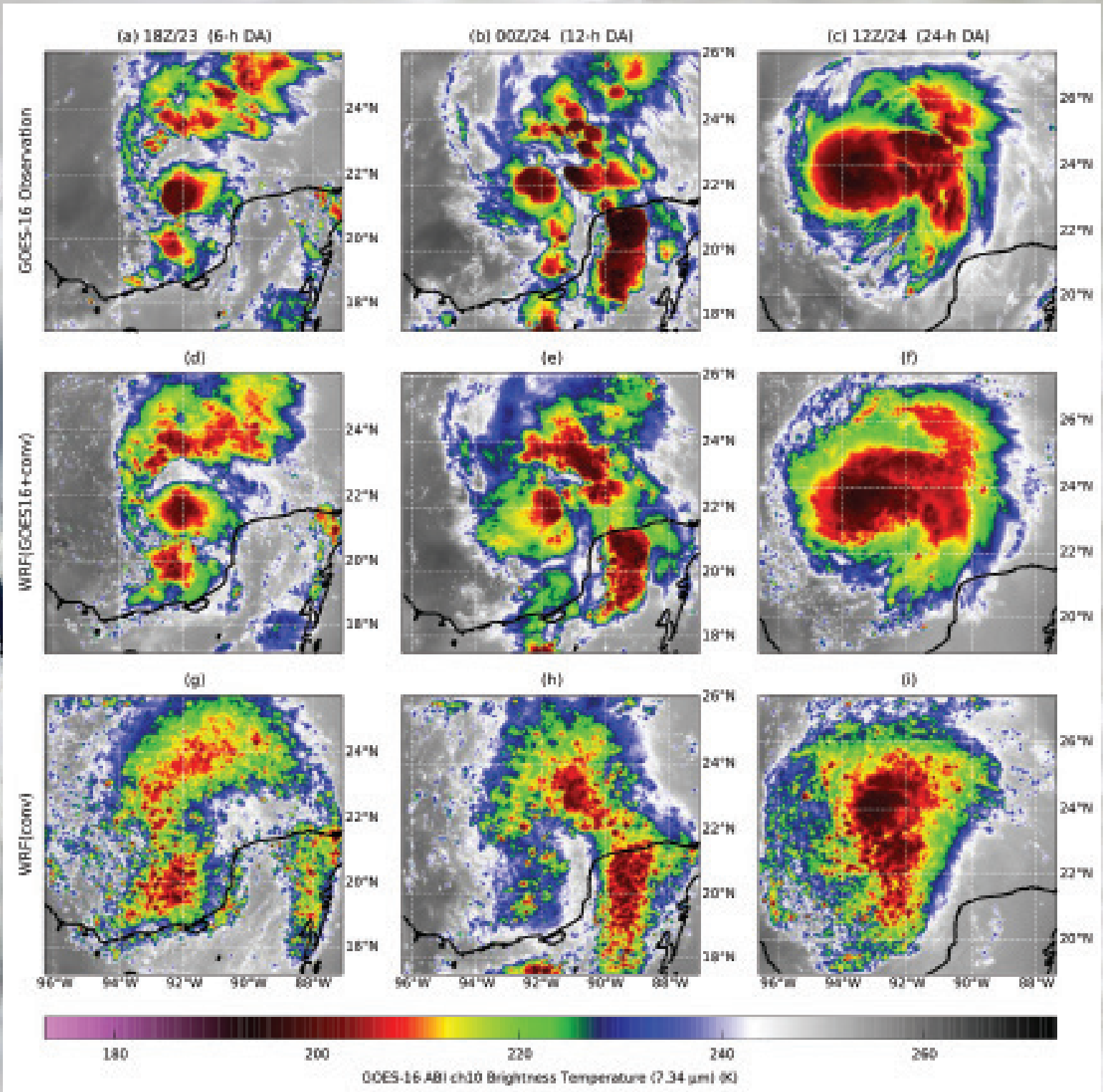
"Our team is the first in the world to directly assimilate the all-sky radiance from a geostationary satellite with cloud-resolving weather prediction models." ~*Fuqing Zhang*

Fuqing Zhang, a distinguished professor of meteorology and a world leader in the field of data assimilation, led the ADAPT team before his death in July 2019. However, Penn State researchers are continuing the important work of creating cutting-edge algorithms that can feed data from the newest satellites into forecast models that predict daily weather, warn of storms and health hazards, and inform farmers when to plant and harvest their crops.

"Data assimilation uses statistics to combine high technology observations with the existing high-resolution numerical weather prediction models," Zhang said in an interview. "We integrate the observations with the models to help them do the best job."

"This requires lots of data and it requires techniques to tell the computer models what the data say," Alley said. "Fuqing's work has been central in improving the ability to put data and models together to give better forecasts. This is not easy or obvious to do; there is a real art in the science of how to put data and models together to get more value out of both."

In October 2018, Zhang and his team became the first to use data obtained from GOES-16 in a numerical weather prediction model used to



The top row shows actual GOES-16 satellite observations in six-hour intervals. The bottom row shows a weather model developed by the National Center for Atmospheric Research and the middle row shows how that model is improved by the use of Penn State's all-sky radiance method.

provide guidance for tornadic thunderstorm forecasting. The results suggest more advanced warnings are possible.

For the tornado research, Zhang worked with David Stensrud, professor and head of the Department of Meteorology and Atmospheric Science, and Yunji Zhang, assistant research professor in meteorology. In another paper published in November, Yunji Zhang and Stensrud found combining data from GOES-16 with traditional weather radar produced even

better forecasts that maintain the early warning times and produce more accurate predictions.

"Say you have severe weather heading toward a football game or a large event," Yunji Zhang said. "If you can have a longer forecast lead time of twenty to forty minutes, you have more time to evacuate. I believe that more human lives can be saved by increasing forecast times."

All-sky data

Parked in geostationary orbit high above the Pacific Ocean, the GOES-17, the newest U.S. weather satellite, started taking breathtaking new images in Earth after going fully operational in February 2019.

The satellite, which along with the GOES-16 monitors the entire country and much of the western hemisphere, uses multiple bands of visible and infrared light to reveal factors such as fog, winds, vegetation, snow and ice, fires, water vapor, and lightning.

Traditional forecast models, however, have only been able to use clear-sky observations, which ignore images with cloudy or rainy skies due to challenges in assimilating the information.

Fuqing Zhang and members of his laboratory developed a method to incorporate all-sky radiance data into forecast models.

"All-sky means using data from both clear sky and rainy, cloudy conditions. And, by the way, that's usually where the severe weather actually occurs," Zhang said. "Our team is the first in the world to directly assimilate the all-sky radiance from a geostationary satellite with cloud-resolving weather prediction models."

The all-sky radiance technique also shows promise for forecasting longer-scale weather events, snowstorms, and hurricanes.

Using the method, Zhang and his team correctly showed Hurricane Harvey would become a Category 4 storm while existing models forecast it as a Category 1. The results are published in the July 2019 issue of the *Bulletin of the American Meteorological Society*.

"We are especially proud of how we can assimilate the inner circulation of the eye wall, much better than anything before," Zhang said. "And we think this has great potential in improving hurricane forecasts." ⌘

In Memoriam

The College of Earth and Mineral Sciences mourns the death of professor Fuqing Zhang who died on July 19, 2019, not long after being diagnosed with cancer. He was 49.

Zhang will be remembered for his energy, enthusiasm, good sense of humor and love of life. He also will be remembered for his many contributions to his field, particularly in data assimilation and prediction science; for the numerous early-career scientists he mentored; and for the myriad scientists from other disciplines whom he introduced to data assimilation.

