CornellEngineering
College of Agriculture and Life Sciences
Earth and Atmospheric Sciences

EAS

NATALIE MAHOWALD, CORNELL'S IRVING PORTER CHURCH PROFESSOR OF ENGINEERING AND LEAD AUTHOR OF 2018 U.N. CLIMATE CHANGE REPORT

PG. 3

CHAIR'S MESSAGE

DEAR ALUMNI AND FRIENDS,

DAVID HYSELL

I am writing to you at the start of my second term as chair of the Department of Earth and Atmospheric Sciences. There have been quite a few changes in the past year that I would like to summarize here. Many of the changes are related to faculty renewal which is occurring at a rapid pace. We have also seen progress on other fronts, most notable in our professional degree programs, our project teams, which are still in their infancy, and our departmental website.

Firstly, I am pleased to welcome Peter Hitchcock to the EAS faculty as an incoming assistant professor. Peter came to us from Ecole Polytechnique where he was an assistant professor studying dynamical and radiative processes governing large-scale circulation in the atmosphere with an emphasis on tropospheric-stratosphere coupling. Peter received his B.A. and M.Sc. degrees from McMaster University and his Ph.D. in physics at the University of Toronto. He was a postdoctoral associate at Cambridge and then at NCAR in Boulder before moving to France. Peter will teach atmospheric dynamics in the spring.

Next, I am happy to report that our faculty will be joined by Patrick Fulton as an incoming assistant professor in the spring 2019 semester. Patrick joins us from Texas A&M University where he was an assistant professor, and his research interests spanned earthquake physics, hydrogeology, thermal geophysics, geofluids and geomechanics, and where he was involved with the International Ocean Drilling Program (IODP). Patrick received his bachelor's degree from the Georgia Institute of Technology and his Ph.D. in geosciences from the Pennsylvania State University.

Finally, I feel fortunate to announce that Karin Olson Hoal will be joining our department in the fall of 2019 as the next Wold Family Professor in Environmental Balance for Human Sustainability. Since 2004, Karin has managed her own consulting company which specializes in geometallurgy and quantitative mineralogy. Her most recent academic background comes from the Colorado School of Mines where she was a research professor and the director or the Advanced Mineralogy Research Center. She has worked all around the world including in Australia, Africa, Europe, South America, and even previously in New York. Karin received her B.Sc. from St. Lawrence University, her M.Sc. from McGill University, and her Ph.D. in geosciences from the University of Massachusetts, Amherst. Karin will replace John Thompson who is the current Wold Family Professor. We wish John well on his next endeavors.

Back home, the department will be launching a new fifth-year professional master's degree program in atmospheric science in the College of Agriculture and Life Sciences (CALS). The new program will admit students during their senior year. Students will spend their senior year and an additional year after that taking classes and performing research. They will receive an M.S. degree after a total of five years of study backed by an immersive research experience. The new program will be an alternative to the Master of Engineering (M.Eng.) professional degree offered currently by the College of Engineering.

Let me next draw your attention to an exciting new initiative led by Professor Toby Ault. Working with an Ithaca-based company, Toby and his students have begun launching instrumented balloons here in upstate New York. The balloons can be tracked using the Amateur Packet Reporting System (APRS) and recovered. The explicit purpose of the balloon launches is to study local weather and regional micro-climate. Implicitly, the program marks the start of what we hope will become a department-wide project team comparable to the teams that are very popular in the College of Engineering. Our goal is eventually to add other components to the effort including autonomous vehicles instrumented for Earth observing.

Finally, readers may have noticed that the EAS website has undergone a makeover recently. The upgrade is part of initiatives underway in the College and in CALS. The website remains a work in progress but is designed to be better integrated with other sites and feeds on campus, and to have a flatter user interface better suited to mobile devices. You can use the website to keep up with news about people and programs in EAS, research, seminars, the curriculum and alumni affairs. We would appreciate your feedback at easinfo@cornell.edu.

Best wishes,

Dave

Dave Hysell
Professor and EAS Chair

Design and Production:
Rob Kurcoba, Judy Starr

Editors:
Syl Kacypyr, Rob Kurcoba, Dawn McWilliams, Judy Starr

Story Contributors:
Rick Allmendinger,Toby Ault, Larry Brown, Paula Burgi, Blaine Friedlander, Teresa Jordan, Syl Kacypyr, Tasnuva Khan, David Nutt

Cover Image:
Natalie Mahowald image by Lindsay France, University Photography

IN THIS ISSUE

HITCHCOCK AND FULTON JOIN EAS FACULTY

"I am thrilled to be joining the Department of Earth and Atmospheric Sciences at Cornell this fall," said **Peter Hitchcock** upon his arrival to Ithaca in September 2018.

Hitchcock's research focuses on the dynamics and variability of the atmospheric circulation at the largest scales, and he has a particular interest in the stratosphere.

"Historically a major focus of stratospheric research has been in understanding the chemistry and dynamics that govern the ozone layer, but in recent decades it has become clear that some of the most fascinating dynamical features of the stratospheric circulation have a surprising impact on near-surface weather and climate. Stratospheric sudden warmings and the quasi-biennial oscillation may not be as familiar as El Niño or the Pacific Decadal Oscillation, but they too impact our weather. Since the stratosphere is often predictable on timescales of months to years, these phenomena can provide valuable information for seasonal forecasting," says Hitchcock.

Many of the questions Hitchcock is thinking about now revolve around the behavior of Rossby waves. These are familiar building blocks of extratropical weather on synoptic scales, but they also serve as a kind of connective tissue for the atmosphere. "Their propagation communicates the state of remote modes of variability in the stratosphere to weather systems that affect our daily life," says Hitchcock. "Although they are well-resolved by the numerical models we use to forecast weather and those we use to make projections about future climate, their behavior is very sensitive to many of the smaller scale physical and dynamical phenomena that are not."

Peter Hitchcock

One of Hitchcock's main goals over the next five years is to build a better understanding of how these waves connect disparate parts of the climate system, and also how they can be better represented in numerical models. "Getting these waves right in models is essential to our ability to predict how the atmospheric circulation will change in response to a whole range of climate forcings, from volcanic eruptions to anthropogenic interventions," Hitchcock adds.

"I am also excited about the growth of operational seasonal forecasting. At the intersection between deterministic weather forecasting and climate projections, these forecasts are extremely challenging to get right. But they are steadily improving, and have huge potential to improve the resilience of our societies to extreme weather. The ensembles produced by seasonal forecasting centers also present an opportunity to develop whole new methods for studying fundamental aspects of atmospheric dynamics," explains Hitchcock.

After arriving in Ithaca with his wife, Hannah Moland, who is active in art and sustainability, Hitchcock says, "Coming from a year in Paris, we are looking forward to enjoying the richness of outdoor activities available in Ithaca and beyond. Moving to Ithaca also brings us closer to my home town of Hamilton, Ontario, and to Hannah's family who live up and down the East Coast."

Patrick Fulton

Patrick Fulton will arrive in January of 2019 as the newest member to the EAS faculty.

Fulton's research interests are related to hydrologic and thermal processes within fault zones and how these processes control fault slip behavior or provide insightful signatures within fault rocks and borehole and geophysical observations.

Much of the work Fulton's group does incorporates field and laboratory data, including innovative borehole monitoring techniques, along with careful quantitative analysis and numerical modeling. Their science tends to combine aspects of hydrogeology, thermal geophysics and rock mechanics.

Ongoing projects involve studying slow earthquakes and related hydrologic transients using subseafloor observatories in the Japan Trench and Hikurangi (New Zealand) subduction zones and onshore borehole monitoring observatories along the Cascadia margin and San Andreas Fault. In addition, through modeling and laboratory experimentation, Fulton's group is investigating the sensitivity of rock strength to fluid pressures, and feedbacks between fluids, earthquakes, and rock damage.

Mahowald is second from the right in the above photo at the October 2018 Intergovernmental Panel on Climate Change in Incheon, South Korea.

2018 IPCC REPORT RELEASED: EXPERTS OUTLINE CLIMATE CHANGE IMPLICATIONS TO WEATHER, HEALTH, ECOSYSTEMS

An *Associated Press* article written by Seth Borenstein and released on October 8, 2018, quoted Cornell's Dr. Natalie Mahowald, Irving Porter Church Professor of Engineering, who said, "We have a monumental task in front of us, but it is not impossible. This is our chance to decide what the world is going to look like."

Mahowald's comments were made after the Nobel Prize-winning United Nations Intergovernmental Panel on Climate Change (IPCC) of which Mahowald was a lead author, released a report following the week of Oct. 1-8, 2018 meetings held in Incheon, South Korea. The report details how Earth's weather, health and ecosystems would be in better shape if the world's leaders could somehow limit future human-caused warming to just 0.9 degrees Fahrenheit from now, instead of the globally agreed-upon goal of 1.8 degrees Fahrenheit.

To limit warming to the lower temperature goal, the world needs "rapid and far-reaching" changes in energy systems, land use, city and industrial design, transportation and building use, the report said. Annual carbon dioxide pollution levels that are still rising now would have to drop by about half by 2030 and then be near zero by 2050. Emissions of other greenhouse gases, such as methane, also will have to drop. Switching away rapidly from fossil fuels like coal, oil and gas to do this could be more expensive than the less ambitious goal, but it would clean the air of other pollutants. And that would have the side benefit of avoiding more than 100 million premature deaths through this century, the report said.

COOLING EFFECT OF PREINDUSTRIAL FIRES ON CLIMATE UNDERESTIMATED

By David Nutt | October 1, 2018

The Industrial Revolution brought about many things: the steam engine, the factory system, mass production. But not, apparently, more wildfires. Actually, the opposite.

A new study, "Reassessment of Pre-Industrial Fire Emissions Strongly Affects Anthropogenic Aerosol Forcing," by a Cornell postdoctoral researcher, published in August in *Nature Communications*, finds that emissions from fire activity were significantly greater in the preindustrial era, which began around 1750, than previously thought. As a result, scientists have underestimated the cooling effect the aerosol particles produced by these fires had on the past climate.

As fire burns, tiny particles—aerosols—are released into the atmosphere, where they can increase the brightness of clouds and reflect sunlight back into space, cooling the planet in the process (also known as indirect radiative forcing). This cooling can help offset increased warming caused by anthropogenic greenhouse gases like carbon dioxide.

