INTRODUCTORY OCEANOGRAPHY
now taught in Bailey Auditorium

...at the Nexus of Energy and Climate Change Science...
Geology alumni, family, and friends gathered for a celebratory weekend in mid-June. Activities were kicked off with a reception for invited speakers in the Ramin Parlor of Sage Hall—the room where original members of the Geological Society of America held their founders’ meeting in 1888. Saturday’s program, “Arc of Geology” included several lectures given by invited speakers. Cornell alumni Bill Brice M.S. ’68, Ph.D. ’71 and Steve Marshak A.B. ’76, as well as John W. Hess, Executive Director of GSA, Victor Ramos, Professor Emeritus, Universidad de Buenos Aires, and EAS faculty members Suzanne Kay, Larry Brown, Geoff Abers, and Katie Keranen gave talks. A Saturday evening dinner at the Paleontological Research Institution and Sunday afternoon picnic at Taughannock Falls State Park capped off the weekend’s events. The weekend was a perfect opportunity to engage with fellow geologists, former classmates and faculty.

Back for the Future
Alumni Celebration Weekend
June 2014

Photo provided by Alex Erendi

Cover Photo by Kathie Hodge

Newsletter produced by Judy Starr
Other Contributors: Rick Allmendinger, Toby Ault, Art Bloom, Erin Camp, Tanvi Chheda, Steve Colucci, Tom Hamill, Terry Jordan, Katie Keranen, Gaige Kerr, Rowena Lohman, Matt Pritchard, Diego Quiros, Lauren Cahoon Roberts, Elise Skalvold, John Thompson, Bill White
This is an exciting time for Earth and Atmospheric Sciences at Cornell. We have always been widely recognized within our disciplinary communities, but the profile of the department within the University has never been higher. Our expertise in fossil fuels, global warming, induced seismicity, freshwater, and natural hazards is routinely sought. EAS faculty are frequently asked to participate in large group projects and hold influential positions on University committees. The strategic plans of both the College of Engineering and the College of Agriculture and Life Sciences—energy, climate change, big data—align well with department strengths. This visibility is beginning to pay off. In the last couple of years we’ve hired four new faculty members: this year, Sara Pryor (atmospheric science) and Geoff Abers (geological sciences) join our faculty as full professors; last year, Katie Keranen (geological sciences) and Toby Ault (atmospheric science) signed on as assistant professors. In addition, Bruce Monger, who many of you know already, was officially appointed as a senior lecturer in EAS.

Our new colleagues are already generating significant buzz: a Science paper published in July by Katie and Geoff and colleagues demonstrated the connection between waste water injection and significantly increased induced seismicity in Oklahoma. Toby was written up in a variety of newspapers and magazines for his research on megadroughts in the western U.S. Sara joined us in August after high profile service on the National Climate Assessment Development Advisory Committee of NOAA for which she was recognized by President Obama. Finally, Bruce teaches the single biggest class at Cornell, Introductory Oceanography, which this Fall has topped out at about 925 students (see cover photo).

Longtime department stalwarts are no slouches either! Suzanne Kay just wrapped up a successful year as President of the Geological Society of America, 125 years after it was founded at Cornell University (in Sage Hall). Lou Derry just won a $1.4 million dollar grant to establish a critical zone laboratory at Cornell. Susan Riha’s leadership of the Water Resources Institute ensures frequent trips to Albany to advise policy makers about a wide range of freshwater issues, not the least of which concern the impact of potential shale gas development. Terry Jordan continues her co-leadership of the innovative Earth Energy Integrated Graduate Education and Research Training (IGERT) program funded by the National Science Foundation, and this year was named a Fellow of the American Geophysical Union (AGU), joining Bill White, Suzanne Kay, and Bryan Isacks as current Fellows. And, speaking of Bryan, we could not be more thrilled that he will receive this year’s Bucher Medal from the American Geophysical Union recognizing his decades of spectacular, innovative contributions to earth science. We will all be celebrating at the AGU meeting in San Francisco.

All this has been a lot to absorb for your new Chair of the Department of Earth and Atmospheric Sciences, but this level of success did make it a lot easier to decide to accept the job! That success is due in no small part to the efforts of my predecessors in this position, Larry Brown and Art DeGaetano. EAS owes them a huge thank you for their efforts to make the department stronger and more visible. They are now blissfully back doing what they love: research and teaching. I know, however, that I will be relying on their wisdom and counsel going forward. In my new role as Chair, I am following a precedent set during the last year of Larry’s term: EAS has transitioned to a single chair model after years of having a chair and a co-chair, one for each college to which we report. This is a good sign, as it implies that the merger of geological sciences and atmospheric science has been successful. I now represent EAS to both the Dean of Engineering, Lance Collins, and the Dean of Agriculture and Life Sciences, Kathryn Boor. Both Deans are strongly supportive of our department.

We are addressing a number of very interesting issues and opportunities this year, which I hope to report on in subsequent newsletters, but in the remainder of this letter, I want to focus on EAS’s position at the nexus of energy and climate change. To say that these issues generate a lot of passion would be an understatement. EAS faculty research spans the gamut including climate modeling, impacts of global warming, glacier flow rate monitoring via remote sensing, fresh water utilization, induced seismicity from waste water injection, carbon sequestration, geothermal energy, algal biofuels, capillary seals in oil and gas reservoirs, and stratigraphy and micro-mechanics of the Marcellus Shale. Of course, each of us has our own opinions, but because of our research expertise we also know more about parts of these issues than most people who participate in passionate public discourse. How should EAS respond to and participate in this increasingly acrimonious and polarizing debate?

Universities should be institutions where rational discourse about difficult issues takes place, where even unpopular positions are listened to and debated respectfully. If we can’t work out these issues in a university setting, where can we expect the discourse to occur? In EAS, we think that both understanding the risks of anthropogenic climate change and meeting the energy and mineral needs of a global population that has almost tripled since I was born are vitally important issues. In general, we believe that objective scientific research published in respected journals, without taking an advocacy position, best serves our stakeholder groups: our students, Cornell, and ultimately the public who needs unbiased information to make informed decisions. In the end, if we prioritize either energy or climate change over the other, society will lose.

