Climate Change SCIENCE INSTITUTE

Newsletter

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OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY

LETTER FROM CCSI LEADERSHIP

October was the first month in many years without Chuck Garten on the ESD staff. Chuck retired at the end of September and did not want a large retirement celebration. Chuck was a special scientist, and one that I admired. He was focused on getting science done and publishing his results – his labs were shining examples of organization and safety consciousness. Chuck has one paper with over 500 citations, three with over 100, and another just about to cross over the 100 mark at 99. We will miss Chuck, but wish him the best in retirement.

CCSI held our first special symposium in October, featuring all the posters and presentations from the September DOE/BER Modeling Science Team Meeting. We will try to do events like this after most major meetings so that we can all see and hear the science presented.

Please use the CCSI template for your public presentations whenever feasible. We want to build name recognition for CCSI, and this form of branding helps.

We are now in the planning stages for our January on-site meeting with our Science Advisory Board. We should have an agenda finalized in December and will let you know who is leading which discussion sessions so that you can seek them out and help.

LABORATORY DIRECTOR VISITS ORNL—NGEE HIGHLIGHTED

On October 27th, Bill Brinkman, Director for DOE's Office of Science, visited ORNL and was presented an update on the Next-Generation Ecosystem Experiments (NGEE) - Arctic project. In the discussion which was supported by a multi-panel visualization in EVEREST, ORNL highlighted major elements of the recently funded model-data integration activity scheduled to take place in Alaska beginning in FY12. David Graham, a microbial physiologist at ORNL, spoke on behalf of the NGEE team and laid out the major questions and tasks of the project.

Impacts of Permafrost Thaw and Degradation—How do permafrost thaw and degradation, and the associated changes in landscape evolution, hydrology, soil biogeochemical processes, and plant community dynamics, affect feedbacks to the climate system?

Arctic Landscapes in Transition—Researchers will develop a process-rich model of Arctic ecosystems leveraging 3-D landscape process simulator, Earth System Model grid cell scale, nonlinear scaling, model uncertainties guide measurement and experiments, and 1-D and 3-D process scale climate models support global/regional models for unproved predictions.

Additionally, NGEE's three focus areas were highlighted:

Geomorphology/ Hydrology—Areas being explored include Heat flux and controls on permafrost degradation, Thermokarst evolution, Surface and subsurface hydrology, and Evolution of permafrost and active layer.

Biogeochemistry—Organic matter decomposition rates, Chemical controls on greenhouse gas (GHG) fluxes, Temperature and oxygen response factors, and Coupled carbon and nitrogen cycles.

Vegetation Dynamics—Changing soil moisture and nitrogen, Plant functional type responses, and GHG and energy feedbacks to climate change.

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Highlighted Researcher GIRI PALANISAMY

Giri, originally from southern India, received his BS and MS in soil science from Tamil Nadu Agricultural University in Coimbatore, India. He then had the opportunity to do a second Master's in New Foundland. However, New Foundland's extreme cold weather proved to be a strong motivator, pushing Giri to complete his degree early so he could move to the warmer locale of Calgary and eventually to Oak Ridge. Giri spends his free time with his family which includes a hyperactive 4 year old and a new baby, he also enjoys working in his vegetable garden.

Early on, Giri Palanisamy had deep roots in science which were further strengthened by his undergraduate coursework in agriculture and environmental sciences, and later by his Master's programs. He studied soil science including land use and land classification using remote sensing technologies and heavy metal transport in soil profiles.

As part of his Master's program, Giri generated a lot of data and discovered the needs and challenges with managing scientific data. He also recognized there were challenges with being able to later retrieve and share his data with his peers, in particular, challenges with data preparation such that others could readily understand and utilize it. In an effort to explore and create solution to these challenges, Giri entered the world of informatics and data analysis, starting with programming and development courses at the University of Calgary where he received a Diploma in Object Oriented Software Technology. Upon graduation, Giri worked as a software developer and was drawn to Oak Ridge National Laboratory in 2002 where he could combine his passion for science and informatics.