"Fuqing's pioneering data assimilation and predictability research has vastly improved our ability to accurately predict hurricanes and other severe weather phenomena," said David Stensrud, head of the Department of Meteorology and Atmospheric Science.

Zhang earned his bachelor of science degree in 1991 and master of science degree in 1994, both in meteorology, from Nanjing University, China. He earned his doctorate in atmospheric science in 2000 from North Carolina State University. https://bit.ly/2RMsqi7 ⌘

A NEW WAY OF SEEING

Penn State: A leader in immersive learning experiences

by David Kubarek

Imagine a world where space and time do not matter, where it's possible to witness critical events in the history of the Earth and humankind or have a sneak peek into the future.

That's what Penn State researchers, through the help of immersive technologies such as virtual reality (VR) and investments in Penn State infrastructure, are hoping to accomplish through a University strategic plan seed grant.

In two pilot experiences, Penn State students are traveling to Iceland to investigate the inner workings of a volcano and jaunting to a place to study its environment more than 425 million years ago, all without setting foot outside the classroom.

These virtual field trips are changing the way students are learning in geosciences and laying the blueprint for how others can embrace these new immersive learning experiences.

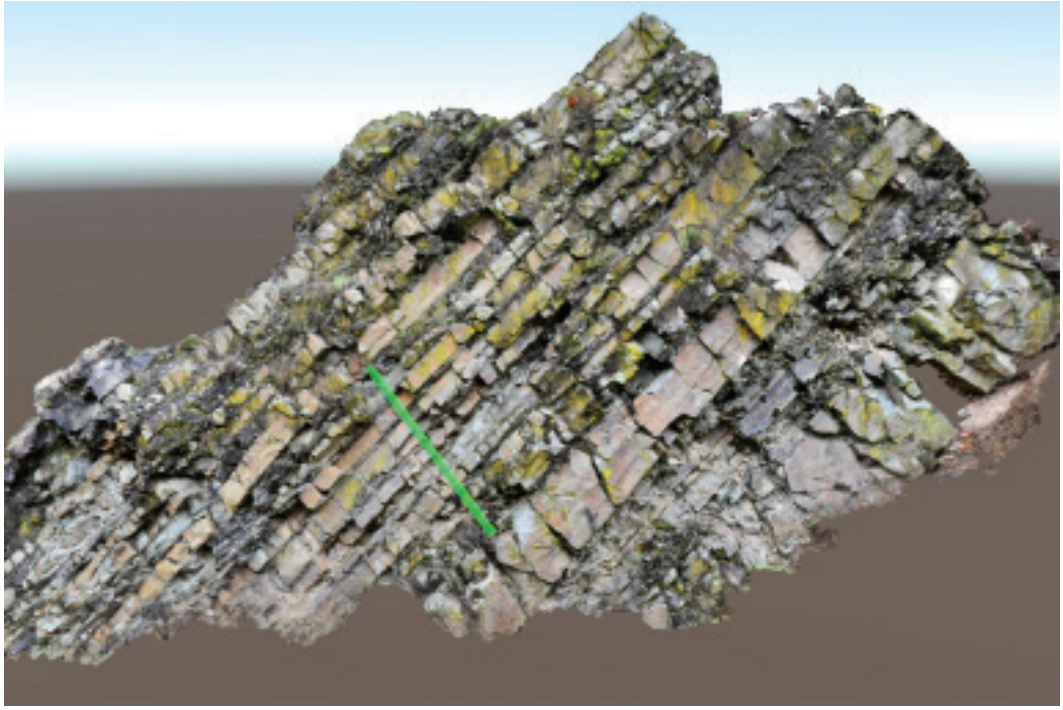
Virtual field trips can be shared across the commonwealth, they provide accessibility of critical field sites across the globe, they are immune to bad weather, will be available for online learners, are cheaper and have a very small carbon footprint. Additionally, they are safe, allow for viewing flexibility, and offer experiences not possible in the real world.

For example, students can instantly travel to both sides of the Atlantic to experience evidence of plate tectonics or look at outcrops of the Appalachians and of those formed during the same time period in western Europe, all

Above: Four students experience a virtual field trip using Oculus Go headsets.

(Left) A student uses HTC Vive to measure the thickness of rock layers. The virtual content is synchronized to a desktop screen.

(Below) A photorealistic model of partial outcrop created by structure-from-motion mapping. The measuring target is marked by a green line.



within the same lab session allowing them to witness the similarities in how each were created.

Peter La Femina, associate professor of geosciences, and Alex Klippel, professor of geography and Gosnell Senior Faculty Scholar, are using the grant to lay a foundation for creating these trips and provide empirical evaluations to understand how immersive experiences enhance education.

"Virtual field trips have the potential to increase accessibility in geoscience education by providing field opportunities to students across the commonwealth who normally would not have access to geologic field sites," La Femina said. "Additionally, these experiences can be used to augment existing field labs and provide background for a field trip or field research project before the students or researchers go in the field."

How virtual comes to life

To create virtual experiences, the researchers use a combination of 360-degree images, high-resolution photography, and photo-based measurements, or photogrammetry, to develop virtual representations of the regions. In addition, the researchers use high resolution, 3-D imaging equipment to capture the terrain and drones for photogrammetry. Information, such as natural sounds and textures, also can be gathered and included to enhance the experience. However, the fastest way for someone to create an immersive experience of a particular location is by using 360-degree images. Researchers in ChoroPhronesis, a unit in the Department of Geography, use

high-end cameras with thirty-six lenses to collect images up to 108 megapixels.

These materials are then stitched together using Unity, a game engine, while augmented features, like measuring tools in the case of the volcano experience, narrations, and supplementary information such as charts, are added to the experience. In the future, additional instruments will be added that will allow users to touch and feel the environment.

These virtual field trips are accessible using HTC Vive and Oculus Go at a growing number of locations across campus including ChoroPhronesis, the Pulse of the Earth lab, The Dreamery, and the Fletcher L. Byrom Earth and Mineral Sciences (EMS) and Pattee libraries. Penn State's investment in immersive virtual reality technology across the Penn State campuses means these resources can be shared far beyond University Park.

La Femina and Klippel, in collaboration with colleagues in Teaching and Learning with Technology (TLT), are also comparing the learning experiences for these virtual trips with data they gathered from students who took part in conventional field trips. In a series of recent experiments, researchers found knowledge gained during virtual field trips matched traditional experiences. The goal, they said, is not only to improve immersive experiences for students, but to improve our understanding of how effective immersive experiences are created.

The activities facilitated through the seed grant also helped organize an immersive community at Penn State, a group of more than 120 members and counting.

"Penn State has the potential to lead immersive learning efforts internationally" Klippel said. Researchers are spearheading an effort to build a network of people interested in immersive technologies and learning experiences. To inspire undergraduate students and spark entrepreneurial ideas early on, Klippel, in collaboration with TLT, developed a general education course that teaches students how to design these experiences.

"Penn State has the potential to lead immersive learning efforts internationally." ~*Alex Klippel*

La Femina and Klippel are continuing to test and improve these experiences while forming guidelines to roll out the tools to faculty members University-wide. That is great news for students at Penn State, where, despite the emphasis on studying abroad, only about 2 percent of students take up the opportunity.

A learning tool with reach

Jiayan Zhao, a doctoral candidate in geography, has an academic interest in creating VR technology and sees its value as a learning tool. Zhao is a member of ChoroPhronesis and helps create much of its immersive learning technology.