This does not, nor should it mean that we all agree with each other about priorities or the interpretation of specific data. Debate is part of the scientific process. However, when we put our data out there, it is because we want the science to speak for itself not because we want to push a political agenda. Elsewhere in this newsletter, you will see vignettes by Terry Jordan, Katie Keranen, Toby Ault, and Matt Pritchard, working on different aspects of energy and climate change. The topics they address are undeniably important and represent very different takes on the issues at hand, but in each case the emphasis is on the science.

It is a privilege and an honor to be the Chair of a department and faculty that is so much at the center of the national and campus debate. I would welcome your thoughts about EAS’s role in public discussions of climate, energy, fresh water, or anything else you would care to bring to my attention.
Professor Sara Pryor is an atmospheric scientist who studies the complexities of our climate system and seeks to improve our ability to predict possible future climate conditions. Her research excellence led to her appointment to the National Climate Assessment Development Advisory Committee convened by the U.S. Department of Commerce’s National Oceanic and Atmospheric Administration, for which she received a letter personally signed by President Obama. “It was an honor to serve both his administration and the country in that capacity,” says Pryor, a new professor in the Earth and Atmospheric Sciences Department.

Before joining Cornell, Pryor was Provost’s Professor and Associate Vice Provost for Faculty and Academic Affairs at Indiana University. Her academic journey began across the Atlantic Ocean—as an undergraduate and graduate student at University of East Anglia in the United Kingdom. However, she spent much of her time during her Ph.D. in the United States at the Scripps Institute of Technology in San Diego and the Desert Research Institute in Reno, Nevada. She then took a position as a postdoctoral fellow at the University of British Columbia in Vancouver, Canada.

“It was a big decision for me to move to North America,” said Pryor, “but at that time atmospheric research in the U.S. was far advanced from the U.K., and moving to a country in which I knew no-one taught me a lot about self-reliance and allowed me to grow and mature personally and intellectually.” She continues, “I still maintain close ties to colleagues at the other institutions at which I have been employed and also have a courtesy appointment in Denmark that allows me to continue to spend time each summer in Europe. These transatlantic research collaborations are absolutely critical to advancing science.”

Pryor’s climate system research has two primary themes: “The first is focusing on how changing atmospheric composi-

A Win-Win for EAS: Two Outstanding Scientists Join Faculty in 2014

Atmospheric Scientist, Sara Pryor

One current project under this category involves examining how forested ecosystems remove aerosol particles from the air, and equally how emissions from forests increase the concentrations of atmospheric aerosol particles. “Atmospheric aerosol particle concentrations represent one of the largest uncertainties in understanding both historical and possible future climate change. This is in part because of the complexities of processes that determine particle composition, size and concentration,” says Pryor.

Professor Pryor’s research into atmospheric aerosol particles is also motivated by our knowledge that they are responsible for over 800,000 premature human deaths per year. In a recent study she and two students quantified human exposure to very high concentrations across the city of Indianapolis and found that although there is a high regional background concentration, it was enhanced in certain locations by emissions from motor vehicles. “Indiana does not conduct motor vehicle emission testing. Our results suggest—if they did, those measures could greatly reduce the human health toll from motor vehicle-related air pollution,” she said.

The other area of Pryor’s research focuses on understanding the dynamics of the climate system; what causes long-term variability and change, and how that knowledge can be used to make better projections of future climate states. Using both numerical models and statistical tools, Pryor’s team aims to predict regional climate change—so what one town can expect to experience as global warming takes hold and alters the atmospheric system as a whole. “Taking large-scale projections of the global climate and making more local-scale predictions of what that means for a given location or region is called downscaling in atmospheric science,” says Pryor, “but in many ways we can think of it as ‘right-scaling’. After all, what matters to most people is what will happen in their vicinity rather than what the global mean temperature might be.” She continues, “Human activities have changed and are changing our climate. While we can still decide how much climate forcing we will apply by emitting heat-trapping gases, for example, we must accept that some climate change has occurred and more is now inevitable. We must adapt to build resilience to that change.” Understanding what types of extreme events a region might experience is critical to making cost-effective adaptation decisions and choices. Pryor’s work in this arena has focused on extreme winds and precipitation, and particularly on impacts to major infrastructure and other high-value assets. “Our work for the International Atomic Energy Authority, European Union and U.S. federal agencies suggest extreme wind and precipitation events over much of North America and Europe will intensify in the coming decades, but also that the wind energy resource can and will continue to provide a cost-effective and carbon-free electric-

Sara Pryor
From there, Abers has traveled to Papua New Guinea to study a particularly active geologic zone where “the Pacific plate and Australian plate are bouncing off of each other and making all these new mountains and ocean basins.” Abers wrote his thesis on how this system active builds mountains, and continues to study the active rifting zone in this region today.

From there, Abers has traveled to study the active rifting zone in this region today. He first became interested in this field as an undergraduate at Brown University, where he recognized the benefits of a career in earth sciences and geology. “I realized I could take rigorous quantitative skills that I got in physics, and then apply them to interesting problems.” He also liked the fact that the field allowed for students to get out into the field and do hands-on research fairly early-on.

Abers has continued that hands-on work ever since. As a graduate student at MIT, he traveled to Papua New Guinea to study a particularly active geologic zone where “the Pacific plate and Australian plate are bouncing off of each other and making all these new mountains and ocean basins.” Abers wrote his thesis on how this system actively builds mountains, and continues to study the active rifting zone in this region today.

Abers’ ongoing field work at Mount St. Helens involves these seismometer arrays, both around the summit and farther around the mountain, that are able to get images as far as 100 km down into the mantle in order to better understand how and if magma builds at that depth. “This will help us create more complete models for what happens when these things do erupt,” says Abers.