"Most people are probably very familiar with the idea of greenhouse gas warming but are less aware that human activities can also create a cooling at the same time, through changes to cloud properties via emissions of aerosols and their pre-cursor gases," said lead author Douglas Hamilton, postdoctoral researcher in earth and atmospheric sciences. "You don't see the full impact of the warming from the greenhouse gases at any point because you also have these aerosols. It's really important for us to understand the cooling effect from these aerosols in order to understand the overall impact human activity has on climate."

To gain a clearer picture of aerosols' historical impact, Hamilton examined fire proxy records, such as ice cores, that hold black carbon emitted from preindustrial fires; charcoal depositions in lake and marine sediments; and scarring in tree rings, along with present-day satellite data documenting the decline in the burnt area caused by fires in recent decades. These paleoenvironmental archives show that fire occurrences worldwide peaked around 1850 and fire emissions have dropped between 45 to 70 percent globally since the Industrial Revolution.

While common sense might suggest fires would rise as human density increased around the planet, in actuality, the establishment of cities, fire departments and local infrastructure, plus the reduction of forests for agricultural purposes, have all curtailed the spread of wildfires, Hamilton said.

Climate change and land-management practices, however, may be reversing that trend. Recent years have seen an increase in the amount of fires in the U.S., for example.

"In some regions we're now starting to see an increase in the amount of fires, and it's projected to continue," Hamilton said. "But where the fires are and where they will increase in the future is not the same as where they were in the past."

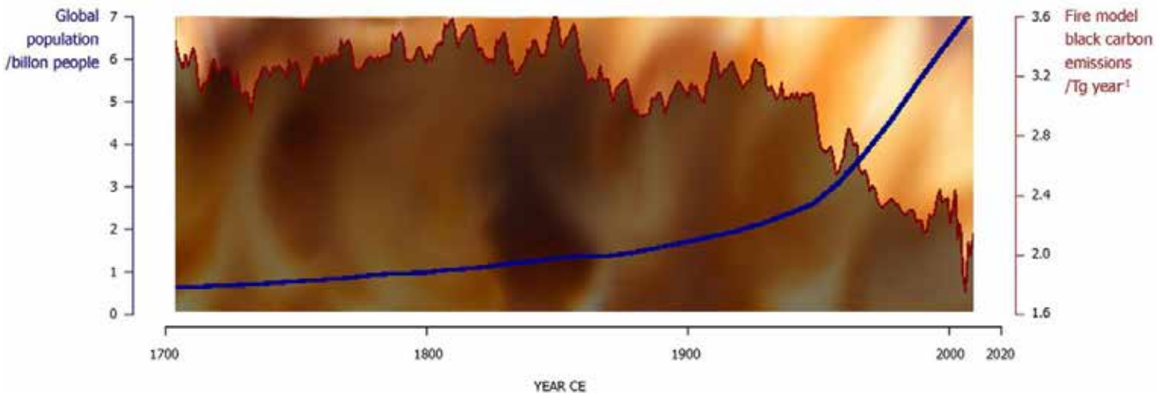
The paper concludes that pre-industrial fire emissions are the single largest source of uncertainty when it comes to understanding the magnitude of climate warming caused by manmade forms of combustion.

Black carbon: friend or foe?

That sense of uncertainty around aerosol impacts on the climate also informs a separate paper Hamilton recently coauthored, "Black Carbon Radiative Effects Highly Sensitive to Emitted Particle Size When Resolving Mixing-State Diversity," also published in *Nature Communications* in August. That study—led by Hitoshi Matsui, a former visiting scholar at Cornell and now at Nagoya University in Japan—finds that better measurements of the size of black carbon particles, and the ways these particles mix with other aerosol compositions in climate models, is more important than previously thought to understanding black carbon's heating effect in the present day, and how it could change in a future with potentially more wildfires and less fossil-fuel burning.

"IN SOME REGIONS WE'RE NOW STARTING TO SEE AN INCREASE IN THE AMOUNT OF FIRES, AND IT'S PROJECTED TO CONTINUE," HAMILTON SAID. "BUT WHERE THE FIRES ARE AND WHERE THEY WILL INCREASE IN THE FUTURE IS NOT THE SAME AS THEY WERE IN THE PAST."

-Douglas Hamilton, Cornell postdoctoral researcher



The above graphic shows the decline of black carbon emissions from fire activity from 1700 to the present, contrasted with the rise in global population.

Black carbon is formed by incomplete combustion of fossil fuels, biofuels and wildfires. Because of its dark color, it absorbs sunlight and warms the planet. The strength of this warming is determined by a particle's size and how diluted it is by other aerosols—such as clearer, organic carbon—or by the condensation of gases that then mix with it.

The researchers developed a more detailed model of black carbon than is currently used. The model factors in a wide range of particle sizes and the different ways black carbon can mix with other atmospheric constituents to show just how nuanced these atmospheric interactions can be. Understanding these interactions is particularly important because one proposed way of mitigating the human impact on the climate is actively reducing only black carbon aerosols while not eliminating others.

"Properly describing the particle size of black carbon particles and their mixing with other aerosol components is very important to understand the contribution of black carbon to the current climate and its future changes," Matsui said.

"What we're showing here in this new advanced model is that, as fires increase in the future, the additional warming that was predicted in more basic models could be an actual cooling relative to present day, because we resolve the size and composition of black carbon in more detail, combined with what is going on with other aerosol and gases that are also co-emitted with the fires," Hamilton said.

Both of these studies add nuances to how effective reducing black carbon to improve air quality and reduce climate change will be, according to Natalie Mahowald, the Irving Porter Church Professor of Engineering and Atkinson Center for a Sustainable Future faculty director for the environment, who coauthored the particle-size paper. "We really need to understand more about preindustrial fires and how we're changing the size distribution of the black carbon emissions. That's the bottom line," Mahowald said. "As we try to move forward and solve problems with air quality and the climate, we need answers to these questions."

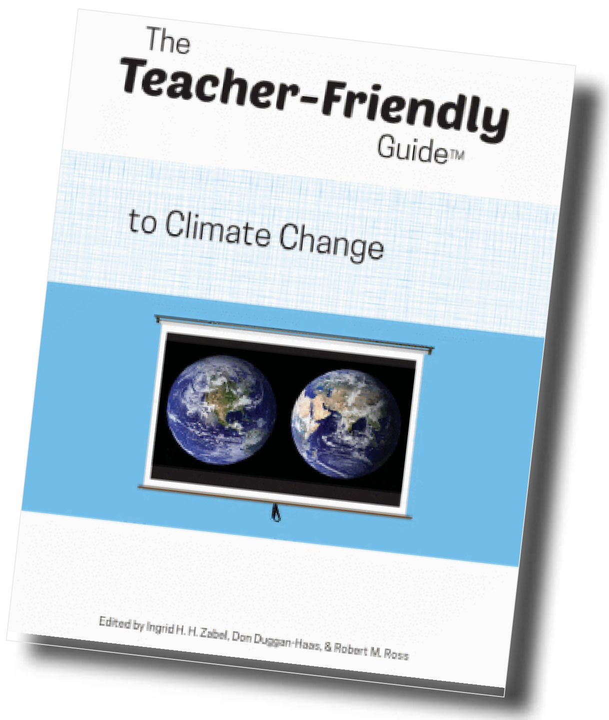
Both studies received financial support from the Atkinson Center for a Sustainable Future. David Nutt, author of this article, is managing editor of the Atkinson Center.

CAMPAIGN AIMS TO BRING CLIMATE SCIENCE TO EVERY U.S. HIGH SCHOOL

By Syl Kacapyr| Cornell Engineering

The Cornell-affiliated Paleontological Research Institution (PRI) has launched a new partnership with the New York Sea Grant (NYSG) program and is in the second phase of a crowdfunding campaign in its quest to bring climate change science to every U.S. high school.

The crowdfunding effort began in 2017 with *The Teacher-Friendly Guide to Climate Change*, a 284-page book that provides teachers with perspectives, statistics and graphics for teaching climate science in the classroom. The book was edited by Ingrid Zabel, PRI's climate change education manager; Don Duggan-Haas, PRI's director of teacher programming; and Rob Ross, an adjunct professor of earth and atmospheric sciences and PRI's associate director for outreach.



"It was originally part of a broader impact project we were working on with professor Natalie Mahowald," said Ross. "Her grant had funds to publish the book, but it didn't have funds to print and distribute on a broad scale."

So PRI launched an online crowdfunding campaign to finance distribution of print and digital versions of the book to teachers across the country. Less than a year later, the book has reached 50,000 educators, including every public high school science teacher in New York City and a two-thirds of all science teachers in New York state.

With the goal of providing the book to 200,000 teachers, PRI has launched the second phase of its crowdfunding campaign through GiveGab, which has already raised more than $115,000.

Heather Renyck teaches earth and environmental sciences to ninth- and 12th-grade students at Bolivar-Richburg Central School in western New York and said while there are many online climate science resources, it can become difficult to find easily digestible and accurate information.

"What makes this resource invaluable is the breadth and organization of climate science topics," said Renyck. "I like the user interface, such as definitions in the margins, online resources in the chapters and useful footnotes. The authors of this book did a great job with making the big picture of climate science accessible to the layperson."

PRI is also reaching teachers through a new series of workshops being administered with NYSG, a cooperative program of Cornell University and the State University of New York that administers a network of integrated research and education services around the state.

The first workshop, "Climate to Go!," was held Aug. 7-9 at the New York City Department of Education's Summer STEM Institute and helped 20 teachers develop activities and approaches to teaching about climate change.

"We thought that it would make sense to partner with colleagues at Cornell who have a physical presence in New York City and have already been working on local resilience issues," said Ross.

Nordica Holochuck, NYSG's Hudson River estuary specialist, said she received positive feedback from workshop attendees.