In addition to the virtual field trip, Zhao, in collaboration with Ping Li, professor of psychology and his doctoral student, Jennifer Legault, created a virtual zoo and a virtual kitchen to study whether immersive experiences foster second language learning such as Mandarin. In that study, the team found less successful learners benefited particularly from the immersive experiences, demonstrating the importance of adapting learning environments to learner characteristics.

Creating environments that led to more efficient learning for those struggling with concepts is something that appeals to him.

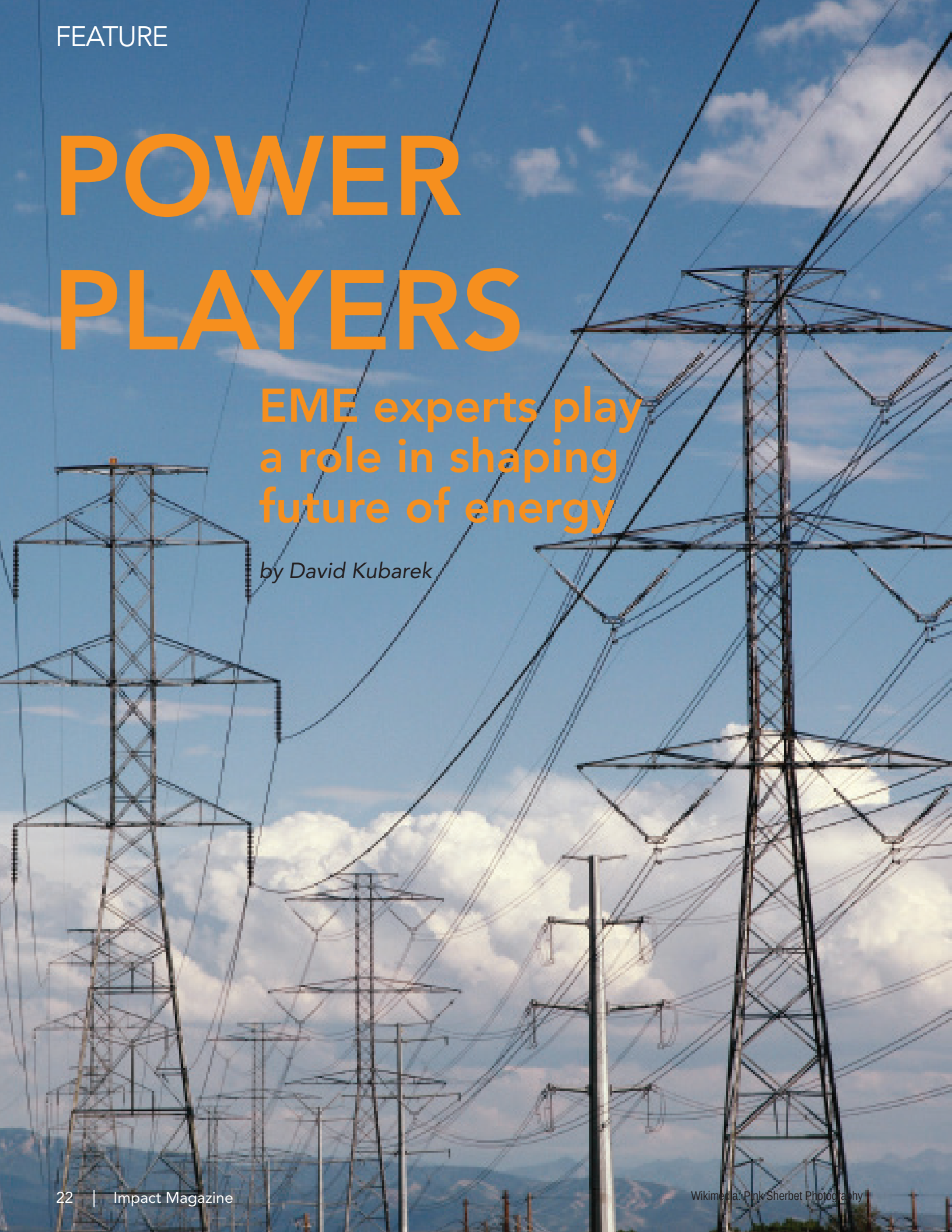
"The context that immersive learning provides can help to bridge the achievement gap between low- and high-ability learners," Zhao said.

At Penn State, immersive learning is supported through TLT and University Libraries, which means tools for designing and using this technology are accessible to all. ⌘

POWER PLAYERS

EME experts play a role in shaping future of energy

by David Kubarek



Wikimedia: Pink Sherbet Photography

Using data from thousands of existing natural gas wells, the most comprehensive well-production data to date, Eugene Morgan, associate teaching professor, plots a heat map (for more on his research, see page 26) of the most lucrative and untapped areas in the Marcellus Shale region.

Just down the hall in the Hosler Building, Jeremy Gernand, assistant professor of industrial health and safefy, is mapping potential spots for wells. His criteria: sites with the least impact on public health.

When you overlay these two maps, the result is potential sources of energy that minimize the risks. And when you pair people like Morgan and Gernand, and the dozens of other researchers with varied expertise in the John and Willie Leone Family Department of Energy and Mineral Engineering, the result is one of the most comprehensive approaches on the planet for leading the future of energy.

Diverse research interests

It's an approach, said Department Head Sanjay Srinivasan, that exists because of the department's diverse research interests and its home in a college that complements those research interests.

"There are departments that focus on renewables or petroleum and natural gas and maybe some minerals but there is no department that spans the entire range of topics from unconventional production, fossil fuels, all the way to solar and other sources," Srinivasan said. "Another unique aspect is how we include economics and finance into our research portfolio."

Experts in fossil fuels, which provided 63.6 percent of the nation's energy in 2018 according to the U.S. Energy Information Administration (EIA), the department's faculty investigate efficient extraction while minimizing impact. Researchers such as Russell Johns, the George E. Trimble Chair in Energy and Mineral Sciences, and Hamid Emami-Meybodi, assistant professor of petroleum and natural gas engineering, guide industry with measures that improve primary and secondary oil extraction. Finding more resources with fewer wells is more cost effective and helps minimize environmental impacts. Their recent research showed minor changes in secondary extraction methods could double secondary oil output.

Others, such as Shimin Liu, associate professor of energy and mineral engineering, address ways to increase the safety for coal miners. His research looks at structural mine safety and ventilation system designs. Although coal for power is playing a diminishing role, it has countless industrial applications such as steel production and carbon filtration.

EME researchers are researching ways to improve ventilation in large-opening mines with funding from the Center for Disease Control's Office of Mine Safety and Health Research. Photo: Sekhar Bhattacharyya

Sekhar Bhattacharyya, associate teachng professor, Derek Elsworth, professor of energy and geo-environmental engineering, and Liu are investigating ways to improve ventilation in underground mines with large openings. This research is important because it can improve safety and offer better design guidelines for mine ventilation systems, which are not understood in detail in the United States," said Bhattacharyya.

The newly launched Center for Critical Minerals, housed within the college, keeps to the time-tested tradition set forth by Dean Edward Steidle, who saw minerals as vital to the nation's future.

Minerals are part of virtually every product manufactured in the modern global economy. New technologies from touch-screen displays to batteries to solar panels and in the medical, energy, and defense industries are increasingly reliant on specific critical minerals not widely used a few decades ago.

Many of these critical minerals are imported. They are classified as critical because they have high economic importance, high supply risk, and their absence would have significant consequences on the nation's security and economy.

At the Center for Geomechanics, Geofluids, and Geohazards, led by faculty in EME and the Department of Geosciences, experts apply knowledge of rock and fluid mechanics to solving real-world problems. The research focuses on three areas: understanding and warning of natural disasters, fuel recovery, and providing safe and sustainable storage of industrial products and waste.