In addition to this project, Abers is also investigating the use of underwater seismometers off the coast of Washington that can record geologic activity offshore—a new application of the traditional seismometer technology. Abers plans to integrate the data from both offshore and land-bound instruments to get an even better understanding of the behavior of major fault zones.

“Seismologist, Geoff Abers

Abers. “Signals bounce off of things and give you an image of what’s going on below.” Using these tools, Abers has been able to look at plates a hundred miles deep, and can study what exactly the crust below is made of.

Today, earth scientists still rely mostly on rocks and lava chemistry to infer what’s going on beneath the Earth’s surface. Seismometers are helpful as well, but have only just begun to reveal the type of information Abers is after. To get the kind of (literally) deep information he’s looking for, Abers sets up broad arrays of seismometers in and around geologically active zones. “For the last 25 years, I’ve been taking increasingly large, dense arrays of seismometers in places where tectonic plates come together, and using the rich complexity of the data they produce to understand the earth’s structure.”

These seismometers “precisely record everything that the ground does.” If two seismometers are placed at a distance from each other, their two recordings can reveal a great deal about the earth’s crust in between them. “There’s some similarity to a CAT scan or MRI,” says Abers.

Most of us don’t think about what’s going on below our feet, much less several miles below. Geoffrey Abers is different. The Earth and Atmospheric Sciences professor devotes his research to the movements and behaviors of Earth’s deep interior, and to inform our general understanding about events such as volcano eruptions and earthquakes. “The main theme of my work is to probe these inaccessible parts of the Earth,” says Abers, “to see where fluids are migrating and where magmas are forming—and get good, quantitative images of the physical environment there.”

Abers’ ongoing efforts in regional climate downscaling.

Sara Pryor decided to come to Cornell “because there are really exciting opportunities for both transformational and trans-disciplinary research,” she says. “I am already working with colleagues from EAS and at Scripps to determine innovative ways to use seismic arrays for detecting and quantifying extreme wind events. If we are successful, we may transform the way we detect and measure damaging winds, yield new physical insights into the causes of extreme wind gusts, and ultimately decrease the risk posed by extreme winds.”
Water Resources and Shale Gas Production

*The Pennsylvania Scene*

In June, Professors Terry Jordan and Rick Allmendinger led ten graduate students on an 8-day study tour of Pennsylvania and westernmost New York State. The purpose was to see the real world of gas and oil extraction from the Marcellus shale, water management, and the known and potential impacts of unconventional gas production on water and water users. The students are an interdisciplinary group, each becoming an expert in an engineering field or in geology, who are in an NSF-supported educational program called the Cornell Earth Energy IGERT. An important theme for this study tour was to prepare these young professionals to understand the natural system, especially water, well enough that they would later anticipate the complex challenges of protecting and sustaining water before they began to design an energy production system.

The activities included extended conversations with Pennsylvania state regulators, the Susquehanna River Basin water regulators, companies that supply water for drilling activity, the water managers within a major gas production company, drilling and completion professionals from another major gas production company, a public health advocate, a county legislator, farmers, researchers, and a group whose mission is to bring environmental advocates and gas production companies together in shared work that improves environmental practices in gas production and reduces impact. Site visits in Pennsylvania included a gas well drill pad, a water extraction site at a stream, a water impoundment in a region of active hydraulic fracturing, the Drake Well Museum, and Penn State’s core storage and research center. In New York they visited an active conventional gas field, the site of the first natural gas well, and a center of agrotourism.

Above: Professor Rick Allmendinger and IGERT graduate students examining Marcellus core in the Penn State core lab. Pictured right (left to right): Adam Hawkins, Russell Zhao, and Mitchell Ishmael.

Left: EAS Professor Terry Jordan and NYS Water Resources Institute (WRI) Research Associate Brian Rahm, stand behind a group of IGERT students who participated in a field trip to Bear Valley coal mine, a central Pennsylvania abandoned coal strip mine near Shamokin in the Anthracite District. Students from left to right in the photo are: Katherine Hergeman, Russell Zhao, Calvin Wheaton, Andrew Shaw, Jared Smith, Arna Palsson, Lauren Stutzman, Adam Hawkins, and John Mason.
CAN WASTEWATER DISPOSAL TRIGGER EARTHQUAKES?

With an extraordinary surge in seismicity since 2008, Oklahoma has leapt ahead of California in earthquake rate in 2014 and has become the most seismically-active state within the conterminous U.S. The nearly 500 magnitude 3 or greater earthquakes this year in Oklahoma are dramatically more than the stable, long-term average of ~1 per year in the decades prior. Close to one thousand earthquakes have been reported as felt in Oklahoma in 2014 (including shallow earthquakes below M3), unsettling the local communities unaccustomed to such ground-shaking.

Recent research, including our *Science* paper in July (Keranen et al., 2014), indicates that wastewater disposal wells are most likely responsible for increasing subsurface fluid pressure, triggering the earthquake swarm. Our research indicates that high-volume wells can perturb fluid pressure tens of kilometers from the injection wells, with the entire central Oklahoma swarm (a substantial fraction of all midcontinent seismicity since 2008) potentially related to a small number of wells. The results from Oklahoma encourage careful consideration of current regulations for wastewater disposal, and compel thorough analysis of risk factors prior to future water cycling in sedimentary units for waste disposal, hydraulic fracturing, carbon capture and storage, or enhanced geothermal operations.

http://www.eas.cornell.edu/people/profile.cfm?netid=kmk299

Submitted by Assistant Professor Katie Keranen

NEW TECHNIQUES WILL IMPROVE UNDERSTANDING OF SEDIMENTARY ROCKS FOR THE FUTURE

You might have thought that geologists would know a vast amount about mudstone (or “shale”, in everyday speech) since it is the most abundant category of sedimentary rocks—roughly 50%. Surprisingly we don’t, even though over 60% of the people of the United States live right on top of such rock. That collective ignorance has been a severe impairment to informed participation by geologists in the work and debates that have swirled around since the emergence 10 years ago of the boom in production of gas and oil from shale.