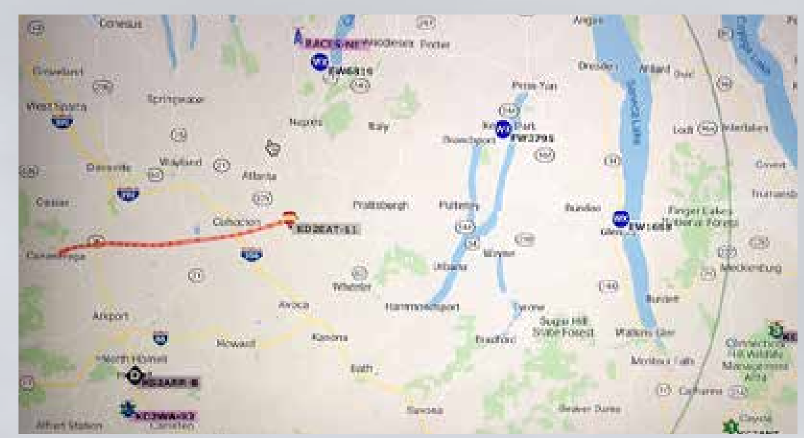
Syl Kacapyr is public relations and content manager for Cornell Engineering.

EMERGENT CLIMATE RISK BALLOON LAUNCH

On a cloudy day in October, Assistant Professor Toby Ault and his research group headed out with excited anticipation to launch their first weather balloon together. It proved an exciting day with both failure and success being part of the experience.

Following the initial launch of the weather balloon, Professor Ault gave an enthusiastic report. He said, "All went well, though not according to plan (as expected.) However, the balloon was launched (from Canaseraga)." Canaseraga is a village in Allegany County, New York, located just southwest of Dansville and north of Hornell. The map above shows APRS tracking about 30 minutes in. It later passed directly over Cayuga Lake near Myers Point.

Ault continues, "It reached the stratosphere and we were able to observe a reversal in the temperature gradient. It reached a maximum altitude of 32 km (~20 miles, 104,000 ft.)."



The total horizontal distance the balloon traveled was 110 miles as the crow flies, which was quite a bit more than planned because the balloon was not quite big enough to exert the buoyant force needed to rise quickly through the fast moving middle troposphere. Ault said, "It made for a long day, but the students were deeply impressed with the activity. It also moves us towards thinking about what a broader, more regular student-led project would look like.

The experimental balloon was eventually recovered from its landing site—a plot of private land. The owner, once given an explanation of why they were on his land, agreed to help them retrieve the balloon. He drove his ATV to where it landed and with a few of the people on the team, managed to secure it.

Dirk Swart (Wicked Devices) and Marc Alessi '18, now a graduate student in the program, inflate the balloon for its launch.

Proof of a successful recovery.

From left standing: Toby Ault, landowner, Dirk Swart, Lance Nino, Mike Hojnowski, Rick Moore, Dimitris Herrera, Colin Evans, Jane Smith, Marc Alessi. Kneeling: Vic Aprei, Carlos Carrillo.

FACULTY UPDATES

Toby Ault took students on a field trip to launch their newly designed balloon which was created to capture more accurate data for weather forecasting and modeling. See article on page 7.

Larry Brown has been very busy this year with the campus Earth Source Heat project. See more about this on pages 10-11.

Larry Cathles retired in late summer of 2018 and became an emeritus professor. Cathles continues to be active in the department and is seen most days working away in Snee Hall.

Steve Colucci and his research group continue research on the stratospheric polar vortex and stratospheric anticyclones, and their relationship to cold-air outbreaks at the earth's surface.

Lou Derry was one of the initial 18 scientists selected by French President Emmanuel Macron in December 2017 for the program, "Make Our Planet Great Again." See the *Cornell Chronicle* article about this on the next page.

Derry has presented several public presentations through 2018 including one to the Climate Change Awareness and Action citizen group, Syracuse, NY: "The Climate of Climate Science on Two sides of the Same Ocean."

Derry also built and successfully tested a low-cost atmospheric CO2 monitor for outdoor environmental applications at Cayuga Nature Center. He is currently helping to develop educational activities to use this and other environmental monitoring data with the staff at the Cayuga Nature Center and Paleontological Research Institution. They will make designs, parts lists and software publically available, and will seek funding to distribute these to high school science programs.

Chuck Greene was elected to a three-year term (2018) as the representative for biological oceanography on The Oceanography Society Council.

Throughout 2018, Greene presented an invited tutorial on "Marine Microalgae: Climate, Energy, and Food Security from the Sea" at the AGU/ASLO/TOS Ocean Sciences Meeting in Portland, Oregon, an invited talk, " Marine Microalgae: Climate, Energy, and Food Security for the 21st Century," as a speaker and panel member at the Circular Carbon Economy Meeting sponsored by the Department of Energy in Golden, CO, and a webinar on "Conservation Oceanography of the North Atlantic Right Whale" sponsored by the Lenfest Ocean Program of the Pew Charitable Trusts October 2018.

Matt Pritchard gave a special EAS lecture during Cornell's Reunion Week 2018 on the late Professor Emeritus **Art Bloom**'s recently published book, "Gorges History: Landscapes and Geology of the Finger Lakes Region."

Sara C. Pryor was awarded the 2018 CALS Research and Extension Award for Outstanding Accomplishments in Research. She is recognized for her work in monitoring wind turbines using seismometers. The value and relevance of Pryor's research is also reflected in her contributions to international debates on renewable energy and climate change.

Suzanne Mahlburg Kay is the recipient of the Herbert Thomas Award from the Geological Society of Chile. The award is given at each Chilean Geologic Congress, held triennially, to a foreigner who has worked with Chilean colleagues in making major contributions to the geology of Chile and contributed to the training of young geologists. The award will be presented during the XV Congreso Geológico Chileno (Chilean Geologic Congress) on Nov. 19, 2018, in Conception Chile. Previous recipients with Cornell connections include John Hunt who received a B.S. from Cornell in the early 1950's and is famous for his work on Andean copper deposits, and Dr. Charles Stern (University of Colorado) who was a visiting professor at Cornell around 1978.

On Nov. 6, 2018, Mahlburg Kay gave a talk in the all-invited Geological Society of America Pardee Symposium on the celebration of the 50th anniversary of plate tectonics at the annual meeting in Indianapolis. The title of her talk was, "Evolution of an Andean Margin: Magmatic and Tectonic View from the Central and Southern Andean."

John Thompson is working with Resolve on their Natural Resources and Energy Leadership Council. Thompson was an invited keynote plenary speaker at the XV Chilean Geological Congress Nov. 18-23, 2018. Thompson also served as chair for the Resources for Future Generations (RFG2018) conference in Vancouver in June of 2018.

Bill White edited the first volume of the Encyclopedia of Earth Sciences series, *Encyclopedia of Geochemistry: A Comprehensive Reference Source on the Chemistry of the Earth*, published by Springer in August 2018.

White also gave two seminars on mantle geochemistry in the State Key Laboratory of Isotope Geochemistry at the Guangzhou Institute of Geochemistry of the Chinese Academy of Sciences, Guangzhou, China, and also participated in field work in the Qinling Mountains in Central China in June 2018.

In October 2017, White was the invited speaker of the University of Kerala, India's Department of Geology's erudite scholar-in-residence lecture series.

Dan Wilks authored and edited a newly published book, *Statistical Postprocessing of Ensemble Forecasts*. Wilks became an emeritus professor upon his retirement in July of 2018.

Dr. Jasper F. Kok, former postdoctoral associate with Professor Natalie Mahowald, has received the American Meteorological Society 2019 Henry G. Houghton Early Career Award for novel approaches to studying the physics of dust emissions into the atmosphere and the interactions of dust aerosols with Earth's climate system and beyond.

French president taps climate scientist to 'Make Our Planet Great Again'

By David Nutt | January 9, 2018

The race to see who will lead the fight against climate change is heating up.

After President Donald Trump announced in 2017 his intention to withdraw the United States from the Paris climate accord, French President Emmanuel Macron proposed a "Make Our Planet Great Again" program that would bring climate scientists to France and fund their research with $70 million in three- to five-year grants. On Dec. 11, Macron unveiled the first round of recipients. Among the initial 18 scientists selected—13 of whom are American—is Louis Derry, professor of earth and atmospheric sciences in the College of Engineering and faculty fellow with Cornell's Atkinson Center for a Sustainable Future.

"Usually people don't pay too much attention to what people like me do," Derry said, "And I think the visibility it gives us in this field is good."

The field, for Derry, is "critical zone" science, which refers to the study of the Earth's outer layer of skin—from the bottom of groundwater to the tops of trees—where water, atmosphere, ecosystems, soil and rock all meet. Derry's research focuses on the intersection of geochemistry and hydrology, specifically the kinds of chemical processes that occur in a natural system. By developing new tracers that provide a chemical or isotopic fingerprint of a particular kind of reaction or source, he gains insight into the reaction mechanisms and ultimately the ways water is moving through the system.

"There are 90 elements in the periodic table, there's a lot of things to play with," Derry said. "We're measuring things at the part-per-trillion level. It's not easy to do that. Or let's say it's easy to screw it up in the process. It's not hard to get it wrong."

Competition for the grants was high, with 1,822 scientists submitting applications. Derry was a natural fit for the program, having lived in France 25 years ago when he was a postdoc studying erosion and weathering in the Himalayan Mountains, and he's fluent in French. And in his role as director of the National Science Foundation office for critical zone observatories (NSF-CZ), he has worked in close partnership with French researchers who have a similar critical zone organization. In fact, Derry was already talking with colleagues in the Paris Institute of Physics of the Globe about a possible collaboration when he learned of Macron's initiative. So they teamed up and put together a proposal.

"These ideas were percolating for a while," said Derry, who plans to step down as director of the NSF-CZ in the spring.

The new project will use isotopic tracers to study how the chemistry of streams is controlled, and how it varies with rainfall and the creation of new pathways. Ultimately, the four-year, 1.5 million euro grant will help researchers better model and predict the ways water systems respond to changes in precipitation caused by an increasingly erratic climate. This has long been a "black box" problem for researchers, who lacked the computational tools needed as well as the ability to make the necessary high-precision measurements, according to Derry. Now the technology is available. And thanks to Marcon's program, so is the funding.

Derry is currently involved with a number of projects at Cornell, from NSF-funded research that studies the chemistry of silicon and aluminum in streams, to an interdisciplinary collaboration with the SRI-Rice program and Matt Reid, assistant professor in civil and environmental engineering, that examines arsenic in rice and water and was funded by the Atkinson Center, where Reid is also a faculty fellow.

"I tell my graduate students all the time that in order to work in these areas

Lou Derry

you kind of need to know everything, but you can't, so you better have smart friends," Derry said.