Researchers are also looking at ways of turning carbon-based waste products into materials.

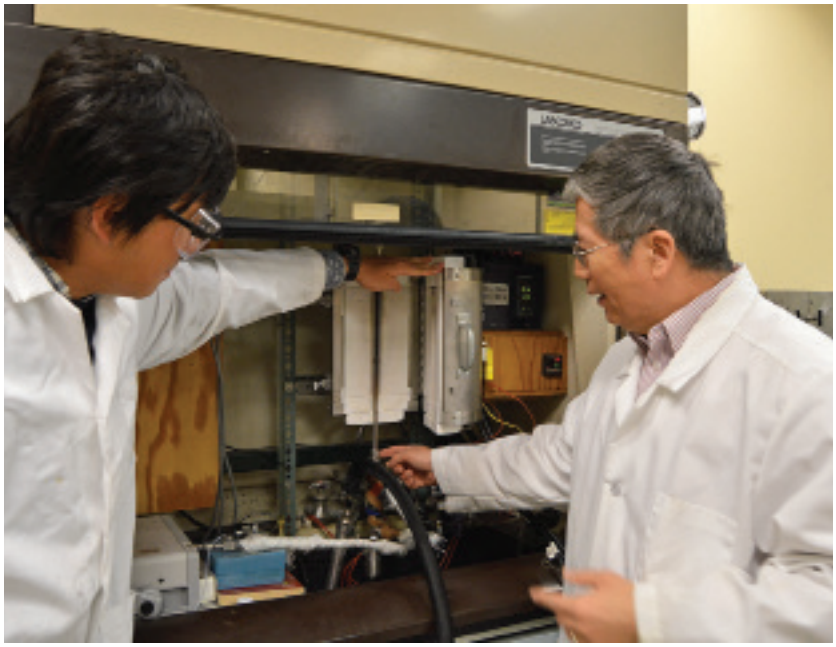
At the EMS Energy Institute, led by Chunshan Song, distinguished professor of fuel science, researchers are exploring efficient ways of converting carbon dioxide and other greenhouse gases into fuels, solvents, useful materials, industrial chemicals, and other products.

"Our current energy system largely relies on carbon-based fossil energies," Song said. "But in the future, if we begin using carbon from carbon dioxide, we can recycle it, create a sustainable carbon-based energy cycle, and then we stabilize the carbon dioxide concentration in the atmosphere."

Positioned for the future

Renewables, the nation's fastest growing energy source, are expected to increase by 2.6 percent a year through 2040, according to EIA.

Jobs have followed. Solar photovoltaic installers top the U.S. Bureau of Labor Statistics' list of fastest growing occupations, and are forecast to more than double between 2016-26. Second is wind turbine service technicians, slightly behind with 96 percent forecasted growth within the same period. The next occupation on the



Chunshan Song and a postdoctoral scholar use a flow reactor to investigate the properties of chemicals created through carbon dioxide conversion.

Penn State recently built a two megawatt advanced utility-scale solar photovoltaic system along Orchard Road. The solar project will be used as a "living lab," making it possible for students, faculty, and community members to conduct research and learn about the solar industry firsthand, furthering Penn State's land-grant mission to serve the broader community.

list, home health aides, is expected to grow at half that rate.

Experts such as Jeffrey Brownson, associate professor of energy and mineral engineering, and colleagues lead the charge in giving undergraduates an edge in these growing energy systems. They represent the Renewable Energy Technologies and Power Systems group, about a dozen Penn State experts tasked with researching interdisciplinary approaches to renewable energy that incorporates economics, engineering, and operations to address the challenges of creating the power system of the future.

Market forces

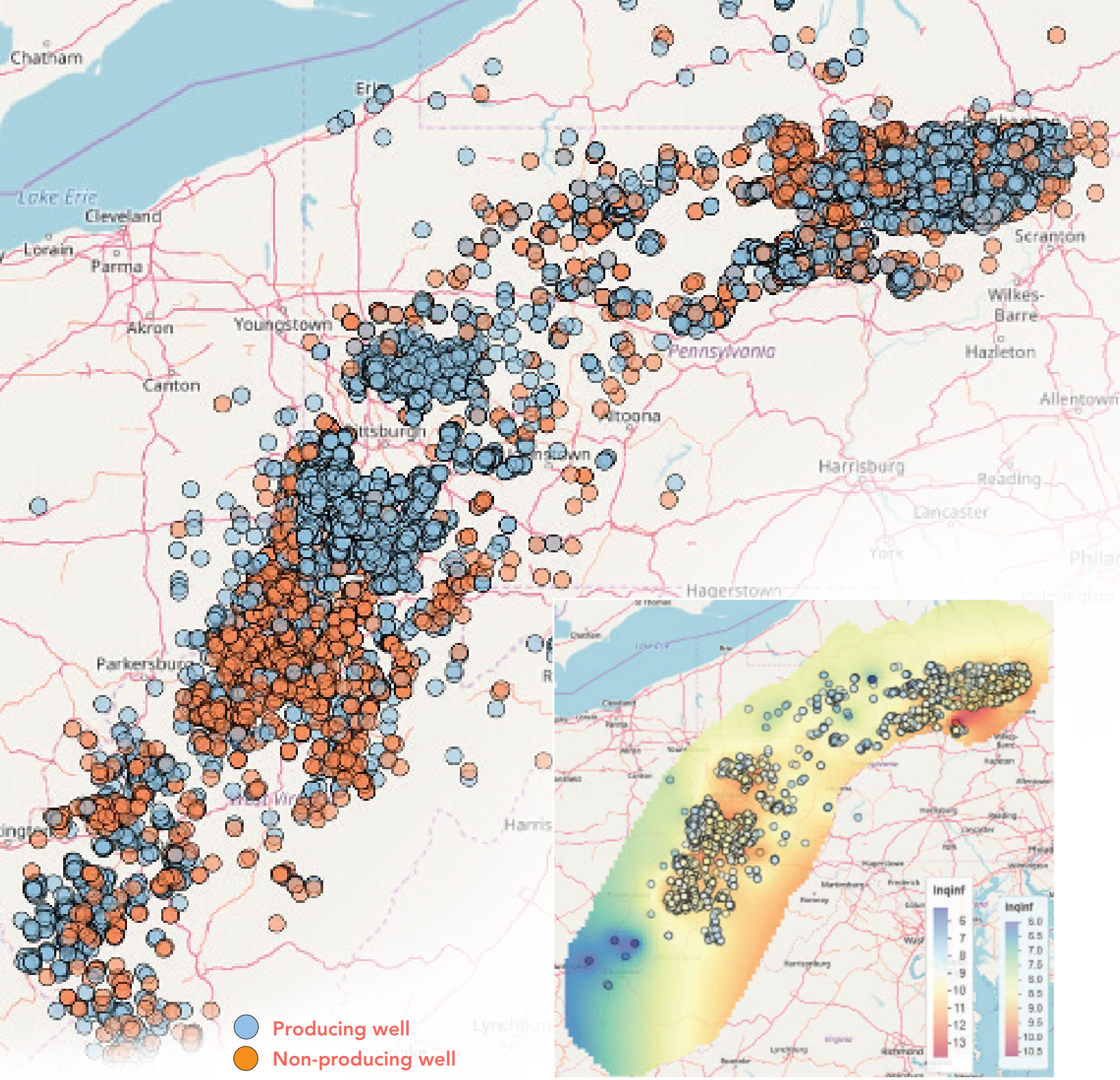
As the grid goes green, energy market experts such as Seth Blumsack, professor of energy policy and economics, are making sure power supplies don't go dark. He looks at how factors such as energy policy, solar and wind-farm locations, and shifting energy needs affect the overall stability of the grid.