Why didn’t sedimentary geologists know much about a common sedimentary rock? There are three big reasons why university-based education and research overlooked mudrocks to an extent that now seems hard to believe. First, much university-based sedimentary geology learning is rooted in what one can see in outcrops. Shale rarely crops out well; usually it is covered by soil and plants. Second, the tools used for the study of sandstone, limestone, or conglomerate are generally not the correct ones for the study of shale. When researchers or educators decided to broaden their knowledge and shift into a new topic, they seldom selected mudstone because it meant learning with all new tools (most of which cost a lot more than their hammer, hand lens, and petrographic microscope.) Lastly, for economic applications of sedimentary rock research, shale was considered the domain of some paleontologists and of geochemists with knowledge about hydrocarbon source rocks, while sedimentary geologists focused on reservoir rocks like sandstone and limestone. We were caught unprepared when regional and national interest in understanding shale gas resources erupted.

As happens often, graduate student researchers have been teaching the faculty the new techniques and discoveries, and the faculty fold this new learning into instructional materials and experiences. This has been EAS Professor Terry Jordan’s strategy.

Graduate students Ceren Karaca (M.S. ’12, John Mason (Ph.D. in progress), and Katherine Herleman (M.S./Ph.D. in progress) have overcome the problem of outcrop by using freshly exposed sections through the Devonian Marcellus Formation in active quarries. There, one can see all the macroscopic details in three dimensions, and can collect samples without reservation. Karaca piloted methods of identifying microfacies characteristics and their relationships to the sequence stratigraphy of the Marcellus basin. Mason has expanded the data set on the spatial extent of microfacies and he is tying the variations in microfacies to variations in the mechanical behavior of the rock. To accomplish this, he has explored Cornell’s excellent inventory of imaging, x-raying, energy dispersing, and hardness-probing machines, largely housed by the Cornell Center for Materials Research and the Cornell Nanofabrication Facility. He also collaborates with engineering colleagues whose specialties are the mechanics of composite materials and nanoscale materials testing. Mason’s ongoing research explores the relationship between a widespread extinction event in the Devonian Marcellus sea, the resulting changes in the abundance and types of calcite in the mudstone, and the mechanical behavior of those rocks today. Herleman is considering other consequences of the microfacies and their variability, in particular some of the potential environmental risks. She uses experiments to determine how the ions released by contact of the shale with simulated hydraulic fracturing fluids vary as a result of the intrinsic variability of the shale microfacies.

Submitted by Professor Terry Jordan
MEGADROUGHTS COULD CAUSE UNPRECEDENTED CHALLENGES

California is currently in the grips of what may turn out to be the most severe drought in the last 150 years. However, paleoclimate evidence from lakes, caves, and tree-ring width measurements indicates that much longer intervals of aridity have occurred in the past. These dry epochs lasting decades, called “megadroughts,” would pose unprecedented challenges to water resources in the southwest if they were to occur again. Our research (Ault et al., 2014), published in the Journal of Climate in October of this year, indicates that climate change might make megadroughts even more likely in the future throughout certain areas of the U.S. Southwest, Northern Mexico, and other semi-arid parts of the world. The study used climate model data alongside paleoclimate records to get a better picture of the dual sources of megadrought risk stemming from natural variability as well as human activity. Does the risk of megadrought pose a “threat to civilization?” Probably not, but our results do emphasize just how precious fresh water is in this country and abroad, and just how important it is to manage it on time horizons of years to multiple decades if we are to thrive as a society despite the risks imposed by megadrought and climate change.

Submitted by Assistant Professor Toby Ault

Photographs taken by former Cornell professors Ralph Stockman Tarr and Oscar Diedrich von Engeln of glaciers in Alaska from 1905-1911 and Greenland in 1896 (including Cornell Glacier that was named by Tarr) will soon be digitized and made available on the Web thanks to a $40,000 award from the Grants Program for Digital Collections in Arts and Sciences.

Tarr, a Cornell professor of geology and geography, and von Engeln, a student and later a professor of geology at Cornell, conducted several field expeditions to Alaska in the early twentieth century and used pioneering photographic techniques to document their findings on these expeditions. According to Alaskan historical glacier photography expert (and former Cornell student) Bruce Molnia of the United States Geological Survey, the fairly untapped Tarr collection is likely to reveal important new observations of glacier change over the past 100 years.

The project is led by Cornell associate professor of history Aaron Sachs, Matt Pritchard, an associ-
Glacial Images of Alaska and Greenland Go Digital

Sach says, “I often use historical photographs in my lecture courses to help students become more fluent in reading and analyzing the visual culture in which they're steeped, and also to help them get in touch with the texture of the past.”

Nine undergraduate students at Cornell and Purdue have been involved in helping to inventory the photographs and compare them with comments in the original field notebooks (also stored in the Cornell archives). Once all of the photographs are digitized in 2015, there are plans for further study of the images and expeditions to Alaska to visit the sites of some of the original photographs to document the glacier change.

The Tarr and von Engeln images will help scientists understand glacier dynamics and document climate change over the long term. One goal of their digitization project, Elliott says, is to determine the precise locations of the glacier photographs to construct a three-dimensional model. Another scientific objective is to quantify the retreat and advance of individual glaciers to better understand the relative effects of regional climate change and the glaciers' response.

2014 marks the centennial year of the book, Alaskan Glacier Studies of the National Geographic Society in the Yakutat Bay, Prince William Sound and Lower Copper River Regions, by Ralph S. Tarr and his Ph.D. student at the time, Lawrence Martin. The book was published by the National Geographic Society who funded several of their trips to Alaska.
Professor Emeritus Bryan Isacks has received the American Geophysical Union’s 2014 Walter H. Bucher Medal. A celebratory reception hosted by EAS will be held on December 18th in San Francisco. Biennially, one individual is chosen to receive this medal. Recipients must be senior scientists and members of AGU who have demonstrated scientific excellence in their body of work over a sustained period of time. Isacks has been recognized for his “original contributions to the basic knowledge of crust and lithosphere.”