Currently, Giri supports several data projects across CCSI. He is the PI for the USGS project, Metadata Clearinghouse for the USGS Core Sciences Program. The goal of this project is to collect metadata from approximately 90 different data providers across the US to provide a federation of data for the biological and earth sciences community to use in their research. The clearinghouse aggregates data ranging from biodiversity to ecology to environment and currently holds over 96,000 metadata records.

In addition, Giri serves as the systems engineer for the ARM Data Archive project and is developing a large-scale computing cluster as a community resource for doing visualization and analysis of ARM radar data. He is also involved in developing various components of the data lifecycle (starting with the archival and distribution of the data) and prepares ARM data for model observation inter-comparison studies.

Giri manages the Mercury consortium of DOE, USGS, and NASA projects, a tool for metadata management, discovery, and access being used by more than 13 scientific projects. Giri will leverage his ability integrate projects, tools, and datasets as he leads a recently initiated effort to identify tools that can be adopted by new and upcoming projects for managing the generated data. The first step will be identification of tools being used across the Institute, followed by the categorization of the tools (e.g., data collection, archiving, and visualization). This catalog will be searchable so researchers can identify the best match for their needs.

Other areas of work include ensuring the long term preservation of data (both model and observational), developing a strategy for assigning DOIs (digital object identifiers) for scientific data sets which will be used to link a publication to its data, and developing a cyber infrastructure for the data sciences observation community. According to Giri, "Right now, a lot of data are being used in the publications, but many cannot be linked back to the data referenced in the publication. The DOI project will create a great benefit to the scientific community when data can be shared in this way so that other researchers can readily gain access." Giri participates in various standards and protocol working groups such as the working group for the ISO metadata standard for energy.

What role does your research play in climate

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PALANISAMY (CONT.)

change research?

"My role is to provide increased access to climate change research data and information. This includes, developing and recommending tools to help various components of data life cycle such as: tools for project collaborations, data collection, preparation, analysis, discovery, distribution, and interoperability. I am currently designing a Large Scale Computing Cluster for the ARM Program; this will be a community resource for large-scale data analysis, processing and visualizations of ARM data. I am also managing a metadata management and discovery tool called Mercury. This tool is being used in over 13 different DOE, NASA, and USGS funded projects. My role also includes ensuring the long-term preservation of climate change data."

Who is the customer for your research?

"Our customers include: the ARM Program which helps the Global Climate Change Models, Climate Change model-observation inter-comparison projects, USGS Biological and biodiversity information networks, NASA Distributed Active Archive Center (DAAC) for biogeochemical science, and NSF Earth Science data observation network (DataOne). The user communities for the above projects are also my customers."

Why is it important to you, personally, to become involved in climate change research?

"My interest in climate change research started during my undergraduate days. I did few courses related to environmental science, and this really triggered my interest in taking more graduate level environmental science courses during my first Master's program. Then, I ended up doing a dedicated second Master's program in environmental sciences. Soon, I realized there was a great opportunity in the environmental informatics areas, which led me to do a software-programming course. ORNL provided me a perfect opportunity to apply both my scientific and IT skills in the climate change informatics area."

In what direction do you see the future of climate change research going?

"I see a very interesting time ahead for us to make some major progress in understanding and adapting to climate change using the currently generated data. There are wide ranges of projects that are studying various aspects of climate change; these projects generate a large volume of very diverse data. It is critical to make these heterogeneous data and information available in commonly available, standards based formats, so that various scientific communities can effectively find and use these data."

NEW STAFF

Fengming Yuan recently joined the Ecosystem and Carbon Cycle Science group as a postdoctoral research associate where he is supporting the application and improvement of landscape biogeochemical model (i.e., CLM-CN) for Arctic or high latitude regions. Fengming received his PhD from the University of Wisconsin—Madison in soil science with a minor in GIS. Most recently, Fengming was a postdoctoral researcher with the Institute of Arctic Biology at the University of Alaska—Fairbanks.