If energy needs fall short, carbon-based power plants are forced to react on the fly. That drives up the costs of energy. Overgeneration also leads to waste and higher costs. Sometimes, errors can lead to brownouts or blackouts, which is not ideal for a nation dependent on a reliable power supply.

Blumsack works with others in the department and the University, including Chiara Lo Prete, assistant professor of energy economics and an expert in energy markets and manipulation, to better understand how policies have a broad impact on energy costs and carbon emissions.

Forecasting wind and solar output can be trying. But having experts in meteorology and atmospheric science and geography, two other departments in the college, leads to collaborations in the same way that geosciences has aided fossil fuels experts.

"This is a unique thing about EMS," Srinivasan said. "We have experts in geosciences, geography, GIS, meteorology, and materials science. Energy production borrows heavily from the technology that's housed here. That's all possible because of where we are in this college." ⌘



New method approximates available gas in untapped areas of the Marcellus Shale region using well production data

Production data holds clues to potential of new wells

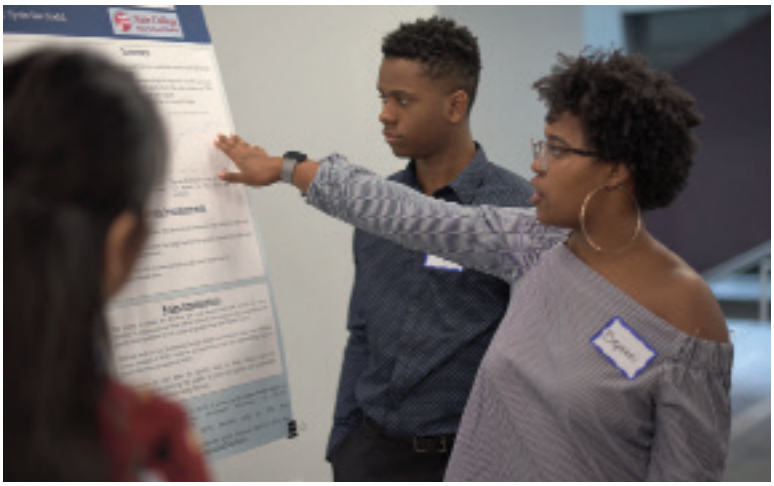
Penn State researchers wanted to know if the production data for existing wells within the Marcellus Shale could predict the output potential of new natural gas wells, without relying on costly core samples from the area.

So they collected data from more than 5,600 existing wells to create a heat map for the region, using only wells with more than two years of production logs, and assigned a decline curve analysis—the amount of production loss over time—for each well. They then applied these decline curves over the entire region of the Marcellus Shale.

The result shows potential high yield areas, noted in blue on the inset on right, can be found more easily and with lower costs. https://bit.ly/36EljOR

ENGAGED STUDENTS

Penn State EnvironMentors team wins first place in national competition



Bryttani Wooten, an undergraduate student at Penn State, serves as a mentor to high school students through the EnvironMentors program. Wooten and her mentees won first prize in June at the EnvironMentors National Science Fair held in Washington, D.C.

A team of Penn State faculty, students, and local high schoolers took first place at the 2019 EnvironMentors National Science Fair. EnvironMentors is a national program sponsored by the National Council for Science and the Environment that pairs university faculty and undergraduate students with underrepresented high schoolers who want to gain research experience before college. Bryttani Wooten, an undergraduate studying meteorology and atmospheric science, and her mentees from the State College Area High School, won the poster competition for their work on a project to monitor air quality in West Africa. Wooten and her mentees were one of three teams selected to represent Penn State at the national science fair. Gregory Jenkins, professor of meteorology, serves as the group's faculty adviser. He initiated the Penn State chapter, which is supported by Penn State's Institutes of Energy and the Environment. https://bit.ly/2sVK76j

The Ryan Family Student Center serves as an advising one-stop shop for undergraduate students in the College of Earth and Mineral Sciences.

EMS Connect builds bridges for students

The College of Earth and Mineral Sciences (EMS) aims to make the transition for students new to University Park smoother through EMS Connect. The student-run organization provides support for undergraduates transitioning from Commonwealth Campuses, switching majors within Penn State or transferring from other universities. EMS Connect, a partnership between the college's Ryan Family Student Center and the undergraduate Student Council, is led by a student committee working closely with college advising and recruiting staff and the GEMS board (Graduates of Earth and Mineral Sciences). "We are always looking for ways to provide information and foster inclusion to students who are new to the college," said Stacy Davidson, an academic adviser who works with EMS Connect on recruitment and retention activities. "The college and our students really felt that there was a gap for these students and wanted to give a more formal and consistent way to connect with them." https://bit.ly/2SWt26H

New club, Women in Materials Science, strengthens ties among women in STEM

Ana Isabel de la Fuente Duran leads a Women in Materials Science club meeting.

Ana Isabel de la Fuente Duran, a senior studying materials science and engineering, founded Women in Materials Science (WiMS) to empower and support women in STEM fields. The club, intended as a space for women to interact across professions, and encourage interactions between students and professionals, has been a success in its first year. For de la Fuente Duran, creating the club was about enacting change for individuals as well as the University. Emphasizing representation, she intends for the club to encourage student involvement and retention in turn. "Representation is one of the most important ways to encourage others to try things they might not otherwise," de la Fuente Duran said. The club is open to a variety of majors as well as faculty and staff across departments. Men are also encouraged to join. https://bit.ly/2SWt6mX

NOAA Hollings Scholars: (first row, left to right) Bryttani Wooten and Kallan Parker; (back row, left to right) Jacob Morse, Andrew Mardirossian, and Grant LaChat.

Five named NOAA Hollings Undergraduate Scholars

Meteorology and atmospheric science juniors Grant LaChat, Andrew Mardirossian, Jacob Morse, Kallan Parker, and Bryttani Wooten received 2019 Ernest F. Hollings Undergraduate Scholarships from the National Atmospheric and Oceanic Association. The Hollings Scholarship recognizes outstanding students studying in NOAA mission fields and includes a two-year academic award of $9,500 per year and a 10-week, full-time, paid summer internship opportunity at any NOAA facility nationwide. The internship is conducted between the first and second years of the award. The Penn State students will conduct their internships during the summer of 2020. https://bit.ly/2MZ1ZUy

Seven students garner NSF Graduate Research Fellowships

Seven EMS graduate students out of a total of twenty-four Penn State students were awarded fellowships from the National Science Foundation Graduate Research Fellowship Program. The program "recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based master's and doctoral degrees at accredited institutions in the United States." For the 2019 competition, NSF received more than 12,000 applications and made approximately 2,000 award offers.

Recipients were aided by the NSF Graduate Research Fellows Incentives Program, funded by EMS and the Graduate School.