While Derry is excited about the opportunities the new project will create—such as promoting the international exchange of researchers and bridging French and U.S. programs—he acknowledges it will be a challenge to juggle his various commitments. He anticipates spending his fall semester teaching and running his lab at Cornell, then living and working in Paris the other half of the year. But it is the current state of research funding in the U.S. that has him truly worried.

"The uncertainty and chaos in the funding and budgeting process through Congress is a significant problem," he said. "You can't just turn off these kinds of research efforts and then turn them back on again. You lose the people, the expertise, the infrastructure, the data streams."

"This is particularly a problem for young scientists because they're trying to start a career. They can't afford to wait a year or two for the funding situation to clarify. If we don't do something, this is going to have a long-term impact on science and engineering, and other disciplines as well," he said. "One of the reasons why the French grant was attractive is it insulates me from that a bit. I'm lucky to be in this situation, but most people aren't. I just happened to be in the right time and the right place."

David Nutt is managing editor at the Atkinson Center for a Sustainable Future.

EARTH SOURCE HEAT

Cornell University is currently exploring the feasibility of Earth Source Heat, our version of an enhanced geothermal system that could potentially meet the heating challenges on our Ithaca campus without the use of fossil fuels. The project is being led by the College of Engineering with support from Facilities and Campus Services.

Professor Larry Brown has secured funding to perform active seismic surveys essential to the critical task of understanding rock formations beneath the campus. His research is based on the vibroseis method, in which a large shaking truck generates sound waves in the ground whose echoes from subsurface features were recorded by approximately 400 small self-recording geophones (nodes) along designated routes.

The vibroseis truck, obtained from the University of Texas at Austin and affectionately known as T-Rex, injected low-frequency vibratory signals in the ground over several seconds at regular intervals. The nodes then recorded the acoustic reflections from various rock formations. These signals can then be used to produce a seismic image which should reveal critical details about the subsurface conditions. Data from these instruments are now being processed at Cornell. Recent Cornell graduate Daniel May '18 who directed the deployment of the instruments, will now lead the team that is processing the collected data for subsequent interpretation.

The project is a not only a living laboratory for seismic research, it has been augmented to engage Cornell with students at Ithaca High School and Dryden High School, by establishing seismic recording stations at those schools. Those stations will help students learn more about both Earth Source Heating as well as seismic exploration methods and analysis of distant earthquakes that may also be recorded. Additional seismographs were placed around the Cornell campus and in the Ithaca Valley to calibrate the local ground response to seismic waves in the future.

Other Cornell faculty are part of the Earth Source Heat project. On May 17, 2018, Associate Professor Katie Keranen was a featured panelist at a public forum hosted by Cornell along with Lance Collins, the Joseph Silbert Dean of Engineering, Jefferson Tester, the Croll Professor of Sustainable Energy Systems and chief scientist for Earth Source Heat, Tony Ingraffea, professor emeritus of civil and environmental engineering, and Todd Cowen, professor of civil and environmental engineering and faculty director for energy at the Atkinson Center for a Sustainable Future.

Daniel May installing a nodal recorder in Stewart Park to calibrate ground response in Ithaca Valley to seismic wave.

May retrieving nodes following the vibroseis surveys near possible ESH drilling locations.

The seismograph stations installed at Ithaca High School to record the vibroseis waves as well as distance earthquakes to quantify ground response in Ithaca Valley. Professor Larry Brown observes May's work while holding an umbrella to protect them from the elements.

T-REX SHAKES AND CALIBRATES

As part of the Earth Source Heat project, 400 seismograph nodes were deployed on and around campus in September 2018. A vibroseis truck, dubbed “T-Rex,” shook along McGowan Woods Road at full power to calibrate several of the seismographs, including two that are at local high schools and one at the School of Veterinary Medicine.

Tasnuva (Ming) Khan '18, stands with Andrew Valentine, a technician from University of Texas at Austin responsible for the operation of T-Rex.

EARTH SOURCE HEAT

GEOLOGICAL AND GEOPHYSICAL ANALYSES AND STUDENT LEARNING IN PREPARATION FOR A POSSIBLE GEOTHERMAL PILOT WELL AT CORNELL

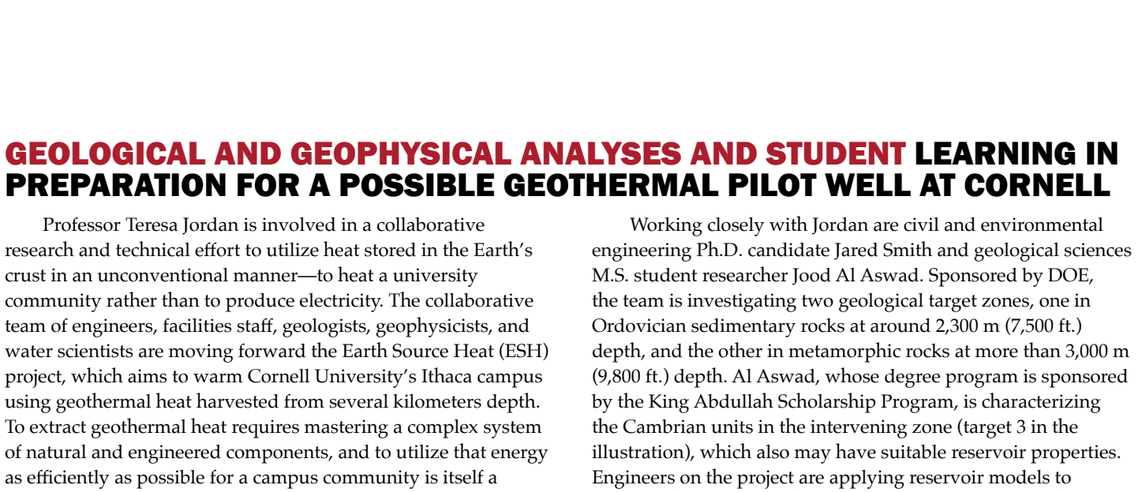
Professor Teresa Jordan is involved in a collaborative research and technical effort to utilize heat stored in the Earth's crust in an unconventional manner—to heat a university community rather than to produce electricity. The collaborative team of engineers, facilities staff, geologists, geophysicists, and water scientists are moving forward the Earth Source Heat (ESH) project, which aims to warm Cornell University's Ithaca campus using geothermal heat harvested from several kilometers depth. To extract geothermal heat requires mastering a complex system of natural and engineered components, and to utilize that energy as efficiently as possible for a campus community is itself a complex system problem.

Currently, the U.S. Department of Energy (DOE) is sponsoring five projects nationally to examine the feasibility of "Deep Direct-Use" (DDU) district heating and cooling. The DOE's DDU program fits very well with Cornell's Earth Source Heat project, and Jordan is the co-principal Investigator of a DOE-sponsored team that is led by chemical and biomolecular engineering professor Jefferson Tester. The project uses legacy data sets from oil, gas and water boreholes to investigate temperatures of the rock at depth and the likelihood of natural flow of fluids through the rocks.

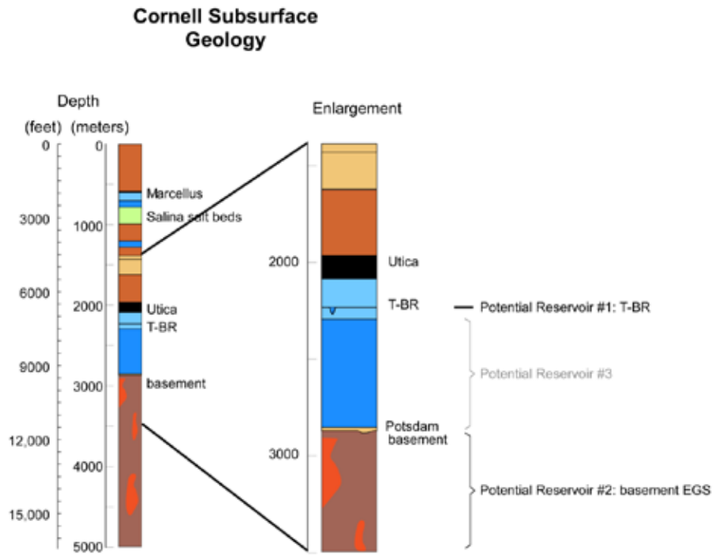
Working closely with Jordan are civil and environmental engineering Ph.D. candidate Jared Smith and geological sciences M.S. student researcher Jood Al Aswad. Sponsored by DOE, the team is investigating two geological target zones, one in Ordovician sedimentary rocks at around 2,300 m (7,500 ft.) depth, and the other in metamorphic rocks at more than 3,000 m (9,800 ft.) depth. Al Aswad, whose degree program is sponsored by the King Abdullah Scholarship Program, is characterizing the Cambrian units in the intervening zone (target 3 in the illustration), which also may have suitable reservoir properties. Engineers on the project are applying reservoir models to simulate the amount of heat that can be extracted from those rocks and delivered to Cornell's heat distribution system.

The team is also investigating various combinations of geothermally supplied heat flux and campus heat distribution system design, to learn what options are possible to meet Cornell's goal of heating without fossil fuels. Ultimately, the pieces will come together in an economic analysis, and as well as in comparisons of the environmental and social values of the plausible Earth Source Heat geological and distribution system options.

Below the sedimentary rocks, the basement rocks below Ithaca are poorly documented, yet vitally important to the design of a geothermal heat extraction program. Key unanswered questions are the nature and spacing of natural fracture sets, the thermal conductivity and heat generation capacity of the metamorphic lithologies, the mechanical properties of the rocks, and the mineralogy that may be involved in rock-water reactions if hot brine circulates through a geothermal reservoir. Two summers ago, Ben Valentino (M.S. '16) conducted petrographic analysis of the sparse samples that exist of the metamorphic basement rocks, using samples collected in the deep gas exploration wells. During the last year, Jordan has been working with Smith, Al Aswad, Cornell facilities full time employee Olaf Gustafson, and Tasnuva Ming Khan '18 to extract information from the metamorphic basement exposed in the Adirondack Mountains that may provide insight to Ithaca's basement. This group has examined in the field the natural fracture sets of the metamorphic rocks in the Adirondacks. With the assistance of Emeritus Professor Bryan Isacks and Professor Rick Allmendinger, Khan is mapping fractures using very high resolution topographic data for parts of the Adirondack High Peaks area.



