PENNSTATE

NEWSLETTER OF THE CENTER FOR ENVIRONMENTAL CHEMISTRY AND GEOCHEMISTRY

FALL 2010

Center for Environmental Chemistry and Geochemistry

INTERFACES

Environmental Chemistry Student Symposium - 2010

The 13th Annual Environmental Chemistry Student Symposium took place on March 26-27, 2010 at the Forest Resources Building. The Keynote Speaker at the event was

Dr. Neil M. Donahue, Professor and Director of the Center for Atmospheric Particle Studies Departments of Chemistry, Chemical Engineering and Engineering and Public Policy, Carnegie Mellon University. Dr. Donahue's Keynote Address on Friday was entitled "Dealing with the Goopy Messy Stuff: The Coupled Oxidation Chemistry and Phase Partitioning of Organic Compounds in the Atmosphere." His closing address was "Aerosols, Chemistry, Climate, and Health: Quantum Chemistry to Global Models."

Sixty presenters from Penn State and several regional universities were represented this year at ECSS. Penn State's participants represented students from the departments of Crop and Soil Sciences, Forest Resources, Plant Pathology, and Horticulture in the College of Agricultural Sciences; the departments of Geosciences, Materials Science and Engineering, Geography, and Meteorology in the College of Earth and Mineral Sciences; the departments of Chemical Engineering, Biological Engineering, Engineering Science and Mechanics, and Civil and Environmental Engineering from the College of Engineering; and the departments of Biology, Biochemistry and Molecular Biology, Chemistry, Forensic Science, and Integrated Biosciences in the Eberly College of Science. In addition, ECSS welcomed four student presenters from Howard University, Villanova University, and Lafayette College.

The success of the ECSS was made possible by the support of, the Earth and Environmental Systems Institute, the Center for Environmental Chemistry and Geochemistry, the Environment and Natural Resources Institute, the Penn State Institutes of Energy and the Environment, the Eberly College of Science, the College of Earth and Mineral Sciences, and the Engineering Energy and Environmental Institute.

2010 ECSS Award Winners

Poster Session: Biochemistry and Microbiology
1st Place: Vasileios Bitas, Plant Pathology
2nd Place: Elizabeth Herndon, Geosciences

Oral Session: Chemistry and Meteorology
1st Place: Jana James, Forensic Science
2nd Place: Caroline Normile, Meteorology

Poster Session: Environ. Engineering & Biochemistry
1st Place-Tie: Hengjing Yan, Environmental Engineer.
1st Place-Tie: Prashanti Iyer, Integrative Biosciences

Poster Session: Geosciences and Crop & Soil Science
1st Place: Clayton Magill, Geosciences
2nd Place: Tanushree Dutta, Soils, and Claudia Rojas, Soil Science (tie)

Poster Session: Undergraduate
1st Place: Daniel Mills, Geobiology
2nd Place: Timothy Byrne, Civil Engineering

Oral Session: Biogeochemistry, Ecology, Geosciences
1st Place: Sarah Pabian, Wildlife & Fisheries Education
2nd Place: Luke McCormack, Ecology

Oral Session: Chemistry and Geosciences
1st Place: Rebecca Sanders, Chemistry
2nd Place: Christin Morrow, Chemistry

Oral Session: Engineering and Materials Sciences
1st Place: Rachel Wagner, Environ. Engineering
2nd Place: Abby Caporuscio, Environ. Engineering

Oral Session: Undergraduate
Kristin Adolfson, Chemical Engineering

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CECG Summer Fellowship Awardees

The CECG awards Summer Fellowship support to Penn State undergraduate or graduate students to pursue work on research topics related to environmental chemistry during summer sessions. This is a broad request where research areas ranging from the biological sciences to engineering to geochemistry are considered. In summer 2010, CECG has funded four students.