Terry Jordan, Cornell’s J. Preston Levis Professor of Engineering, is among this year’s elected AGU Fellows. She joins 61 others in completing the Class of 2014.

Professor Rowena Lohman received the 2013 Geodesy Section Award given in recognition of major advances in geodesy.

Oceanography professor Chuck Greene was a member of the science advisory team of the Emmy award winning “Years of Living Dangerously.” The team won in the category of Outstanding Nonfiction Series.

From the Showtime official site of the series, it is described: “This groundbreaking documentary event series explores the human impact of climate change. From the damage wrought by Hurricane Sandy to the upheaval caused by drought in the Middle East, ‘Years of Living Dangerously’ combines the blockbuster storytelling styles of top Hollywood movie makers with the reporting expertise of Hollywood’s brightest stars and today’s most respected journalists.”

Professor Bill White was a senior participant and lecturer at the Summer 2014 Cooperative Institute for Dynamic Earth Research (CIDER) in Santa Barbara. The photo below was provided by White.

Senior Lecturer Bruce Monger’s Introduction Oceanography class has been moved to Bailey Hall to accommodate the 900+ students enrolled. This class continues to be one of Cornell’s most popular! See this newsletter cover photo (taken by Kathie Hodge) showing the lecture in session in Bailey Hall.

World Professor John Thompson has been elected to the Global Agenda Council: Future of Mining and Metals, which is part of the World Economic Forum. The Council’s purpose is to identify and evaluate priority issues as part of the World Economic Forum. Thompson is also a member of the Advisory Board for the related Mining and Metals in a Sustainable World 2050 initiative.

The mandate of the twenty-one person “Future of Mining and Metals” Global Agenda Council is to provide thought leadership to the World Economic Forum’s Mining and Metals Industry communities. As part of the process, the World Economic Forum launched the “Mining and Metals in a Sustainable World 2050” initiative in recognition of the fundamental economic, demographic and technological transformations expected by the year 2050, and consideration of the impact that these changes are likely to have on the mining and metals sector.

Suzanne Mahlburg Kay, William and Katherine Snee Professor of Geological Sciences at Cornell University is now an honorary professor (Profesora Honoraria) at the University of Buenos Aires. Kay is only the second honorary professor appointed in the geological sciences at the University of Buenos Aires. The resolution for the appointment was approved on May 14, 2014 by the Consejo Superior with the official presentation of the certificate on December 2, 2014 when Kay gave a lecture entitled “Una perspectiva a través de ~30 años de investigación geológica en Argentina”. The lecture followed by a reception at the University that included an Argentine asado.

The approval of the Kay appointment was in Resolucion 210/14 with the decision based on academic accomplishments at the global level and contributions to the University of Buenos Aires and other universities in Argentina through short courses and the collaborative field course with Cornell, which began in 1996. Another consideration was Kay’s recent presidency of the Geological Society of America, which is the largest society dedicated solely to the Geological Science in the world. http://www.ideal.gl.fcen.uba.ar/?p=4357.
Former Governor of Hawaii Linda Lingle visited the Timothy N. Heasley Mineral Museum while she was on campus this fall for a visit and presentation co-hosted by Cornell alumnus Norman Turkish and alumna Sara Beth Canady. Professor Emeritus Bill Bassett and gemologist Elise Skalwold welcomed the guests to Snee Hall and Skalwold gave them an overview of the collections held in the Heasley museum which include most recently added specimens of the Edward Arthur Metzger gem collection.

Left to right in the photo above are Sara Beth Canaday, Norman Turkish, Linda Lingle, Elise Skalwold, Bill Bassett. Skalwold, co-author of the Edward Arthur Metzger Gem Collection book signs a copy for Lingle.

KAUFMAN INSTOC SYMPOSIUM 2014

THE APPALACHIANS: New Views of an Old Orogen—Landscapes, Earth Structure, and Earthquakes

Scientists questioned established paradigms as they gathered in Snee Hall for the Ninth Annual Kaufman INSTOC Symposium in September. “The Appalachians: New Views of an Old Orogen—Landscapes, Earth Structure, and Earthquakes” brought scientists from fourteen top universities. Attendance topped 75 for this year’s symposium—the largest ever. These small meetings have a reputation for fostering discussion and starting new collaborations in a relaxed atmosphere.

Each of the eight invited speakers gave a 30 minute talk on one aspect of the theme. Current Jack Oliver Visiting Professor, Karen Fischer of Brown University gave the keynote talk, “Implications of Crust and Mantle Structure for the Enigmatic Evolution of the Appalachian Landscape.” Other invited speakers included Jim Hibbard of North Carolina State University, Frank Pazzaglia of Lehigh University, Taylor Perron of Massachusetts Institute of Technology, Jerry Mitrovica of Harvard University, Rob Moucha of Syracuse University, Cindy Ebinger of University of Rochester, and Bill Holt of Stony Brook University.

Eleven students, researchers, and faculty also presented posters and gave 2-minute “lightning talks” during the plenary session. Artist Jay Hart of Trumansburg, friend of the Department, created a new graphic showing the topography of the entire Appalachians for the symposium, and described how he created the color scale for this piece, which was most appreciated by attendees.
The Cornell Chapter of the American Meteorological Society (CCAMS) has developed a new concept this year to introduce further weather forecasting techniques to those interested in meteorology. We have begun a bi-monthly forecasting night series that includes guest seminars and interactive forecasting sessions. Our first few forecasting nights included workshops to introduce numerical weather prediction and mesoscale/synoptic scale observations through nowcasting and medium range forecasting. These workshops included interactive sessions to explore the plethora of weather programs, modules, and websites available for amateur and professional meteorologists. The most recent forecasting night included a guest presentation by Cornell alumnus, Jeff Stein, chief editor of The Ithaca Voice. Stein discussed the importance of efficiently communicating science and meteorology to the general public through new methods due to the changes and trends in media communication. He has also allowed CCAMS members the opportunity to publish weather forecast articles in The Ithaca Voice. We are hoping to expand our forecasting nights to produce regional forecasts for the Ithaca area through the CCAMS website and social media outlets. This will allow interested students to gain forecast experience through trial and error.