Pictured left to right: Jared Smith (Civil and Environmental Engineering graduate student), Olaf Gustafson (Cornell facilities staff geologist), Professor Teresa Jordan and geological sciences graduate student, Jood Al Aswad on field trip to examine fractures in the metamorphic rocks of northern New York state.



EARTH ENERGY EDUCATION

During the spring 2018 semester, EAS offered an undergraduate course dedicated to Earth Source Heat, titled Addressing Energy Needs with Earth Source Heat: Subsurface Characterization at Cornell. This one credit course met three times a week for one month. Professor Matt Pritchard was the lead organizer for this course, with significant back-up from Professor Terry Jordan. Also contributing content to the course were CBE Professor Jeff Tester, and Cornell Facilities staff professionals Steve Beyers and Ole Gustafson. Fourteen students completed the course, at ranks that ranged from freshman to the Master of Engineering professional degree program, to the Master of Science program. The students' departmental affiliations were even broader, spanning EAS, City & Regional Planning, Biology, and four engineering fields: chemical, biological/environmental, civil/environmental, and mechanical and aerospace.

Pritchard and Jordan developed the course content to achieve the following learning outcomes:

- Communicate to peers and the general public the reasons that geothermal energy plays an important role in Cornell's plan to achieve carbon neutrality.
- Articulate in words and diagrams the physical underpinnings for a source of geothermal heat in the subsurface below Cornell.
- Compare and contrast Cornell's aspiration for campus heating via Earth Source Heat to existing direct-use community heating projects elsewhere.
- Describe several simple experiments that can be conducted using geophysical remote sensing and/or a pilot borehole, and how the results would enable answering key research questions.

Although faculty and staff expertise to cover these objectives was readily available, selecting written materials for the novel content and suitable to the broad range of skills and expertise among the students was a challenge. Consequently, the capstone activity for the students was, as a collaborative group, to compose and illustrate a "textbook" for future versions of the course.

Groundwater loss prompts more California land sinking

By Blaine Friedlander | Cornell Chronicle
Kevin Laubacker/Brand Communications

Kyle Murray and Rowena Lohman examined the southern portion of California's Central Valley. They found that in spite of heavy rains in early 2017, groundwater extraction for agriculture and human use leads to a continual sinking of land, as seen from satellites.

Despite higher-than-normal amounts of rain in early 2017, the large agricultural and metropolitan communities that rely on groundwater in central California experienced only a short respite from an ongoing drought.

When the rain stopped, drought conditions returned and the ground has continued to sink, by up to a half-meter annually, according to a new Cornell study in *Science Advances*.

"With the heavy storms in early 2017, Californians were hopeful that the drought was over," said Kyle Murray, a Cornell doctoral candidate in the field of geophysics. "There was a pause in land subsidence over a large area, and even uplift of the land in some areas. But by early summer the subsidence continued at a similar rate we observed during the drought."

Murray and Rowena Lohman, Cornell associate professor in earth and atmospheric sciences, examined satellite imagery of the San Joaquin Valley. This region, like many others in the western United States, faces ongoing groundwater extraction, happening faster than it can be replenished. Their research, "Short-lived Pause in Central California Subsidence After Heavy Winter Precipitation of 2017," was published Aug. 29 in *Science Advances*.

About 80 percent of groundwater usage in California is agricultural. In the farming region of the Tulare Basin in central California, growers have been extracting groundwater for more than a century, said the researchers. Winter rains in the valley and snowmelt from the surrounding mountains replenish the groundwater annually to some extent, but drought has parched the valley since 2011.

Between 1962 and 2011, previous studies had found that the average volume of groundwater depletion each year was at least a half cubic-mile. Using satellite-based measurements between 2012 and 2016, depletion of the Tulare Basin groundwater volume was estimated at 10 miles cubed, which is comparable to five times the water volume of Cayuga Lake (in the New York's Finger Lakes region) in that period of time.

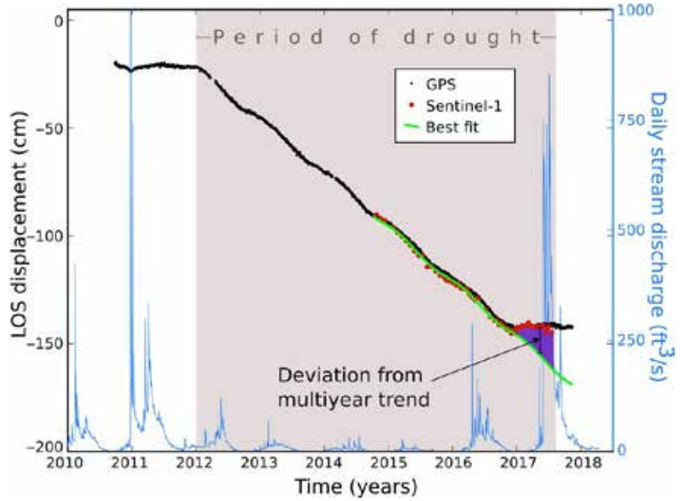
Fresno and Visalia border the Tulare Basin to the north, with Bakersfield to the south. About 250 agricultural products grow there with an estimated value of $17 billion annually, according to the U.S. Geological Survey. The valley holds about 75 percent of the California's irrigated agricultural land and supplies 8 percent of the United States' agricultural output.

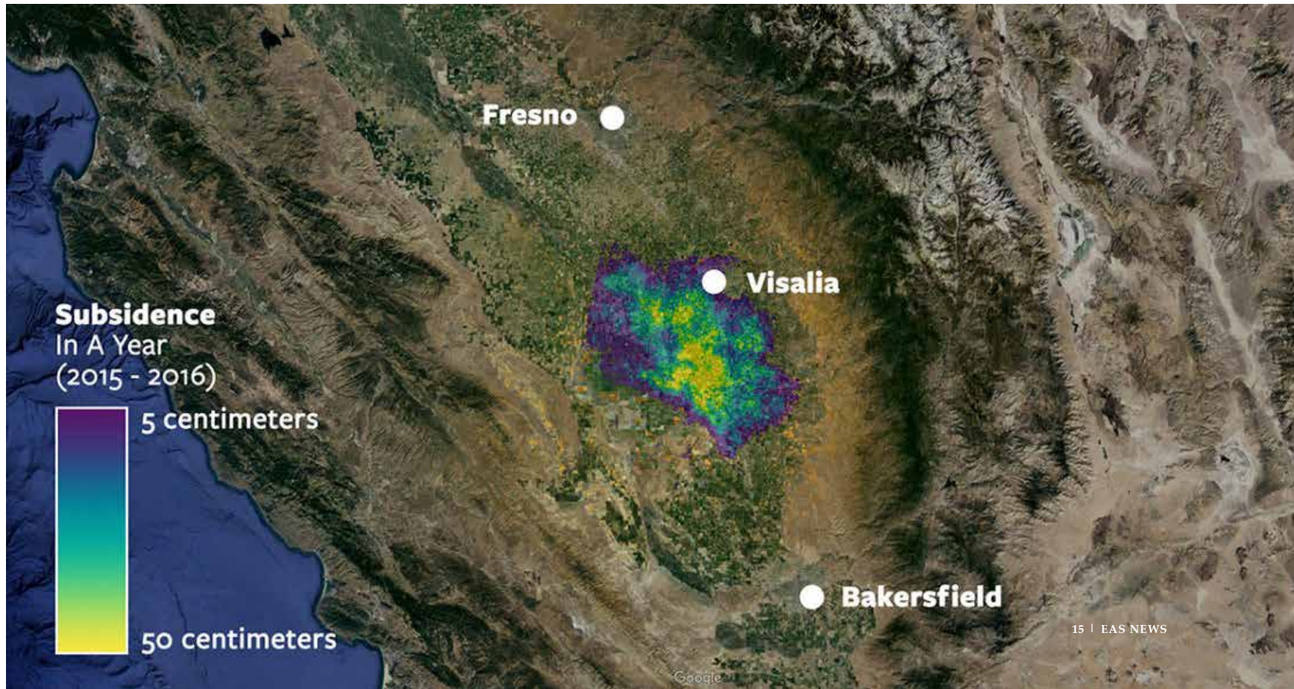
"The California water problem has been examined from different angles in the past decades. This is one piece of that," said Lohman. "In this research, we observed 50 centimeters of subsidence during the drought, and then heavy rains and snowfall over several months in the spring occurred and subsidence slowed down. Six months after the rain—in summer, 2017—we observed that subsidence rates are again approaching their previous high levels. It was business as usual."

As an engineering problem, subsidence damages infrastructure, causes roads to crack and give rise to sinkholes—expensive problems to fix, said Lohman. "One of the places where it really matters in California is the aqueduct system that brings water to the region. They're engineered very carefully to have the correct slope to carry a given amount of water," she said. "Now, one of the major aqueducts in that area is bowed and can't deliver as much water. It's been a huge engineering nightmare."

Groundwater—as an agricultural and municipal resource—is incredibly important to communities in central California and elsewhere. Said Lohman: "The subsidence we see is a sign of how much the groundwater is being depleted. Eventually, the water quality and cost of extracting it could get to the point where it is effectively no longer available."

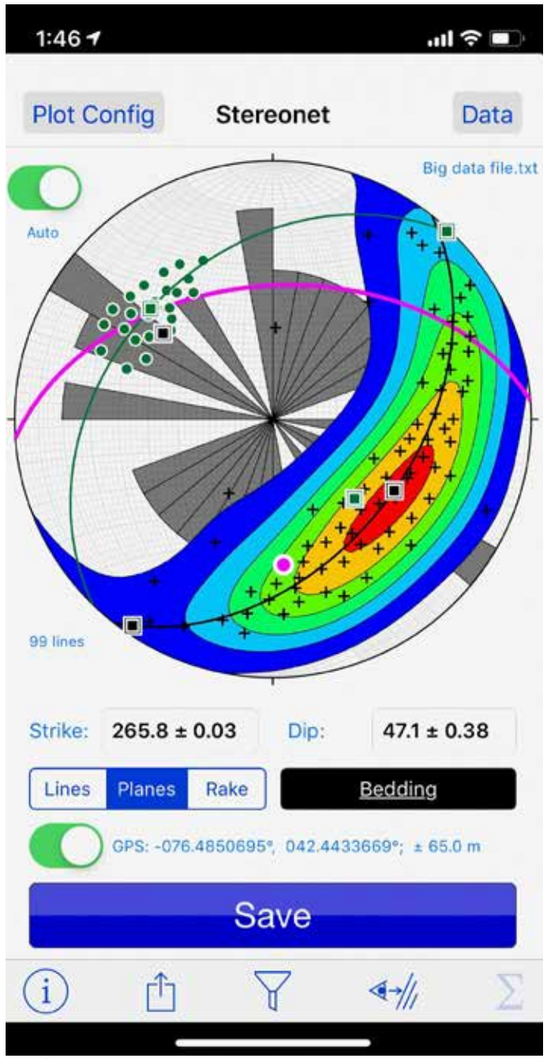
Funding for this research was provided by NASA.
Graphics credit: Murray and Lohman.