CALENDAR

AGU Fall Meeting 2011 (San Francisco, CA) ..... 5-9 December 2011
92nd Amer. Meteorological Society Meeting (New Orleans, LA) ..... 22-26 January 2012
2012 Annual CCSI SAB Meeting (Oak Ridge, TN) ..... 30 January— 1 February 2012
UQWG (Boulder, CO) ..... 30 January— 1 February 2012
Whole Atmosphere Working Group (Boulder, CO) ..... 1 February 2012
Atmosphere Model WG Meeting (Boulder, CO) ..... 1-3 February 2012
AAAS Annual Meeting (Vancouver, Canada) ..... 16-20 Feb 2012
2012 Ocean Sciences Meeting (Salt Lake City, UT) ..... 20–24 February 2012

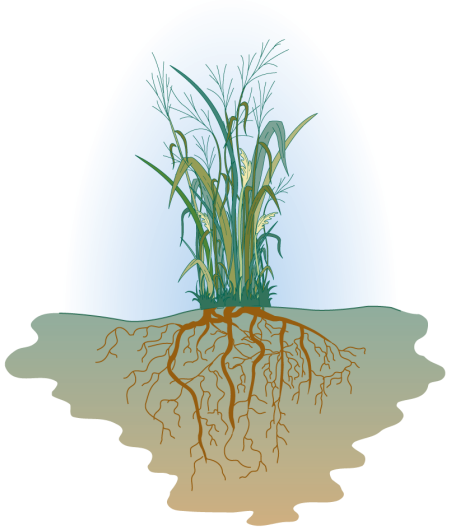
Highlighted Research

CARBON SEQUESTRATION IN TERRESTRIAL ECOSYTEMS (CSITE)

The Carbon Sequestration in Terrestrial Ecosystems (CSiTE) project acquires fundamental knowledge that underpins the implementation of soil carbon sequestration as a climate mitigation strategy. Research is based on the premise that understanding the basic mechanisms controlling soil carbon processes in managed and unmanaged ecosystems will facilitate developing approaches for enhancing carbon capture and long-term storage in soils. The longstanding goal of CSiTE investigators is to discover and characterize links among physical, chemical, and biological processes that influence (1) how quantity and quality of plant biomass input influence soil carbon storage; (2) how soil structural properties control carbon lifetimes in managed storage pools; and (3) how microbial communities respond to litter inputs and how community function influences stabilization of soil carbon.

Integration of multiscale research is achieved by coordinating research conducted both in the laboratory and at field sites around the United States where land-use practices, experimental manipulations, or chronosequences afforded opportunities to observe how climate, soil, and land-use impacts on soil carbon and to understand the system-level consequences of potentially implementing sequestration strategies. Project participants represented a multi-lab collaboration among plant, microbial, and soil scientists at ORNL, Argonne National Laboratory, Boise State University, National Renewable Energy Laboratory, Ohio State University, Pacific Northwest National Laboratory, Texas A&M University, USDA Land Management & Water Conservation Research Unit, and University of California-Davis. Started in 1999, the CSiTE project resulted in numerous findings and associated peer-reviewed publications. The following are some of the findings and results identified through CSiTE in FY11.

Emerging role of microaggregate models in describing soil organic matter dynamics: Empirical data from laboratory and field experiments were used to estimate the biological and environmental effects on the rate of formation and breakdown of macroaggregates and microaggregates, and the organic matter dynamics within these different aggregate classes. A simulation model was validated with long-term field data. It was shown that the advantage of a model is that its internal structure can be validated by field data. Furthermore, models that are based on mechanistic processes have the potential advantage of being more robust and, therefore, providing predictions to a larger array of scenarios, including scenarios that cannot be manipulated in field conditions.



Turnover times of soil microaggregates in C3 and C4 ecosystems: The results of this experiment suggested that soil organic matter is probably better conceptualized as a continuum rather than discrete pools, and the fractions isolated are likely composites of multiple pools. These findings demonstrate that pools that appear to be extremely stable can be dynamic over the decadal timescales important to the global carbon cycle.