2010 CECG Summer Fellowship Awardees:
Khadouja Harouaka, Department of Geosciences
Matthew Fantle, adviser
Stephen Meckler, Department of Chemistry
Doug Archibald, adviser
Cara Nordberg, Department of Veterinary and Biomedical Sciences, Dan Sykes, adviser
Carla Rosenfeld, Department of Crop and Soil Sciences, Carmen Enid Martinez, adviser

Fuentes Investigates Plant Emissions from the Ground Up

Jose D. Fuentes' research is rooted in the interactions of vegetation and atmosphere: A micrometeorologist, Fuentes is interested in identifying the trace gases that vegetation—trees, in particular—release into the atmosphere.

"The forest breathes," Fuentes said, and to understand how much it inhales and what is exhaled inside and above forests, he designs "tree" towers ranging in height from 30 meters to 100 meters. Placed within forests, the towers are instrumented to measure the non-methane hydrocarbons that plants emit into the atmosphere.

Fuentes' goal: To understand what gases plants release, how atmospheric conditions affect those emissions, and what impacts those reactions are having on the composition of the air.

The professor of meteorology's research projects stretch across the globe from the mangrove forests of the Florida Everglades to Senegal and from Brazil to the polar regions of northern Canada and USA. Research funders include NSF, NASA and the Department of Energy.

In the Everglades National Park near the Gulf of Mexico, for instance, Fuentes has a tower that has been recording energy and carbon dioxide exchanges between the forest and the atmosphere since the project's start in 2003. Hurricane Wilma's landfall in 2005, which destroyed a significant portion of the trees near the tower, has provided Fuentes with the rare opportunity to study ecosystem response to disturbances and thus contrast pre- and post-hurricane the capacity of mangroves to exchange energy and carbon with the atmosphere.

"This is a rare opportunity to track the recovery process of an ecosystem," Fuentes said.

His recent excursions into the mangrove forest have also revealed another ecosystem change—namely, sea-level rise associated with climate change.

Fuentes does not confine his research to natural environments as he also does field work in urban areas, notably the Washington, D.C.-Baltimore-New York corridor, where he studies how the biosphere is affected by an atmosphere clogged with emissions from smokestacks, power plants and cars.

Besides affecting trees, that air pollution may be dulling the scents released from flower blooms by altering the chemistry of the scent molecules. Fuentes has calculated that a flower's scent—critical for attracting pollinators—travels far fewer feet today than 150 years largely because of the impacts of increased pollution.

A self-described story teller, Fuentes draws on his research in his teaching to help students see connections between what they learn in class and how it can be applied.

"I want my students to be critical thinkers, to learn how to apply science to address the problems of our society, both large and small," he said. "Our work has great relevance in our society to address environmental problems."

Fuentes joined the Department of Meteorology in July 2009 after 15 years at the University of Virginia.

MS Student's Experiments Shed Light on Isotopic Fractionation in Underground Caves

Khadouja Harouaka, a second-year geosciences Master's student, is interested in the Big Picture—the origins of life.

Working with assistant professor Matt Fantle, Harouaka is applying her chemistry undergraduate degree to the study of calcium isotopes in gypsum deposits in the Frasassi karst cave system in Italy. Her goal: To determine whether calcium isotopes can be an indicator of biogenic processes on Earth and other planets.

"Gypsum is the ideal calcium-bearing mineral to be utilized as a biomarker because of its stability, relative insolubility and its single cationic oxidation state," Harouaka said. "And the Frasassi caves are ideal, too, because they possess newly forming and ancient gypsum deposits and the environmental conditions are constant year-round."

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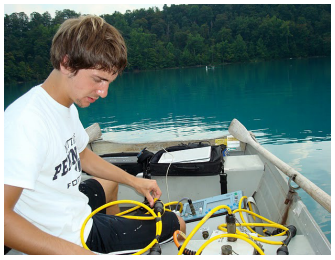
Kump, Macalady, and Singha Investigate the Green Lake Ecosystem

This summer, Lee Kump, Jenn Macalady and Kamini Singha (Geosciences) collected background data within the Green Lake (NY) ecosystem to investigate the self-restorative properties and time-scale of the 20-meter deep chemocline. They suspended a 1.5-m square by 3-m high limnocorral between 18 and 21 m water depth in the middle of the lake. Homogenization of the water within the chemocline was done, for this preliminary study, with a large paddle from the surface. Fluid electrical conductivity, pH, oxidation-reduction potential, turbidity, and oxygen saturation were measured before and after mixing to explore the success of the homogenization and the timing to return of the stratified system. Pilot data shows that the time to re-establish the chemocline is on the order of 2-3 weeks.