STEREONET

Though well-known for his geological research, several tens of thousands of scientists and students, in fields diverse as planetary science, archeology, anthropology, geotechnical engineering, and even entomology, know Professor Rick Allmendinger for his user-friendly software. He is helping to lead the digital revolution in field data collection using smart phones and employing real time geometric constraints to improve geologic mapping. And, you can give his apps a spin for free.

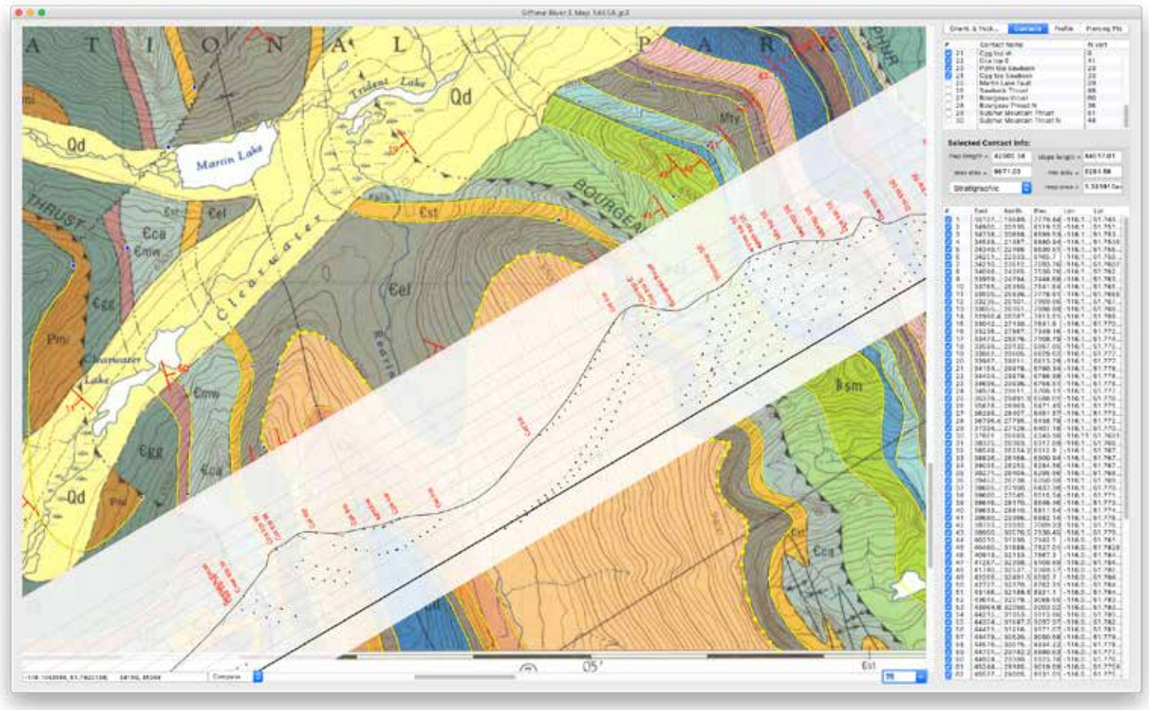


App: Stereoone

Structural geology is all about geometry: documenting the current shape and orientation of various deformation features and then deconstructing them back to their initial conditions. These tasks lend themselves to mathematical rigor and automation via computing. As a Cornell undergraduate in the early 1970s, immediately after the move of the Geological Sciences Department to Cornell Engineering, Rick Allmendinger was encouraged to take not one but two computer science classes. Back then, computing was not the user-friendly activity that it is today: code was recorded on punch cards and heaven forbid you slip and drop your box of cards on an icy Libe Slope! Nonetheless, taking those two courses more than 40 years ago, along with a lot of cool science in between, eventually contributed to Allmendinger becoming one of the best-known structural geologists of his generation.

"My professional career began with the advent of personal computers and has continued through the dawn of mobile devices," said Allmendinger. "Just to accomplish our own research, we had to write our own programs because there was nothing available. It turns out that those programs were of interest to a large number of other scientists as well." Allmendinger is the author of a suite of major programs and numerous utility apps that are available for Macintosh, Windows, and Linux platforms. Today, his various download web pages get more than 58,000 hits per year. The programs are free and employ modern, user friendly interfaces that encourage deep exploration of data sets. Because all of the programs were developed by a practicing field structural geologist, they are intuitively designed for, and appeal to, other field geologists.

His most popular program, Stereonet, was one of the first such programs available anywhere for personal computers and today accounts for more than half of the total downloads. "Back when I first developed it in the mid-1980s, personal computers were so slow that you could literally watch the display draw a great circle segment by segment," said Allmendinger. Stereonet has now found uses far beyond structural geology: archeologists use it to plot the orientations of artifacts, geotechnical engineers use if for slope stability evaluation, planetary scientists display their spatial measurements, and an entomologist even reported



using the program to show the orientation of larval nests.

Today, however, Allmendinger is most excited about two related applications: extracting quantitative information from geological maps and using mobile devices to capture data in the field. The old graphical methods of extracting data from geological maps are so slow and tedious that maps are very underutilized. "I wrote a program a few years ago to facilitate the extraction of stratigraphic map thicknesses because we wanted to factor that uncertainty into balanced cross-section shortening estimates," said Allmendinger.

GMDE (Geologic Map Data Extractor) now does a host of other calculations as well and is a primary vehicle that Allmendinger uses in his structural geology teaching. The program makes it easy to extract XYZ data from a map for the students to use in their calculations and then check their answers against that which the program provides. Allmendinger's 2012 book, "Structural Geology Algorithms," documents his code and has already accrued nearly 500 citations.

Mobile devices are the future of field work, according to Allmendinger. "Few geologists realize how many highly accurate sensors are packed into the smartphone that they carry around in their pocket," said Allmendinger, who now has three apps available in the iOS app store.

Stereonet Mobile not only displays strikes and dips but can also be used to collect orientation data instead of a Brunton Compass. Field data collection is about an order of magnitude faster with a smartphone than with a traditional analog compass, meaning that the field geologist can begin to enjoy the benefits of data redundancy and increased signal to noise ratio. "Following the Pisagua earthquake in 2014, we collected about 3,700 measurements of coseismic cracks with iPhones in just 12 days of field work, something that would have been impossible with traditional Bruntons." Two other mobile apps facilitate field collection of fault-slip data and stratigraphic section data.

"Of course, as a scientist, you want to be known for your science contributions and I think my publication record bears that out," said Allmendinger. "However, my software has reached a vastly larger audience and that, too, is gratifying."

Check out his programs at: http://www.geo.cornell.edu/geology/faculty/RWA/program


Rick Allmendinger takes measurements using his mobile app.

STUDENT AWARDS AND HONORS

Doyeon (DK) Kim Ph.D. '18 (Brown), now a postdoctoral associate in EAS, received a 2018 Student Presentation Award from the Seismological Society of America for his presentation, "High Resolution Imagine of the Plate Interface in Central Alaskan Subduction Zone Using Autocorrelation with Local Earthquakes." Kim was mentored by Professors Katie Keranen, Geoff Abers and Larry Brown.

Jansen Smith, Ph.D. '18 (Dietl) was co-author of a highly publicized paper with Greg Dietl, adjunct associate professor in EAS and curator of Cenzoic invertebrates at the Paleontological Research Institution (PRI) in Ithaca, and John Handley, a research associate at PRI and a scientist with the University of Rochester's Goergen Institute for Data Science. The title of their work is "Effects of Dams on Downstream Molluscan Predator-Prey Interactions in the Colorado River Estuary," and was published in the *Proceedings of the Royal Society B*, May 30, 2018.

Joey Durkin (Jordan) was selected for an Outstanding Student Poster and PICO (OSPP) Award at the European Geosciences Union General Assembly 2018 in Vienna Austria. Only one out of 33 students receive this award. His presentation was titled, "Impact of different crustal elastic models on interpreting regional GIA deformation in southeast Alaska." Co-authors were Sam Kachuck Ph.D. '18 (Cathles) and Professor Matt Pritchard.

Marc Alessi '18 (DeGaetano and Ault) received the 2018 Father James B. Macelwane annual award in meteorology from the American Meteorological Society for his honors thesis, "Identifying a Soil Moisture-Rainfall Feedback in the 2016 New York Summer Drought."

Tasnuva "Ming" Khan '18 (Allmon) stayed on after graduation to work on Cornell's Earth Source Heat project. Khan has multiple lab and field based assignments. In particular, her research involves identifying lateral mass discontinuities using gravity methods; the orientation of fractures in the crystalline basement using digital elevation models of the Adirondacks as a proxy; and stress states using oil and gas well logs.

Sage Mitchell (Greene) spent the spring 2018 semester as a teaching assistant with the CORALS program in Friday Harbor, Washington.

Anant Hariharan '18 received a National Science Foundation (NSF) Graduate Research Fellowship Program (GRFP) award for his research in the field of seismology. Only 2,000 students received the NSF fellowship awards out of over 12,000 applicants.

Alida Perez Fodich (Derry) and **Kyle Murray** (Lohman) are featured students on Cornell Engineering's Ph.D. spotlight section of their website.

Whyjay Zheng (Pritchard) produced a popular YouTube time-lapse video on the collapsing Vavilov Ice Cap in the Russian High Arctic. The article that it complements was published in *Earth and Planetary Science Letters*. The paper whose first author is Mike Willis, former postdoc of Matt Pritchard, "Unprecedented Ice Loss in Russian Ice Cap," shows how quickly cold glaciers can change speed and lose mass.