Submitted by Gaige Kerr, Co-President, CCAMS

Cornell atmospheric science alumni shown above gathered at the 31st Conference on Hurricanes and Tropical Meteorology in San Diego, California from March 31-April 4, 2014. Owen Doherty ’03 is currently a postdoctoral research fellow at Scripps Institution of Oceanography where his focus is on climate variability in the tropics. 2005 alumnus, Daniel Stern is an NSF graduate fellow at the National Center for Atmospheric Research (NCAR). Leon Nguyen ’09 is a graduate student at the University of Albany, Jeffrey Gall ’03 is head of hazard research at Validus Research, Allison Wing ’08 is an NSF postdoctoral research fellow at Columbia University’s Lamont-Doherty Earth Observatory in the Division of Ocean and Climate Physics, David Ryglicki ’05 is a meteorologist at Fleet Numerical Meteorology and Oceanography Center, Owen Shieh ’07 is a weather and climate program coordinator at the National Disaster Preparedness Training Center, and Christina Williams B.S. ’05, Ph.D. ’10 is an assistant research scientist at Texas A&M University.

Earthquake! Waves and Epicenters

EAS graduate students Holly Taylor, Chelsea Scott, and Erin Camp, as well as undergraduate Alana Semple participated in Expanding Your Horizons in April 2014. The program welcomes ninth grade girls from local high schools for science-related workshops. This year’s workshop titled “Earthquake!” taught the girls about earthquakes and seismic waves, and the basics of reading a seismic record. The focus of the workshop was an interactive grid-based experiment that allowed the girls to explore how triangulation is used to locate earthquake epicenters.
Members of EarthScope traveled to Washington D.C. in May 2014 to hold two days of briefings for invited congressional staff, agency personnel and other interested parties in cooperation with the Congressional Hazards Caucus, co-chaired by Representative Zoe Lofgren, Senator Lisa Murkowski, and Senator Mary Landrieu.

Introductions were given by J. Ramon Arrowsmith, EarthScope National Office Director and Professor of Geology, Arizona State University. William Leith, Ph.D., United States Geological Survey, Senior Advisor on Earthquake and Geological Hazards, was the moderator. Each of the following gave overviews of research success and societal benefits:

Mark Simons, Professor of Geophysics, California Institute of Technology: Research and Societal Benefits of EarthScope; Rowena Lohman, Assistant Professor of Geophysics and Tectonics, Cornell University: Research and Societal Benefits of the Plate Boundary Observatory—GPS and Imaging; Hersh Gilbert, Associate Professor, Purdue University: Research and Societal Benefits of the USArray—Seismology.

Organizers of this event were Professor J. Ramon Arrowsmith, ESNO Director; Bob Detrick, President Incorporated Research Institutions for Seismology (IRIS); M. Meghan Miller, President, UNAVCO, Inc., and the following organizations: the American Geophysical Union; the Geological Society of America, and the Seismological Society of America.

EarthScope, a major Earth observing program for ten years, funded by the National Science Foundation, will continue for another five years to examine the Earth’s atmosphere, surface and subsurface across the United States. Additional support and collaborations continue with USGS, NASA, NOAA, FEMA, DOE and other Federal agencies.

EarthScope includes:

- Plate Boundary Observatory (PBO) – More than 1,100 GPS stations, 145 meteorological instruments, 78 borehole geophysical instruments and other tools
- USArray – 400 seismometers moving across the U.S., plus flexible seismic and magnetotelluric arrays
- San Andreas Fault Observatory at Depth (SAFOD) – two-mile deep hole drilled into the San Andreas Fault

EarthScope broader impacts include:

- Earthquake early warning, volcanic eruptions and volcanic ash plume warnings
- Understanding induced seismicity
- Deciphering ground changes due to fluid injections (i.e., fracking fluid disposal) or extractions (e.g., groundwater or petroleum)
- Measuring soil moisture, snow depth or aquifer levels
- Enhancing weather forecasts, hurricane tracking, tsunami warnings, forest fire potential alerts, and space weather tracking
- Open access to data
- Education and outreach
- Land-use planning and development, such as for surveying or engineering
Awards/Events/News

**Commencement 2014**

Left: Former Department Chair Larry Brown hands out diploma announcements and gifts of congratulations to the graduates in the Science of Earth Systems major.

Commencement 2014 Award Recipients:

**Undergraduate:**
- Chester Buchanan Memorial Award—Kathryn Bland
- Frank H.T. Rhodes Award—Adam Stewart
- Michael W. Mitchell Prize—Kathryn Beaumont, Erynn Johnson, Caitlin McDonnell, Roger Michaelides

**Graduate:**
- Bryan Isacks Excellence in Teaching Award—Robert Levine
- Department of Earth and Atmospheric Sciences Research Excellence Award—Erin Meyer-Gutbrod
- Estwing Award—Holly Taylor
- Meyer Bender Memorial Scholarship—Scott Henderson

Left: Steve Bender and Scott Henderson share a moment after Scott receives the Meyer Bender award.

Above: Travis Duran looks proud and pleased to be in attendance--crutches and all!

Left: Holly Taylor proudly displays her new Estwing hammer. Above: Holly Taylor

Above: Class of 2014 undergraduates from the Science of Earth Systems major. Below: Professors Brown (far left) and Derry (center) with Geological Sciences graduates left to right: Felipe Aron, Rahim Gulamaliyev, (Derry), Holly Taylor, Tianqi Liu. Right: Stephen and Maxine Bender who were thrilled to be in attendance, display a department gift they received in recognition of many years of dedication and support to the Department of Earth and Atmospheric Sciences.
Mr. Jay C. Bloom, son of Emeritus Professor Art Bloom, has established a fund to honor his father. In August, Earth and Atmospheric Sciences hosted a reception in Snee Hall to celebrate the receiving of this generous gift and to recognize the whole Bloom family for its many years of Cornell involvement and their generous support to its educational mission. Many family members and friends of the Blooms attended.