Root size and chemistry determine rates of litter decomposition: It was demonstrated through this study that (1) root litter C:N ratios and the relative abundance of roots within three distinct root diameter size classes differed among root systems of the cultivars; (2) differences in decomposition among cultivars were greatest when roots in the 0-0.5 diameter size class were added to soil, and on-average roots within this diameter size class decomposed faster and promoted soil organic matter decomposition more than roots in the other diameter size classes; (3) for each of the cultivars, total root system decomposition rates could be predicted by roots of each one of the root diameter size classes decomposing by themselves; and (4) differences in decomposition rates among cultivars were neither explained root C:N ratios, nor by the relative abundance of fungi and bacteria in soil. Soil scientists concluded that the relative abundance of the finest roots in a root system may an important plant trait for shaping decomposition processes. However, genetic variabil-

CSITE (CONT.)

ity in fine decomposition among cultivars warrants for more detailed studies on the mechanisms that drive decomposition of fine roots.

Litter carbon and nitrogen dynamics in response to fertilization: Results from this multidisciplinary study revealed that carbon and nitrogen pools represented by coarse live roots, fine live roots, coarse dead roots, fine dead roots, and rhizomes rival those of above-ground biomass and that root-to-shoot biomass ratios increase with nitrogen fertilization. When coupled with other research conducted by this same team on the effect of tissue chemistry on root decomposition, these results suggest that nitrogen fertilization could accelerate root decomposition and, consequently, impact soil carbon storage beneath switchgrass. The belowground response to nitrogen additions appear to depend on the interplay between processes leading to protection of soil carbon inputs and the change in root decomposition rate as a function of changing root tissue chemistry.

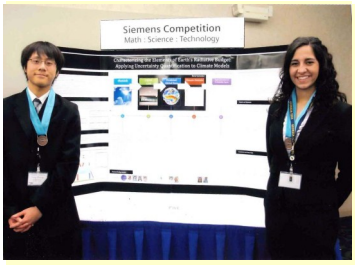
Root exudates control soil microbial communities: Their results, reported in the journal *New Phytologist*, show that labile soil carbon inputs can regulate decomposition of more recalcitrant organic matter by controlling the activity and relative abundance of fungi and bacteria. This result supports the "priming" theory that has suggested these labile inputs affect decomposition by providing fuel that jump starts the microbial community, which then allows them to use more of the harder to degrade soil and litter carbon sources.

Use of data mining and knowledge discovery in soil carbon studies: Insights from complex networks including dyads, triads, and subsets of variables were exclusively related to each other and could be interpreted as simple associations.

CSiTE staff working in the field.

A majority of the variables appeared to be well integrated within a complex network with small-world properties where soil carbon and nitrogen form the link between variables related to soil properties and another related to biomass and biological activity.

STUDENT INTERNS ARE SIEMEN'S REGIONAL FINALISTS



Congratulations to Madie Chakoumakos and Tony Zhuang, mentored by CCSI Member Rick Archibald, for being named regional finalists in this year's Siemens Competition in Math, Science, and Technology! Madie and Tony, with the project titled "Characterizing the Elements of the Earth's Radiative Budget: Applying Uncertainty Quantification to Climate Models," were among 96 students from 21 states to make it to the regional finals. The Siemens Competition is an annual competition among high school students for college scholarships ranging from $1,000 to $100,000.

Madie and Tony worked with Rick throughout last summer to characterize the effect of the radiation budget within the Community Earth System Model as various parameters in the Community Atmosphere Model were changed. "Both Madie and Tony were very engaged, energetic, and thoughtful," stated Rick. "I would often walk by their office in Building 6012 and hear their active conversations, as they helped each other come to a greater understanding of the problems. I had to recruit Kate Evan and Bai Yang to help in mentoring just to keep pace with them!"