SGO OUTREACH

The EAS Student Graduate Organization (SGO) organized interviews of Snee Hall's exemplary technician, George Hade, and Emeritus Professors Muawia Barazangi and Dan Karig for posterity. The willing subjects shared a wealth of knowledge and history. The students recorded the sessions which can be viewed on YouTube, courtesy SGO's president, Paula Burgi. Other officers of SGO are vice president and treasurer, Dana Peterson, GPSA representative, Kyle Murray, faculty liaison, Alida Perez Fodich, and member at large, Andrés Aguirre.

Paula Burgi

HADE

George Hade is described by Paula Burgi as "an instrument engineer who worked in the golden years of plate tectonic theory." As a brief biography, she added, "George Hade was born and raised in New Jersey. After high school, he worked a few odd jobs and then joined the navy in 1948. He worked as a naval aviation flight engineer for 4 years. He then left the Navy, and worked for a short stint as an engineer for drag racers. After running into an old friend who invited him to New York City, George enrolled in engineering classes at NYU and a local night school in New Jersey, completing his education in 1956. As fortune had it, he answered an ad in the newspaper for a instrumentation designer and engineer at Lamont Observatory at Columbia University. He worked there until 1972, before moving to Cornell where he has worked until now."

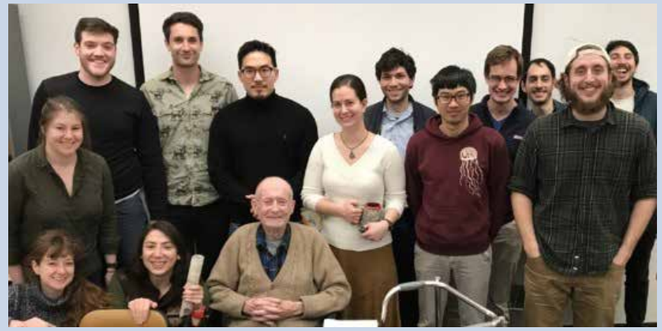
While at Lamont, he helped develop high-gain broad band systems, assisted with the Fiji/Tonga seismic station deployment (essential to the development of plate tectonics theory), and helped establish the largest underground geophysical observatory in the world. At Cornell, he was part of the earthquake prediction program in Vanuatu, helped developed the highest resolution instruments of the time (e.g. oscillatory equipment), and lead many projects exploring new instrumentation methods for geophysics. George Hades' interview can be seen on YouTube: youtu.be/YN_NPGeO6DE

BARAZANGI

Burgi introduced Barazangi by saying, "Muawia Barazangi, a seismologist who created the first global map of seismicity, discovered the back-arc seismic anomaly, discovered intraplate seismicity in California, and so much more. Muawia is originally from Syria, and traveled to the USA for his bachelor's degree at University of Minnesota in the 1960s. He then went to Lamont Observatory at Columbia University for his Ph.D., subsequently moving to Cornell University and becoming full professor. Muawia enjoys practical jokes, classical music, and feeding hungry graduate students." His video can be viewed on YouTube: youtu.be/f7F8__RJeGs

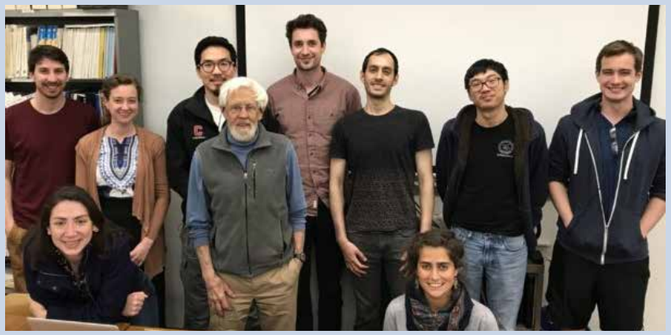
KARIG

Dan Karig is described by Burgi as "a marine geophysicist, experimentalist, world-class athlete, and more! Karig did his master's work at Colorado School of Mines, and moved to Scripps Oceanographic Institute for his Ph.D. While there (~1970), he made the major discovery of back-arc basins, which was a huge advance in the understanding of plate tectonics. Dan went on to become a professor at Cornell University, continuing his research in back and fore-arc basins and other problems in tectonics. After retirement, he became a world champion cross country skier and marathon canoer. He is still active in research pertaining to the local (upstate New York) glacial history. View his recorded interview: youtu.be/TAZ08IBsNDs



Technician and storyteller extraordinaire, George Hade, surrounded by the graduate students attending his talk. Students clockwise: Alida Perez-Fodich, Dana Peterson, Katie Grant, Nate Stevens, Kyle Murray, Doyeon Kim, Patricia MacQueen, Aristides Alfaro, Whyjay Zheng, Casey Root, Andres Aguirre, Michael Mann, Paul Morgan

Emeritus professor and caretaker of Snee Hall, Muawia Barazangi with the graduate students who attended his talk. Students clockwise: Alida Perez Fodich, Kyle Murray, Lester Olivares, Kevin Reath, Michael Mann, Whyjay Zheng, Patricia MacQueen, Kayla Crosbie, Roque Soto Castaneda, Jinyi Li, Paul Morgan, Katie Grant, Charlotte Devitre, Dana Peterson, Irene del Real Contreras



Emeritus professor and dedicated educator of geological sciences, Dan Karig, standing amongst attendees of his talk. Students clockwise: Alida Perez Fodich, Paul Morgan, Dana Peterson, Doyeon Kim, Kyle Murray, Andres Aguirre, Whyjay Zheng, Casey Root, Irene del Real Contreras

FUTURE OF RIGHT WHALES DEPENDS ON ADAPTIVE CONSERVATION POLICIES

By Blaine Friedlander | Cornell Chronicle

Humanity may forfeit the chance to save North Atlantic right whales from extinction if new international conservation policies are not drawn up and implemented quickly, according to a new Cornell study in the June 2018 issue of *Oceanography*.

Following a dramatic northward shift in the whales' territory, scientists last summer confirmed the deaths of at least 17 right whales primarily in Canada's Gulf of St. Lawrence. This range shift brought right whales into areas unprotected by policies meant to reduce ship strikes and fishing gear entanglements.

"The 2017 Gulf of St. Lawrence emergency management action was informed by the temporary, near real-time right whale search effort, but these rapid-response measures were arduous and expensive," said Erin L. Meyer-Gutbrod, Ph.D. '16, now a postdoctoral scholar at the University of California, Santa Barbara, who co-authored the study with Charles Greene, Cornell professor of earth and atmospheric sciences, and Kimberley Davies, Dalhousie University postdoctoral fellow.

"We are now challenged to develop a program that combines scientific effort and conservation policy that is sustainable and adaptive," said Meyer-Gutbrod.

The North Atlantic right whale population currently hovers around 500 animals, with about 20 percent being reproductive females. This small, highly endangered population cannot sustain elevated mortality rates for long.

Studies from 1980 to 2012 showed that the right whale population was gradually increasing. More recent population models, which include demographic data through 2015, indicate that the right whale population has entered a period of decline, Meyer-Gutbrod said.

Marine experts know most, if not all, of the whales by name or number. Researchers observed only five North Atlantic right whale calf births in spring 2017, and zero births in spring 2018. If the dramatic increase in right whale mortality rates observed last year persists, the population will decline to extinction in 30 to 35 years, Meyer-Gutbrod said.

Canadian government agency Fisheries and Oceans Canada has an updated 2018 plan to protect right whales in the Gulf of St. Lawrence by including mandatory speed reductions for vessels greater than 20 meters (65.5 feet) long, closing snow crab fisheries early to prevent equipment entanglement, and creating areas where no snow crab or lobster harvesting gear is permitted.

Additionally, the scientists suggest restoring the now-defunct Continuous Plankton Recorder Survey program in the Gulf of Maine to monitor prey conditions for the right whales in their traditional foraging areas. Right whales typically need to consume over 2,500 pounds of plankton daily, but the southern distributional range of their preferred prey species may be shifting northward with warming ocean temperatures.

The scientists also suggest: increasing vessel-based, aerial and passive-acoustic monitoring; examining the management area strategies for fisheries and shipping channels in the Gulf of St. Lawrence this summer; testing fishing gear modifications to reduce entanglement risks; and finding ways to minimize the overlap between sojourning whales and fishing gear in space and time.

"The mounting pressure from a warming and increasingly acidified ocean requires timely implementation of adaptive conservation and management policies to protect ocean ecosystems and their living inhabitants," said Greene.

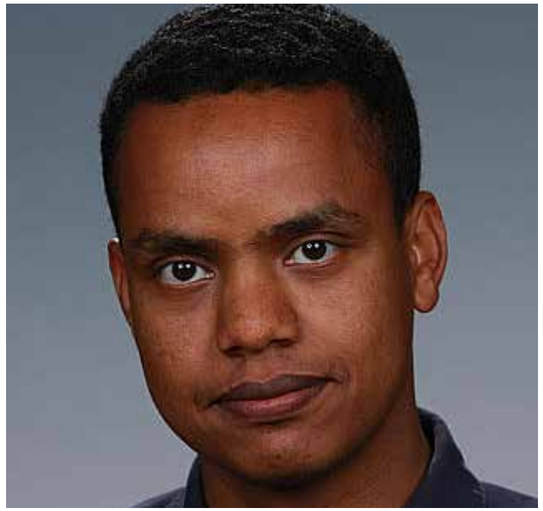
Added Meyer-Gutbrod: "As it has in the past, the fate of this iconic species—and the ecosystem upon which it depends and contributes—will be determined by policy decisions."

Meyer-Gutbrod was funded by Cornell's Atkinson Center for a Sustainable Future and by the National Defense Science and Engineering Graduate Fellowship Program of the Department of Defense. Greene was supported by the Atkinson Center and the Office of Naval Research.

SAMSON HAGOS '08

Samson Hagos received his M.S./Ph.D. in atmospheric sciences from the College of Agriculture and Life Sciences in 2008 under the advisorship of Kerry Cook. Hagos came to Cornell after earning a bachelor's degree in physics from the University of Asmara in his home country of Eritrea. Hagos is employed by Pacific Northwest National Laboratory (PNNL) where he is an earth systems analysis and modeling scientist. Following Cornell graduation and prior to joining PNNL, Hagos spent two years as a postdoctoral associate at the University of Miami, Rosenstiel School of Marine and Atmospheric Sciences.