Art Bloom continues to be widely admired for his important work at Cornell, particularly in the field of geomorphology. Bloom joined the Cornell faculty after receiving his Ph.D. from Yale in 1959. His service to Cornell spanned a critical time in geology, from the age of geosynclines through the birth and maturation of Plate Tectonics. Bloom’s knowledge of local bedrock and surficial geology of the Finger Lakes region has been an invaluable resource for many through the years. His first love, though, has always been geomorphology, coast lines, and in particular sea level change, a topic that first caught his attention as a young naval officer in the Pacific and has acquired profound importance in the past few decades. This work took him from coastal Maine to the islands of the western Pacific to the coast of South America.

The Arthur L. Bloom Fund for Geological Sciences Research and Education in the Pacific Region will allow geological scientists and students to use the latest technologies while traveling the Pacific region to probe our physical environment. The fund will support research on a wide variety of processes which drive the solid earth, the oceans, and the atmosphere: from geo-hazards to critical resources, the origin of mountains to the origin of megastorms, from reading the geological record of ancient earth to forecasting meteorological threats to future earth.

*The term “Pacific Region” refers to the Pacific Ocean, its islands, and its margins.*
Steve Jessup, Atmospheric Science B.S. ‘02, M.S. ‘06, Ph.D. ‘11, accepted an assistant professorship in the Department of Earth Sciences at the State University of New York at Brockport. Mark Wysocki was his Cornell B.S. advisor, Art DeGaetano was his M.S. advisor, and Steve Colucci was his Ph.D. advisor.

Julia Morgan Ph.D. ’93, received the 2013 Paul G. Silver Award at the AGU Fall Meeting for Outstanding Scientific Service, which recognizes the recipient’s outstanding contributions to the fields of geodesy, seismology, or tectonophysics through mentoring of junior colleagues, leadership of community research initiatives, or other forms of unselfish collaboration in research. Dr. Morgan has been a full professor at Rice University since 2009.

John Amos ’85, Founder and President of SkyTruth, is a recipient of the 2014 Cornell Douglas Foundation’s Jean and Leslie Douglas Pearl Award. SkyTruth uses satellite images and other remote sensing data to understand and communicate local, regional and global environmental issues. They have been featured in the Washington Post and most recently, the Smithsonian.

Neesha Schnepf, Science of Earth Systems B.S. ‘13, currently a graduate student at the Massachusetts Institute of Technology, received an National Science Foundation Graduate Research Fellowship Program (GRFP) fellowship. Schnepf completed a senior thesis last year with Matt Pritchard entitled “An analysis of tsunami electromagnetic signals.”

Geological Sciences Ph.D. candidate, Dana Friend (pictured left), spent three weeks in England during the summer of 2014 doing research for her dissertation. Most of the time, she was working under the guidance of Dr. Jon Todd at the British Museum of Natural History in London. She took advantage of their excellent and unparalleled marine invertebrate fossil collections to gather data on Eocene molluscs from England and the Paris Basin. Her trip also included field work on the coastal cliffs of southern England, collecting fossils from famous localities. Highlights of her trip included handling fossils collected and labeled by Darwin himself, and getting covered in mud while digging for fossils!

Pictured to the right, a photo taken by recent SES undergraduate major, Jennifer Cooper, was selected by the International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) for their 2015 Volcanoes Calendar. The calendar is comprised of pictures of volcanoes from all around the world. Cooper’s photo was taken while she was a volcanology intern at the Universidad de Colima in Mexico in April 2013.

Volcán de Colima (3839m) is a member of the Colima volcanic complex, the most prominent volcanic center of the western Mexican Volcanic Belt. Historically active, its frequent eruptions date back to the 16th century, with occasional major explosions destroying the summit and creating a steep-sided crater. A new lava dome is seen protruding from the summit crater following a renewed awakening in January 2013. Dedicated to Kelby Hicks, who passed away while doing fieldwork on Colima in April 2013.
Cornell atmospheric science alumnus Tom Hamill, B.S. ‘85 and Ph.D. ’97, is a meteorologist at the National Oceanic and Atmospheric Administration (NOAA) in the Physical Sciences Division. He began his career there in 2005. Prior to his appointment, he spent five years at the former NOAA/Climate Diagnostic Center at the University of Colorado, CIRES, as a research scientist.

Hamill is the NOAA Next Generation Global Prediction System Team Lead, ensemble and statistical post-processing teams as well as the Post-Processing Team Lead of the National Weather Service (NWS) Sandy Supplemental “Blender” Project. Hamill has been a familiar speaker at the National Centers for Environmental Prediction, and has been an invited lecturer across the globe including places like Italy, Germany, Argentina, Belgium, and Austria.

From the southern tier of New York, Tom’s family eventually moved to Florida where he lived until his college days. He remembers becoming interested in weather around the age of eight when hurricane Agnes flooded much of upstate New York (including his hometown), Pennsylvania, and Maryland. Tom also remembers following the Apollo space program, but instead of setting his sights on becoming an astronaut, he latched onto meteorology due to his love of the weather, thus becoming his long-term niche.

Like a lot of meteorologists you’ll meet, he was intrigued by weather, especially extreme weather. Hamill says, “No snowstorm could be big enough, no thunderbolt too loud for my taste. The challenge was to find a way to study that and then make a career of it. Being the youngest of eight kids, my parents could only afford to help with a bit of my college costs. But I was very fortunate—I won a United States Air Force scholarship that paid for tuition at Cornell, and spent enough years in the Air Force thereafter to figure out what research problems were worth tackling when I went back for an advanced degree.”