The students competed against other regional finalists November 4th and 5th at Georgia Tech in Atlanta. While they did not make it to the final round, "the experience was once in a lifetime," stated Madie. "Not only was the opportunity to share our research incredible, but also listening to the other students was amazing. The competition truly fosters young individuals' talent in math, science and, engineering. This experience has made me want to become a biomedical engineer. In college, I plan to pursue this dream." Tony also found this to be a rewarding experience: "The Siemens Regional Finals was both fun and enlightening. I enjoyed talking to everyone, from math to life in general. After listening to their presentations, I realized how different disciplines were connected. One group even used a similar technique. Although I am currently undecided as to where I want to attend college, I would like to major in Biomedical Engineering, Medicine, or Molecular Biology."

OAK RIDGE CLIMATE CHANGE SCIENCE INSTITUTE

One Bethel Valley Road
P.O. Box 2008, MS-6301
Oak Ridge, TN 37831-6301

Phone: 865-574-5435
Fax: 865-574-6476
E-mail: climatenews@ornl.gov

We're on the Web!
www.climatechangescience.ornl.gov

Coming in November's Edition

Highlighted Researcher: Jeff Warren
Highlighted Research: Regional Modeling

Developing and executing programs for the multi-agency, multi-disciplinary climate change research partnerships at Oak Ridge National Laboratory.

RECENT PUBLICATIONS

Garten, C. T. Jr., 2011: "Review and Model-Based Analysis of Factors Influencing Soil Carbon Sequestration Beneath Switchgrass (Panicum virgatum)", *Bioenergy Research*, doi:10.1007/s12155-011-9154-2. (ERKP311)

Graham D. E., M. D. Wallenstein, T. A. Vishnivetskaya, M. P. Waldrop, T. J. Phelps, S. M. Pfiffner, T. C. Onstott, L. G. Whyte, D. Gilichinsky, D. A. Elias, R. Mackelprang, N. C. VerBerkmoes, R. L. Hettich, D. Wagner, S. D. Wullschleger and J. K. Jansson, 2011: "Microbes in Thawing Permafrost: The Unknown Variable in the Climate Change Equation," *The ISME Journal: Multidisciplinary Journal of Microbial Ecology* (in press). (ERKP757)

Diffenbaugh N. S., M. Ashfaq and Martin Scherer, 2011: "Transient Regional Climate Change: A High-resolution, Century-scale, Ensemble Simulation of Climate in the Continental United States," *J. Geophys. Res.,* in press

Garten, C. T., Jr. 2011: "Comparison of Forest Soil Carbon Dynamics at Five Sites along a Latitudinal Gradient," *Geoderma,* 167-168:30-40, doi:10.1016/j.geoderma.2011.08.007 (ERKP788)

Gu L., W.J. Massman, R. Leuning, S. G. Pallardy, T. Meyers, P. J. Hanson, J. S. Riggs, K. P. Hosman and B. Yang, 2012: "The Fundamental Equation of Eddy Covariance and its Application in Flux Measurements," *Agricultural and Forest Meteorology,* 152:135-148; doi:10.1016/j.agrformet.2011.09.014 (ERKP788)

Yang X., Post W. M. 2011: "Phosphorus transformations as a function of pedogenesis: A Synthesis of Soil Phosphorus Data using Hedley Fractionation Method," *Biogeosciences,* 8:2907-2916, doi:10.5194/bg-8-2907-2011 (ERKP788)

Robert Sisneros, Jian Huang, George Ostrouchov, and Forrest Hoffman. Visualizing Life Zone Boundary Sensitivities Across Climate Models and Temporal Spans, Workshop on Data Mining in Earth System Science (DMESS 2011) at the International Conference on Computational Science (ICCS 2011) Japan, June 1-3, 2011 (ERKP773)

CURRENT CCSI JOB OPPORTUNITIES

We seek motivated individuals across a range of educational and professional experience including M.S. through Ph.D. academic qualifications at junior, as well as senior levels of experience to address some of the most pressing questions in global climate change science. You can view complete staff position descriptions and apply at http://jobs.ornl.gov. Postdoctoral and post-master's research position descriptions and online application are at http://www.orau.org/ornl/postdocs/ornl-pd-pm/default.aspx.

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