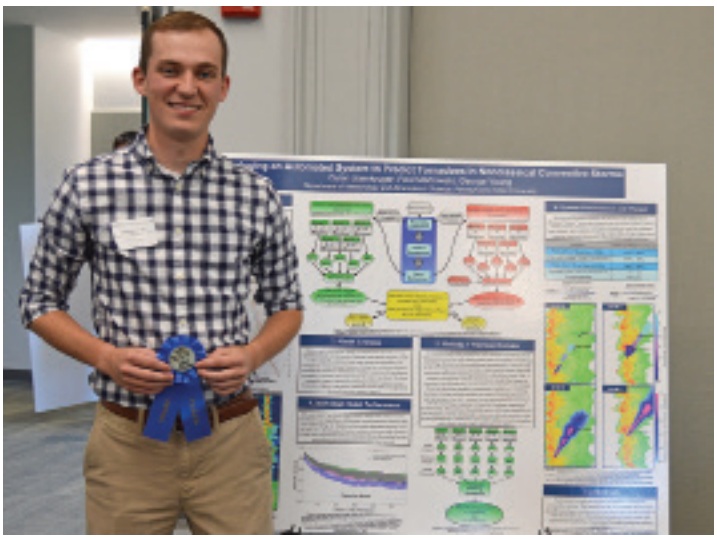
The seven graduate students are Timothy Bowen, Katy Gerace, Sarah Lowum, and Riccardo Torsi, materials science and engineering; Shawn Murdzek and Ara'L Yarber, meteorology and atmospheric

science; and Andrew Shaughnessy, geosciences.

The following students received an honorable mention: Catalina Mejia and Adriana Rizzo, geosciences. In addition, the following EMS alumni—now at other institutions—received NSF offers and honorable mentions: Audrey Dunham, geosciences; Kaitlyn Peterson, geography; Kathryn Sautter, Michael Spencer, and Everett Zofchak, materials science and engineering. https://bit.ly/35xJYmA

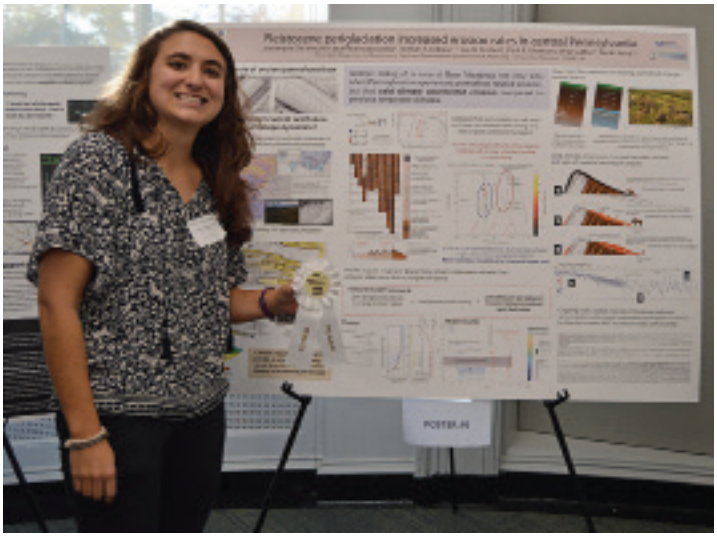
Graduate poster competition and recognition event

The college hosted a fall graduate poster competition and recognition event to showcase and reward the exemplary research happening within the college's graduate community. The poster session was organized by the college's Graduate Student Council in partnership with the EMS Office of Graduate Education and Research (ADGER). Each of the college's five departments selected the best three posters from their graduate students for submission in the college-level competition. https://bit.ly/2QTuN1U



Dylan Steinkruger, graduate student in meteorology and atmospheric science, won first place for his poster "Developing an Automated System to Predict Tornadoes in Nonclassical Convective Storms."

Emily Domanico, graduate student in geography, won first runner up for her poster "Monitoring Urban Rail Networks: A Study of Map Use in Transit Control Centers."



Joanmarie Del Vecchio, graduate student in geosciences, won second runner up for her poster "Pleistocene Periglaciation Increased Erosion Rates in Central Pennsylvania."

Graduate Council members also were recognized: (left to right) Hartzel Gillespie, Jaime Harter (ADGER staff), Daulet Magzymov, John Hellmann (ADGER associate dean), Karan Doss, Mark Simpson, and Kristina Rolph.

AROUND THE COLLEGE

Keller wins Breakthrough of the Year award

Klaus Keller, professor of geosciences, was awarded the Paul F. Robertson Award for Research Breakthrough of the Year for his research on climate risk management and decision support solutions. Keller's research group seeks to bring together scientific research and communities to develop effective and affordable solutions to adapt to climate change.

(Left to right) Paul Roberton '71, Klaus Keller, and Lee Kump at the college's annual Wilson Awards Banquet.

Weather World broadcast now available for livestreaming

Weather World, the Department of Meteorology and Atmospheric Science's weekday fifteen-minute weather broadcast, is now available for livestreaming. The show airs Monday through Friday at 5:30 and 5:45 p.m. on WPSU and at 5:45 p.m. on the Pennsylvania Cable Network (PCN). Each new episode can be streamed for 24 hours after airing. https://bit.ly/2R3blQk

Warren M. Washington Building

Penn State officially changed the name of Building 328 at Innovation Park to the Warren M. Washington Building. Washington, an acclaimed climate science pioneer, made history at Penn State in 1964 by becoming the second African-American to earn a doctorate in meteorology nationwide. It's only fitting that his name adorn a building at Penn State's Innovation Park, the first to be named for a University innovator and pioneer. https://bit.ly/2NaSIc9

Warren and Mary Washington in front of the newly named Warren M. Washington Building.

Sanjay Srinivasan, conference chair, addressing conference attendees.

Mathematical geosciences conference focuses on food, energy, water nexus

More than 175 researchers, students, and industry professionals from companies and universities from more than thirty countries gathered on Penn State's University Park campus for the Twentieth Annual Conference of the International Association for Mathematical Geosciences. Held annually, this was only the second time the international conference had been hosted in the United States. The conference focused on geomodeling issues at the intersection of food, water and energy.

"It was indeed a privilege to have such an august assembly of scholars from all parts of the world and hear them engage in topics of profound importance," said Sanjay Srinivasan, conference chair and head of the John and Willie Leone Family Department of Energy and Mineral Engineering. https://bit.ly/2N2Kin5

Online Geospatial Education celebrates twenty years

Here is something to think about—some of Penn State's current students weren't even born when Online Geospatial Education at Penn State offered its first class. While online classes are now considered normal, for the educators who launched these distance education courses in the late 1990s, it was a novel and risky venture. Online Geospatial Education at Penn State is celebrating twenty years of offering online classes in geographic information sciences (GIS), remote sensing, and geospatial intelligence.

"The professional landscape has changed a great deal since our programs began twenty years ago, and we've never stopped working to anticipate that change by offering new courses, launching new credentials, and continually improving the instructional design of our classes," said Anthony Robinson, director of Online Geospatial Education programs. https://bit.ly/2QAWde9

Fall 2019 MGIS graduates

Museum director takes over with eye on expansion

Jane Cook, who took over for Russ Graham as the new director of the Earth and Mineral Sciences Museum & Art Gallery, plans to build on the museum's legacy by introducing exhibits that align with the expanded research goals of the college. Previously, Cook was chief scientist at the Corning Museum of Glass.

Her goal is to focus on storytelling and expanding the museum to tell stories related to the future of the college. And to do that in a way that inspires others.

"I want the museum to be seen around the world as an exemplar of what a small university museum can be," Cook said. "I want it to be valued and used as a resource for education, for entertainment, and for community-building. I want it to be a go-to, a principled and valued part of Penn State and a place that people continue to remember." https://bit.ly/37LYCIA

Mann awarded the 2019 Tyler Prize for Environmental Achievement

Michael Mann, distinguished professor of atmospheric science, was awarded the 2019 Tyler Prize for Environmental Achievement. Founded in 1973, the Tyler Prize—often referred to as the "Nobel Prize for the Environment"—remains the premiere international award for environmental science.

Mann shared the honor with fellow climate scientist Warren Washington, Penn State alumnus and retired distinguished scholar at the National Center for Atmospheric Research.