“Cornell has meant so much to me,” says Hamill. “The education system in my corner of Florida was not the best; excellence in surfing was looked up to more than excellence in academics. At Cornell, I was surrounded by other smart students and many tremendous professors and felt at home academically for the first time in my life. Though I didn’t know it so much at the time, in retrospect, my undergraduate atmospheric fluid dynamics and thermodynamics professor Warren Knapp was a big influence for me, demystifying how the atmosphere worked. Thanks so much, Warren. I also sampled courses widely across the university, enjoying Psych 101 taught by Prof. James Maas, Prof. Ted Lowi’s American government course, and Prof. John McMurry’s organic chemistry course. In my return graduate career, in addition to excellent mentorship from Profs. Steve Colucci and Dan Wilks in my department, I had top-notch math instruction from Prof. Steve Strogatz, and was dazzled to learn about the dynamics of other planetary atmospheres from Prof. Peter Gierasch in astronomy.”

Hamill met many new friends through outdoor activities like going on group rides around the Finger Lakes through the Outing Club or rock climbing down in the “Gunks” via Cornell Outdoor Education.

Hamill says that the best thing about his current job at NOAA is the intersection of working on “thorny scientific issues of practical consequence”, and then seeing those methods make it into the products that the National Weather Service uses routinely. His ambitions include collaborating with colleagues at universities like Cornell to entrain and implement the best ideas from academia to help the NWS make the best possible weather forecasts. He’d someday even like to teach again. In the meantime, if any current or future students are interested in learning more about what a career at NOAA is all about, he would be happy to help.

Becoming a dad later in life than most, Tom says his 3-year old son is a “hoot,” and judging from the number of times he says “why?” each day, Hamill thinks he may just have a budding young scientist at home.
Southern Alps Adventure

Science of Earth Systems major, Tanvi Chheda ’16, observed millions of years of geological history in New Zealand when she spent the Spring 2014 semester studying at the University of Canterbury. Her research was focused on liquefaction that caused great damage to the infrastructure in Christchurch, New Zealand during the 2010-11 earthquakes. Chheda mapped the deformation in the Southern Alps using LiDAR maps to narrow down the possible scarp of the Alpine fault where no outcrop could be found due to dense forestation. Her group searched for evidence of past earthquakes, assessing the possible consequences of an 8.0M earthquake on the Alpine fault such as damming, flood, aggregation, infrastructure damage, fire, rescue routes to the town of Franz Josef, glacier instability and advance, avalanches, etc. Chheda was empowered and impressed with the geologically gorgeous sites of the land. During the semester, in addition to taking classes, Tanvi worked with Professor Mark Quigley, an Associate Professor in tectonics and geomorphology in the Department of Geological Sciences at the University of Canterbury. The two looked at the mechanics of liquefaction that had caused major damage to Christchurch in 2010 and 2011.

During her stay in New Zealand, Tanvi took some time to travel to beautiful small towns, hike and reflect on her own life and aims. This, she said, “made me wiser and more humble in ways I wouldn’t have become without making the journey.”

An undergraduate in the College of Engineering and Class of 2016 Tata Scholar, Chheda strives to expand her personal knowledge base by taking advantage of opportunities in a variety of areas. In 2013, she presented her work on hydrous phases relevant to subduction zone settings at the AGU’s Fall meeting in San Francisco which resulted in her receiving the Outstanding Student Paper Award in the Mineral and Rock Physics section. As part of an assignment in the Engineering Introductory course, ENGR 1130 Sustainable Design for Appledore Island, Chheda created 3-D relief maps of Appledore Island, home of Shoals Marine Lab, which the instructor chose to illustrate details of the location of Shoals Marine Lab facilities. As part of the Mario Einaudi Center for International Studies, Tanvi was one of three student volunteers in 2013-14 who participated in the South Asia Language and Culture Program, teaching Hindi at the Greater Ithaca Activities Center (GIAC) After-school Program as part of outreach by the Cornell Educational Resources for International Studies (CERIS). She is also a leader in the Science of Earth Systems Student Association (SESSA).

In October 2014, Tanvi made her mark as a Cornell undergraduate student researcher at the Geological Society of America’s meeting in Vancouver, British Columbia. She gave an oral presentation titled, “The Physics and Mechanics of Liquefaction.”

Upper left: Tanvi standing on a high point in Christchurch. Upper right: Tanvi feeding llamas during a weekend outing. Above: During a day of mapping a kilometer scale plunging anticline and other features in the Southern Alps, Tanvi gazes up at an outcrop while taking a break from the challenging hike up steep slopes, often amidst Matagouri, or wild Irishman bushes.
Geological Sciences Ph.D. candidate, Diego Quiros, has had a busy year. In January 2014, together with his advisor, Larry Brown and fellow graduate student, Doyeon (DK) Kim, Diego conducted a controlled source seismic experiment to calibrate a previous seismic survey that used traffic noise for imaging the subsurface. Also in January, he was invited to give a talk at the IRIS workshop—Active Source Data Management. The title of his talk was, “Crossover Seismology: Blurring the Line Between Passive and Active Source Experiments.”

In February, Quiros traveled to Socorro, New Mexico for training at the IRIS-PASSCAL instrument center. There he received training on broad band sensors for later deployment in Africa. In March, Quiros traveled to Ethiopia covering approximately 10,000 km across the country to complete the deployment of 30 broad band seismic stations for Professor Katie Keranen whose research is focused on the Ethiopian section of the East African rift. Then in June, Quiros returned to New Mexico with DK Kim to conduct an experiment similar to one they had previously performed in Ithaca. This involved using seismometers to record traffic noise from roadway vehicles as a means for imaging the subsurface. For the New Mexico experiment, they recorded train noise along a railway.

Bogota, Columbia was Quiros’ next trip. In July, he attended a conference in Bogota of the Latin-American and Caribbean Seismological Commission (LASCSC). He received a travel support grant from the conference to present a talk titled, “Imaging Deep Magma: Lessons Learned From Experiments on an Interplate Volcano and an Intraplate Earthquake.”
How can you help the Earth and Atmospheric Sciences Programs?

Consider supporting one of the priorities we’ve listed below:

- Field Programs
- Graduate Assistantships
- Postdoctoral Fellowships
- Upgrades to Research and Teaching Equipment and Facilities
- Student Conference and Meeting Travel Expenses

Give at: www.eas.cornell.edu/eas/alumni/give/index