Nathan Barber, Geosciences undergrad, collects self potential data to map the location of the chemocline

Outside of the limnocorral, the field team tested methods that will eventually be used within the limnocorral. They used an array of graphite electrodes to measure the naturally occurring voltages across the chemocline. They found that these measurements clearly show the oxic-anoxic interface, and could be used to remotely monitor changes from within the chemocline without the disturbance of lowering an ORP probe.

This fall, the team intends to use divers to affix the graphite electrodes within the limnocorral and rehomogenize the water within the limnocorral to better detail the biological and biogeochemical dynamics of recovery.

Jose Fuentes and Karl Mueller Determine Environmental Control on Floral Volatile Emissions and Chemistry

The objectives of this project are: i) to determine the environmental control on floral volatile emissions and to investigate chemistry of floral scents and products arising from reactions with ozone, hydroxyl and nitrate radicals, ii) determine the olfactory responses of pollinators to threshold amounts of individual volatiles and mixtures of volatiles, and iii) study floral volatile emissions and their spatio-temporal resolution within and above plant canopies. New flower cuvettes were designed and tested to study volatile emissions from flowers of different morphology. The chamber consists of a base made out of virgin Teflon. A Teflon sheet is mounted on the base to provide enough volume where flowers can be placed without touching the cuvette walls (Photo below). Virgin Teflon is chosen to manufacture the chamber because it minimizes the losses of floral volatiles due to adsorption. The circular base is split in two halves and a hole is located in the middle of the base. Flowers, still attached to plants, are placed inside the cuvette and their petioles go through the hole in the middle of the cuvette base. An inlet port is mounted on the base to allow scrubbed ambient air to enter the cuvette. Also, an outlet port is mounted on the base to allow air to flow out of the cuvette. Air temperature and relative humidity are measured inside the chamber. Sunlight levels are measured using a quantum sensor externally mounted on the chamber. The resulting environmental data are needed to express volatile emissions as a function of light levels and temperature.

This picture shows the cuvette unit to study volatile emissions from flowers of different morphologies.

Flow of air in and out of the chamber is regulated with mass flow controllers. An air pump pushes air through a column full of activated charcoal that removes ozone and volatile compounds from the ambient air. Floral volatile emissions, as a function of light and temperature, are estimated by knowing the concentration of volatiles entering and leaving the flower cuvette, the flow rare passing through the cuvette, and flower biomass. At the end of each experiment, the flower enclosed in the cuvette is harvested and dried to determine its dry weight. Ordinarily one flower, or a set of florets, is placed inside the cuvette and several air samples are taken throughout the day to analyze for volatiles and thus determine the diurnal variations of emissions. As air is sampled from the flower cuvette relative humidity, temperature and sunlight levels are continuously monitored.

Jose Fuentes is from the department of Meteorology and Karl Mueller is from the department of Chemistry.

Kenneth Pratt, Meteorology graduate student, shows the cuvette unit to enclose flowers and instrument to record air temperature and relative humidity inside the cuvette.

MS Student Experiments *(Continued from page 2)*

Born in State College while her father was earning his Ph.D. from Penn State, Harouaka grew up in Saudi Arabia where she attended a small, government-run school for expatriates—her graduating class numbered only 15. She returned to the area to attend Penn State, graduating in May 2007.

Harouaka traces her interest in geochemistry to a class taught by Hiroshi Ohmoto that she took as an undergraduate. Opportunities to be trained on state-of-the-art instrumentation and modeling techniques sold her on geosciences.

This past summer, Harouaka was awarded a CECG Fellowship to investigate gypsum growth rates and the chemical properties of the solutions from which gypsum grows in order to explain differences in morphology and calcium isotopic fractionation in the sulfidic Frasassi caves. The mineral composition of those caves creates conditions for the growth of microbial or snottite communities that are highly acidic and resemble slime.