"One of the things that makes this award special for me is sharing it with a personal hero of mine, Warren Washington, an illustrious graduate of our program here at Penn State who has contributed fundamentally to the field of climate modeling," Mann said.

Mann was honored with this award not only for his research in reconstructing the Earth's past climate and placing modern climate change in a long-term context, but also for his communication and outreach efforts. https://bit.ly/36FSJMQ

Michael Mann and Warren Washington at the Tyler Prize ceremony at the Ritz Carlton Hotel in San Francisco.

"We love the smell of coffee in the afternoon"

50+ years of Coffee Hour in the Department of Geography

by Angela Rogers

Fall 2018 was the fiftieth anniversary of the Department of Geography Coffee Hour, weekly socializing and a lecture on Friday afternoons. Although the methods have modernized, Coffee Hour remains true to its purpose, which Peirce Lewis and Wilbur Zelinksy described in a 1987 article in the *Professional Geographer* as "creating and preserving a sense of intellectual and social community within the department."

Professors Emeritus of Geography, Ronald Abler and John Adams, established Coffee Hour at Penn State in the fall of 1968, based on their previous experiences at University of Minnesota.

"We were both imbued with the coffee hour experience and thought it would be good for the department," Abler said. "It was clear to us that coffee hours were a major factor in the centrality and prestige of the University of Minnesota geography program, and we thought that the department here would benefit as well."

Adams explained why it worked, "The fact that we regularly invited colleagues from across the campus to tell us what they were researching and writing about flattered them and enhanced our reputation as a vigorously inquiring department."

Variety is of central importance in the weekly offerings. "Even then, much less than now, it was easy for faculty members to become stove-piped in their own disciplines and sub-specialties," Abler said. "And it was fun to learn something new every week and at the end of the week."

What's new with Coffee Hour? The lecture takes place in room 112 Walker Building, a 134-seat auditorium. Once a semester, students are the speakers—often their first opportunity to give a research talk. The lecture is webcast, so it can be accessed by online students and alumni.

"The 'Coffee Hour To Go' endowment supports the webcast and also allows us to invite international scholars," said Cynthia Brewer, head of the department.

What's the same? As reported in the Lewis and Zelinsky article, a lot it seems.

"Thus, in the Geography Department at Penn State, 3:30 p.m. on Friday afternoon means the smell of coffee, a hum of anticipation and knowledge that the seminar room is open for snacking and general conversation before the speaker is introduced at 4:00 p.m."

Lewis, Peirce and Wilbur Zelinsky. 1987. "The Coffee Hour at Penn State." *Professional Geographer* 39, no.1: 75-79. https://doi.org/10.1111/j.0033-0124.1987.00075.x

FACULTY NOTES

Evans named AAAS Fellow

Jenni Evans, professor of meteorology and atmospheric science and director of Penn State's Institute for Computational and Data Sciences, who studies weather and climate in the tropics, was named a Fellow of the American Association for the Advancement of Science (AAAS) for novel contributions to quantitative understanding of the life cycle of tropical cyclones and associated weather extremes, and for outstanding leadership in the atmospheric sciences.

Forest named Project Drawdown Senior Fellow

Chris Forest, professor of climate dynamics, was named a Senior Fellow for Project Drawdown. Senior Fellows are "systems thinkers, experts in their field and Drawdown Ambassadors to the world." He is the first Penn Stater to receive the honor. Project Drawdown is a nonprofit organization that works to identify the top 100 solutions to achieve drawdown of atmospheric carbon dioxide and communicates those findings to the world.

Furman named Global Faculty Fellow

Tanya Furman, professor of geosciences, was named a Global Faculty Fellow. The Global Faculty Fellowship program is intended to advance Penn State's global engagement goals. Furman will create assessment tools and implement an assessment protocol, looking at the level of globalization in both the types of courses and programs offered as well as the content within the curriculum of the college.

Kimel wins Undergraduate Program Leadership Award

R. Allen Kimel, associate teaching professor of materials science and engineering and associate head for undergraduate studies, received Penn State's 2019 Undergraduate Program Leadership Award. The award recognizes individuals who have major responsibilities for the delivery of undergraduate education within a unit and who are providing leadership that has transformed or revitalized the undergraduate program in some way.

King named to the Faculty Academy

Beth King, associate teaching professor in the Department of Geography, was named to the Faculty Academy program through the Student Engagement Network. King intends to create a study abroad experience that builds on the Center for Advancement of Undergraduate Studies and Experience (CAUSE) program. Undergraduate students and online adult graduate students will collaborate to design solutions for the European refugee crisis.

Kleit receives USAEE Senior Fellow Award

Andrew Kleit, professor of energy and environmental economics, received a U.S. Association for Energy Economics (USAEE) Senior Fellow Award. The recognition honors individuals who have exemplified distinguished service in the field of energy economics. Kleit was the founding program chair of the Energy Business and Finance (EBF) program, created in 2004.

FACULTY NOTES

MacEachren recipient of Graduate Faculty Teaching Award

Alan MacEachren, professor of geography, received Penn State's 2019 Graduate Faculty Teaching Award. The award, established in 1992 by Penn State's Graduate School, is presented to faculty members in recognition of outstanding teaching performance and advising of graduate students.

Mann awarded Praxis Award in Professional Ethics

Michael Mann, distinguished professor of atmospheric science and director of Penn State's Earth System Science Center, received the 2019 Praxis Award in Professional Ethics. The award recognizes a professional or academic who shows the highest ethical ideals of their profession or who has contributed to professional ethics scholarship. Mann received the award for his significant contributions to climate science and communication and advocacy efforts.

Markowski elected AMS Fellow

Paul Markowski, professor and associate head for the graduate program in the Department of Meteorology and Atmospheric Science, was elected as a Fellow of the American Meteorological Society. Less than half a percent of the membership receives this distinction, a recognition of outstanding contributions in the field of atmospheric and related sciences.

Mohney earns Graduate Program Chair Leadership Award

Suzanne Mohney, professor of materials science and engineering, received the Penn State Graduate School Alumni Society Graduate Program Chair Leadership Award. As chair of the Intercollege Graduate Degree Program in Materials Science and Engineering, Mohney grew the graduate program, increased the quality and diversity of students, engaged faculty advisers, and expanded professional development opportunities available to students.

Marone awarded Louis Néel Medal

Chris Marone, professor of geosciences, received the European Geosciences Union's 2019 Louis Néel Medal. The medal is awarded to individuals in recognition of outstanding achievements in rock magnetism, rock physics, and geomaterials. Marone was selected for his "seminal contributions to the understanding of fault mechanics and earthquake generating processes, and for innovation in experimental techniques and apparatus development."

Patzkowsky elected GSA Fellow

Mark Patzkowsky, professor of geosciences, was elected a 2019 fellow of the Geological Society of America. Patzkowsky was selected for "advancing the field of paleobiology by establishing ground rules for rigorous interpretation of the field and database paleontological record and applying them to further our understanding of extinction, radiation, function and habitability of the whole ecosystem in deep time."

FACULTY NOTES

Redwing awarded Faculty Scholar Medal

Joan Redwing, professor of materials science and engineering, received a Faculty Scholar Medal. The award for excellence in scholarship, research, and the arts honors those who have excelled in creative work and expresses the University's gratitude and appreciation for their achievements.

Sinnott named Big Ten Academic Alliance DEO Fellow

Susan Sinnott, head of the Department of Materials Science and Engineering, was appointed a Department Executive Officer (DEO) Fellow. Through the Big Ten Academic Alliance's DEO leadership program, participants who have demonstrated exceptional ability through university administrative assignments or other significant positions, are aided in further developing their leadership and managerial skills.