Hagos chose Cornell for his studies because he felt that Cornell was an excellent school with a lot of resources. He says, "the atmospheric science graduate program was particularly attractive for it allows the student to design their academic program based on their background and interests. It also provides opportunity to interact with prominent faculty members not only in the atmospheric sciences, but also in related fields such as planetary sciences, fluid mechanics and applied mathematics." Hagos was really interested in understanding complex systems and in solving physics and mathematical problems, so Cornell's atmospheric science program gave him a unique opportunity to use his interests and aptitude to work on problems that are not only technically challenging, but also are of utmost societal importance and urgency. While at Cornell, Hagos benefitted from the guidance of his advisor, Professor Kerry Cook, and under her tutelage, was able to publish his findings.



Samson Hagos

While at Cornell, Hagos' graduate work was on regional climate modeling. For his Ph.D. thesis, he developed a regional mixed layer ocean model and coupled it with an atmospheric model. He also worked on problems related to the onset of the West African monsoon and on the causes of the Sahel droughts of the last decades of the 20th century (which he experienced firsthand growing up in Eritrea).

Hagos' current research interests are focused on understanding and modeling of precipitation processes over a wide range of spatiotemporal scales, from the life-cycles of individual convective cells, to tropical intra-seasonal oscillations, atmospheric rivers and monsoon systems as well as their responses to global climate change.

The American Meteorological Society has recognized Hagos with a 2019 award for his outstanding work. For novel use of observations, theory, and modeling to advance understanding of tropical convection and its interactions with the large-scale circulation, Hagos has received the 2019 Clarence Leroy Meisinger Early Career Award.

Hagos hopes to "contribute my small part to help make this earth a great home for us, our children and grandchildren by continuing to be part of the global scientific enterprise."

Director of Meteorology at ClimaCell, Daniel Rothenberg '11

"I knew pretty early on that I wanted to study meteorology in college; I had spent some time in High School volunteering at the National Weather Service Weather Forecast Office in Louisville, KY, and was a huge weather nerd. The biggest open question, though, was what I actually wanted to do with my degree in atmospheric science. I gambled that working hard in my major and supplementing with rigorous math, physics, and computer science courses would help me find my way as I worked through college.

At Cornell and as an undergraduate, I didn't have a really well-developed idea of what research interested me until quite late. However, I knew that I wanted to fuse two different interests—computer science and atmospheric science. Naturally, something involving atmospheric or climate modeling was a good fit for joining these two interests. Professor Natalie Mahowald started teaching during my first year, and once I learned about her background and research interests, and how they involved numerical modeling, I approached her about research opportunities. I ended up working on a multi-disciplinary project involving biogeochemistry and climate.

EAS provided a very well-rounded STEM education. The comprehensive exposure to topics across math and science really prepared me for my graduate studies (the only person in my graduate cohort who I thought had seen more from their basic, mandatory classes than I did was a friend from Caltech—but that's a whole different type of college experience.) But the really great thing about the major was that chance to integrate other interests. During my tenure on campus, a lot of EAS students would find time to study in applied economics and management or other pre-business courses. There was just as much opportunity to branch out into computer science or other technical courses of study, too—and there was always ample opportunity to bring that knowledge back home and apply it to EAS work in some way, shape or form.

I immediately attended MIT for graduate school after Cornell. There, I went straight into the Ph.D. program in atmospheric science, working on problems relating to aerosols in the climate system. My advisor didn't have a set, mandatory project for me to work on, but we developed a very prescient project which used sophisticated new modeling techniques to build parameterizations for climate models which we hoped would improve our ability to study the aerosol indirect effect on climate.

I'm an avid violinist, and still enjoy playing in numerous orchestras and chamber ensembles. Since moving to the private sector I've had to scale back considerably, but nothing feels as rewarding as picking up the violin after pouring over two decades of study into it.

Beyond my music, I spend a lot of time working on side projects involving cool technologies and computational problems. Nowadays, with the democratization of compute resources and their availability on the cloud, anyone can set up an high performance computing system on the cheap. I continue some of my research, but spend just as much time looking at ways to apply AI and machine learning to interesting problems in our field.

Something I've learned over the last few years is not too to worry or hope too much about the long-term. I have personal goals, such as starting my family, but professionally, I've come to discover that the more you plan, the more likely you'll be to miss really amazing opportunities as they randomly appear."

Rothenberg offers some advice to students:

" There's this thing that you learn to appreciate later on in life called a "life-work balance." It's easy at a place like Cornell to lose yourself in your studies and your work. Don't. Always make time to cultivate your hobbies and interests, and be sure to stay in touch with your friends or social scene. As wonderful as meteorology and EAS are, there is much more to life than sitting in Mann library cramming for your dynamics mid-term every night. Go randomly grab a bite at one of the spots on the Commons, and say "hi" to a stranger. Check out what's going on at Ithaca College. Make a short road-trip to hike up Watkins Glen. If you're into it, check out a concert in Syracuse or Rochester— the Cornell Concert Commission brings awesome shows to campus, but check out your favorite band in an unfamiliar environment. Join a totally random club just for the sake of it.

The point of all this is to experience all of the amazing things that Cornell and the region have to offer. After all, after college, you may never really get another chance to take advantage of them!

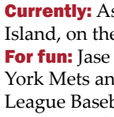
For the more hardcore, academic-types: learn how to write scientific software. Develop and cultivate those skills early, and practice them often. The physical sciences are rapidly changing, and these technical skills—how to create reproducible, transparent code and work—will be the skills you need to succeed in the research world of tomorrow."

Daniel Rothenberg

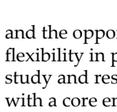
Jase Bernhardt, B.S. '12, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: Performed research at the Northeast Regional Climate Center all 4 years under the direction of Regional Climatologist Keith Eggleston and digitized historical climate data; analyzed east coast winter storm climatology with Professor Art DeGaetano.
Currently: Assistant professor at Hofstra University on Long Island, on the tenure-track.
For fun: Jase loves running, lifting weights, watching the New York Mets and traveling. Jase is attempting to reach each Major League Baseball stadium and each state capitol building. He's visited 26 of each of these already!

Louis Caiola, B.S. '17, Science of Earth Systems, Engineering; M.Eng. '18 (Energy Economics and Engineering)
While at Cornell: Studied subsurface energy recovery and sedimentary rock characterization. Enjoyed the close-knit community, specialized modules, and the opportunity for field study abroad. EAS allowed the most flexibility in pursuing energy industry interests with the ability to study and research energy and mineral resources in conjunction with a core engineering curriculum.
Currently: Deep-water production engineering at Shell Oil in New Orleans supporting Gulf of Mexico assets.
For fun: Louis enjoys fishing and surfing. More recently, Louis has been really enjoying exploring New Orleans culture.

John Cintineo, B.S. '09, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: The tight-knit community of faculty and students was indispensable for rigorous, open inquiry and personal growth. Studied severe thunderstorms, hurricanes and snowstorms. John grew up on a flower farm, always tracking the weather.
Currently: Research meteorologist, Space Science and Engineering Center/Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison
For fun: John likes serving his community church and playing with his kids.



Adam Epstein, B.S. '14, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: Focus was on how to most effectively communicate emergencies to the public through linking communications minor with meteorology courses. The best thing about Cornell as a whole was to be surrounded by people driven to succeed.
Currently: Broadcast meteorologist at FOX40 News in the Morning in Sacramento, California.
For fun: Adam plays competitive year-round volleyball, indoors and on the sand.



Peter Hall, B.S. '95, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: Interests were in forecasting and getting experience in the TV business. The best thing about EAS and Cornell was absolutely Professor Mark Wysocki by far. He always had time for his students for any questions regarding his classes, about forecasting the weather, about possible career paths and anything at all in life.
Currently: Employed at WSTM NBC3 in Syracuse where he started right after graduation.
For fun: Peter enjoys cooking, playing drums/guitars, and listening to music.

Stephen Hudson, B.S. '00, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: Interest was mainly in Arctic and Antarctic climate. Stephen enjoyed the community that seemed to naturally form among the fairly small group of atmospheric science majors and developed good relationships with the instructors as well.
Currently: Research scientist at the Norwegian Polar Institute in Tromso, Norway.
For fun: Stephen likes travelling and scuba diving, being outside, reading and brewing beer (or find good breweries while travelling.

Garrett Koehler, B.S. '12, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: For a short period of time, conducted undergraduate research with Professor Natalie Mahowald. The opportunity to work with such a renowned professor as an undergraduate highlights the immense opportunities that undergraduates have.
Currently: Air quality consultant, primarily conducting air dispersion modeling for clients in the petroleum refining, chemical manufacturing, roofing and asphalt, and IT data center industries.
For fun: Garrett enjoys spending time outdoors. In the summer Garrett spends time on the lake with family and friends; in the winter he is an avid waterfowl hunter.

Maureen McCann, B.S. '02, Atmospheric Science, Agriculture and Life Sciences.
While at Cornell: Broadcasting focus by participating in the local student television station at Ithaca College.
Currently: Broadcast meteorologist at Spectrum News 13 in Orlando, Florida since 2013; graduate student focusing on emergency management and geographic information systems at University of Central Florida. In addition to her role as a morning meteorologist, Maureen serves as the Commissioner on Professional Affairs for the American Meteorology Society.
For fun: Maureen enjoys going to the beach year-round now that she's in Florida, in addition to playing tennis and golf. And, being from Boston, she still likes to follow the Red Sox, Patriots, Bruins and Celtics.

Alex Perez, '12, who minored in science of earth systems as an undergraduate at Cornell, and is now an M.D./Ph.D. candidate at Weill Cornell Medicine, appeared in *Forbes* in the 30 Under 30 - Science 2018 category. Perez's career goal as a physician-scientist is to use computational techniques to better understand cancer. To that end he developed GuideScan, a app for researchers who use CRISPR that ensures precision in adding and removing sequences from DNA molecules. GuideScan is currently being used by more than 3,000 researchers worldwide.

Cornell Engineering
College of Agriculture and Life Sciences
Earth and Atmospheric Sciences
2122 Snee Hall/11th Floor Bradfield Hall
Cornell University
Ithaca, NY 14853



Thank you to all who have contributed to the EAS 2020 Vision Endowment. We still need more help to reach that ultimate goal of $1 million by 2020. Please make your gift to Earth and Atmospheric Sciences because *Science Matters.*
https://www.eas.cornell.edu/eas/alumni/give-eas