"The hypothesis is that the interactions of these snottites with the gypsum deposition may create a biogenic signature in the calcium isotopes of these mineral," Harouaka said.

What she learned was that "a change in the morphology of the gypsum deposits occurred as a function of saturation states, where solutions of low saturation precipitated larger needle like crystals and solutions of higher saturation precipitated much smaller and flatter crystals," Harouaka said. "This is significant because the cave waters are mostly under saturated in gypsum, and yet the caves possess gypsum deposits that resemble the small crystals grown in the saturated solution."

Harouaka's future work includes reproducing the crystal growth experiments in solutions that mimic the water chemistry in the caves. If the same results can be obtained from crystals grown these solutions, then this may be the first clue to a non-inorganic growth mechanism of the gypsum in the caves.

CECG Briefs

Save the date for the Environmental Chemistry Student Symposium which will be held April 8-9, 2011. The location of the event will be at the Life Science Bridge and 102 Chemistry Building. Key-note speaker is forthcoming and the Abstracts will be due in 2011.

The Annual CECG Wine and Cheese Event will take place on Tuesday, February 1, 2011, at the Nittany Lion Inn Fireside Room. Dr. Jim Bristow from the Lawremce Berkeley National Laboratory will be the keynote speaker.

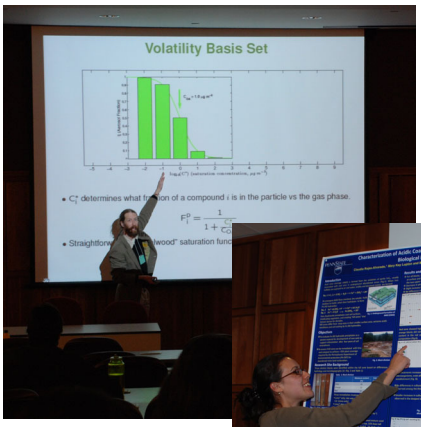
ECSS Awards *(Continued from page 1)*

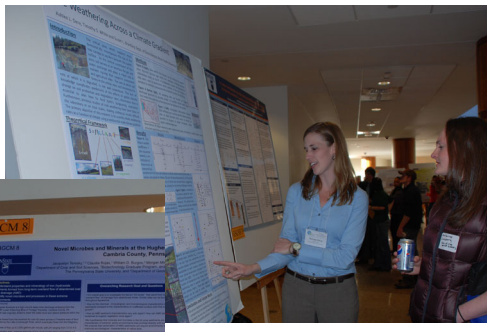
Photo Contest:
1st Place: Elizabeth Herndon, Geosciences
2nd Place: Emma Gaalaas Mullaney, Geography
3rd Place: Robert Wolford, Environmental Engineering

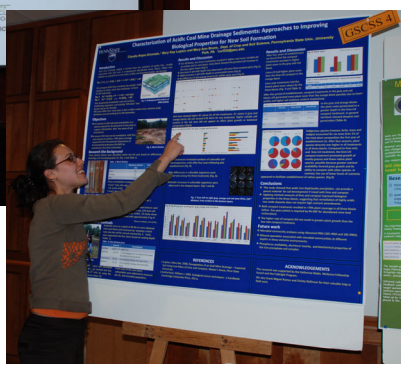
T-Shirt Design Contest
Daniel Mendenhall, Chemistry

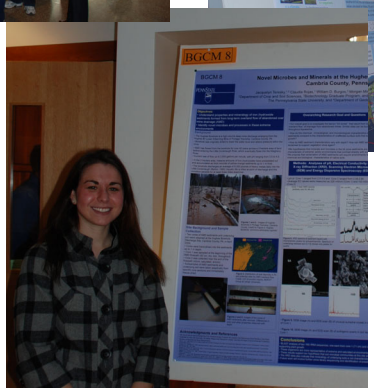
Contributions to the CECG Newsletter made by:
Jose Fuentes, Margaret Hopkins, Lee Kump, Debra Lambert, Jenn Macalady, Kamini Singha, and Anne Thompson

Snapshot Moments from the Environmental Chemistry Student Symposium









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