Smithwick appointed associate director of IEE

Erica Smithwick, the E. Willard and Ruby S. Miller Professor of Geography, has been named an associate director of Penn State's Institutes of Energy and the Environment, one of seven interdisciplinary research institutes at Penn State with more than 500 faculty, staff, and students advancing the energy and environmental research missions of the University.

Song receives ACS George A. Olah Award

Chunshan Song, distinguished professor of fuel science and director of the EMS Energy Institute, received the 2019 George A. Olah Award in Hydrocarbon or Petroleum Chemistry from the American Chemical Society. Song received the award for "groundbreaking contributions to adsorptive desulfurization of hydrocarbon fuels, adsorptive carbon dioxide separation, and catalytic carbon dioxide conversion to fuels and chemicals."

Stensrud receives top honor from AMS

David Stensrud, head of the Department of Meteorology and Atmospheric Science, was awarded the Charles Franklin Brooks Award for Outstanding Service to the Society from the American Meteorological Society. Stensrud received the award for "exceptional contributions to the society through service as editor and co-chief editor of *Weather and Forecasting*, chair of the Mesoscale Processes committee, and commissioner for the Scientific and Technological Activity Commission."

Trolier-McKinstry elected member of NAE

Susan Trolier-McKinstry, the Steward S. Flaschen Professor of Ceramic Science and Engineering, was elected a member of the National Academy of Engineering. The NAE recognized Trolier-McKinstry for "development of thin film multilayer ceramic capacitors and piezoelectric microelectromechanical systems."Election to the National Academy of Engineering is among the highest professional distinctions given to an engineer.

ALUMNI ACCOLADES

Delbert Day honored with Distinguished Alumni Award

Delbert Day '60g '61g received a 2019 Distinguished Alumni Award—the University's highest honor presented to its alumni—from the Penn State Board of Trustees. Day, a Curators' Distinguished Professor Emeritus of Ceramic Engineering at Missouri University of Science and Technology (S&T), earned his master's and doctoral degrees in ceramic technology from Penn State. He is a prolific inventor whose work with specialty glasses has led to treatments for cancer, bone tissue regeneration, and wound care. https://bit.ly/2tCTPur

Daniel Lentz earns Alumni Achievement Award

Daniel Lentz '10g is one of fifteen recipients of the 2019 Penn State Alumni Association Alumni Achievement Award, which recognizes alumni thirty-five years of age and younger for their extraordinary professional accomplishments. Lentz, a product development specialist at 3M, earned his doctoral degree in materials science and engineering from Penn State, concentrating on polymer science. He has built a highly accomplished career at 3M through the integration of materials and process expertise. His talents have resulted in technology improvements in a variety of areas, including optical films, roll-to-roll processing, and abrasives. Lentz is a committed supporter of Penn State at all levels—student recruiting, research, and faculty development. He champions collaborative engagements and recruiting for 3M as the head of their Penn State University Relations Team. https://bit.ly/35xynUD

Stan Benjamin awarded Hosler Alumni Scholar Medal

Stan Benjamin '80g '83g received the 2019 Charles L. Hosler Alumni Scholar Medal from the College of Earth and Mineral Sciences. The award, named for Charles L. Hosler, dean emeritus of the college and Penn State Distinguished Alumnus, honors alumni who have made outstanding contributions to the development of science through research, teaching, or administrative leadership. Benjamin, a senior scientist at NOAA, received his master's and doctoral degrees in meteorology from Penn State. Benjamin revolutionized the numerical prediction of high-impact weather during his NOAA career, greatly improving forecast guidance of threatening weather. https://bit.ly/37MJTNx

Stan Benjamin (left) receives the Hosler Alumni Scholar Medal from Lee Kump, the John Leone Dean in the College of Earth and Mineral Sciences.

Penn State alumnus and longtime supporter, John Leone is congratulated by President Eric Barron at a ceremony honoring him as Penn State's 2015 Philanthropist of the Year.

John Leone $5 million gift endows Dean's Chair

Penn State alumnus and leading philanthropist John Leone '56 has made a gift of $5 million to endow the John Leone Dean's Chair in the College of Earth and Mineral Sciences. Leone is president and chief executive officer of Bonney Forge, an industry leader in manufacturing flow control products and specially engineered products for the energy industries. The endowed chair will provide the dean with discretionary funds to enhance student engagement opportunities outside the classroom; promote innovation and entrepreneurship; address the underrepresentation of women and minorities in the college's STEM disciplines; and sustain and grow leadership in energy, materials and environmental education, research, and outreach; among other priorities. Leone has made gifts to the University for nearly four decades. In 2010, he and his late first wife, Willie, supported the Department of Energy and Mineral Engineering—now named for the couple—with the largest individual gift to the college, to create such opportunities as a faculty chair, undergraduate scholarships, and graduate fellowships. He has received numerous awards and honors from the University, including the Philanthropist of the Year Award and Distinguished Alumni Award. He also made a $1.5 million gift to support renovations to the Lasch Football Building. https://bit.ly/2QXr9Er

Kat Campayo: GEMS Diamond Award recipient

Katherine Campayo, a 2019 graduate in Energy Business and Finance, was the recipient of the 2019 GEMS Diamond Award.

Established in 2006, the award honors and recognizes a graduating student who shows excellence and balance in academic achievement and volunteer involvement in both University and community activities. The award includes a lifetime membership in the Penn State Alumni Association.

Erik Pytlak '91, president of the GEMS Board, presenting the Diamond Award to Katherine Campayo at the spring 2019 graduation ceremony.

Photo (left to right): Tim Charatan, Mackenzie Williams, Alex Tomoff, Zakariya Khayat, Sam Baker, Tramond Baisden, and Lee Kump.

GEMS Showcase Early Career Panel

The 2019 Graduates of Earth and Mineral Sciences (GEMS) Showcase featured an early career panel with recent alumni who shared academic and professional experiences and insights. Lee Kump, the John Leone Dean in the College of Earth and Mineral Sciences, gave the welcome address and Tim Charatan, a senior in materials science and engineering and EMS Student Council president, introduced the speakers and served as the moderator. Panelists included: Tramond Baisden '13 '15g GEOSC, production geologist, Shell Oil Company, New Orleans, Louisiana; Sam Baker '17 MNGE, mining engineer, Rosebud Mining Company, Kittanning, Pennsylvania; Zakariya Khayat '15 '17g MATSE, metallurgical engineer, Corning Inc., Corning, New York; Alex Tomoff '18 METEO, graduate student in atmospheric science, State University of New York at Albany; and Mackenzie Williams '19 METEO, rotational analyst, Direct Energy, Iselin, New Jersey. https://bit.ly/2Fz90Y1

Thank you!

To all of the College of Earth and Mineral Sciences' supporters and friends—thank you! Philanthropy helps provide the college with the resources needed to train our students to become the next generation of leaders, conduct innovative research, hire world-class faculty, and reimagine our laboratories and classrooms.

We need your help to ensure the college's success. Making an investment in the College of Earth and Mineral Sciences, whether through scholarships that help provide access to a college education, or through support for engaged scholarship programs that prepare students for life after college, or through support for faculty that allow our college to attract and retain the brightest and best, your support is vital.

Learn how you can give to the College of Earth and Mineral Sciences by visiting the following webpage: www.ems.psu.edu/giving/give-college/give-now.

If you have any questions, please contact the college directly at development@ems.psu.edu or call 814-863-2289 to explore providing philanthropic support.

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