Climate Change SCIENCE INSTITUTE

Newsletter

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OAK RIDGE NATIONAL LABORATORY
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LETTER FROM CCSI LEADERSHIP

As many of you have now heard, Dr. Dave Bader will be leaving ORNL this summer. His departure will leave a big hole in the leadership of the CCSI, and we will miss him in many ways. His insights on how to advance data systems and integrate observation and modeling projects will be especially missed. The good news is that he will proactively work with CCSI leadership to understand all the connections that he started so that we may continue to nurture them.

It has been said that all change is "good," although these changes will certainly challenge our creativity to provide for complete continuity after Dave has left. We will be engaging CCSI staff on how to define and structure future integrative efforts. The importance of collaborations across ORNL will continue to be emphasized in our path forward. A key gap with Dave's departure will be related to the leadership of Research Theme 2 – Data Integration, Dissemination, and Informatics. We will be exploring succession scenarios and will likely be engaging CCSI staff for input on filling this important role.

As you will read elsewhere in the newsletter, the highly-integrated multi-laboratory CSSEF (Climate Science for a Sustainable Energy Future) proposal that Dave led on behalf of Dr. William Brinkman's office has passed peer review and has been given the green light to proceed. This is an exciting endeavor, and we at ORNL look forward to working with Dave and our other laboratory partners as this new project kicks off for DOE.

COLD EXTREMES PAPER RECEIVING WIDESPREAD ATTENTION

Geophysical Research Letters recently published the paper, "Persisting cold extremes under 21st-century warming scenarios," of whom two of the three authors are CCSI members (Karsten Steinhaeuser and Auroop Ganguly). This paper has been also been highlighted in both *Nature Climate Change* and *Nature*.

The paper concluded that analyses of climate model simulations and observations reveal that extreme cold events are likely to persist across each land-continent even under 21st-century warming scenarios. The grid-based intensity, duration and frequency of cold extreme events are calculated annually through three indices: the coldest annual consecutive three-day average of daily maximum temperature, the annual maximum of consecutive frost days, and the total number of frost days. Nine global climate models forced with a moderate greenhouse-gas emissions scenario compares the indices over 2091–2100 versus 1991–2000. The credibility of model-simulated cold extremes is evaluated through both bias scores relative to reanalysis data in the past and multi-model agreement in the future. The number of times the value of each annual index in 2091–2100 exceeds the decadal average of the corresponding index in 1991–2000 is counted. The results indicate that intensity and duration of grid-based cold extremes, when viewed as a global total, will often be as severe as current typical conditions in many regions, but the corresponding frequency does not show this persistence. While the models agree on the projected persistence of cold extremes in terms of global counts, regionally, inter-model variability and disparity in model performance tends to dominate. Their findings suggest that, despite a general warming trend, regional preparedness for extreme cold events cannot be compromised even towards the end of the century.

Citation: Kodra, E., K. Steinhaeuser, and A. R. Ganguly (2011), Persisting cold extremes under 21st-century warming scenarios, *Geophys. Res. Lett.*, 38, L08705, doi:10.1029/2011GL047103.

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Highlighted Researcher TOM BODEN

Tom grew up in Ohio and attended Ohio University, graduating cum laude with a bachelor of science in zoology, and then the Institute of Environmental Sciences at Miami University where he earned a master's of environmental sciences in applied ecology. The pivotal moment for Tom came when, as a grad student, he was required to do an internship for a minimum of six months in addition to completing his thesis. Tom chose to go to a national laboratory which at that time, he said, "was not in vogue." While Tom had spent significant time in the field and laboratory, he was intrigued by the hands on data management and computing aspect. Tom's six-month internship evolved into a 15-month internship and ultimately a permanent position. At that point, he still envisioned staying at ORNL only for a few years, but, as Tom likes to say, he never left. From the start, Tom has worked in the CDIAC program and now directs the data center he entered as an intern. In Tom's spare time, he attends to the "honey do" list and serves as a chauffeur for his youngest son. He is also presently coaching the Cedar Bluff Middle School baseball team.

Tom Boden has been with the Carbon Dioxide Information Analysis Center (CDIAC) for 25 years, becoming the director in 2004. CDIAC, DOE's primary climate change data and information clearinghouse since 1982, is a member of the International Council for Scientific Union's World Data Center (WDC) System. Tom serves as the Director of the WDC for Atmospheric Trace Gases. Tom is also the group lead for the Environmental Data and Science Systems group and serves as the data manager for the AmeriFlux network, a collection of instrumented towers located in terrestrial ecosystems of Central, North, and South America making continuous measurements of carbon dioxide (CO_2), water, and radiation fluxes via eddy covariance techniques and companion meteorological measurements. Tom supports the annual production of time series of global, regional, and national CO_2 emission estimates from fossil-fuel use and cement production.

Having been with the same organization for this extended period of time, Tom has had the opportunity to see the evolution of CDIAC and the effects of the massive technological changes which have occurred over its lifetime. Tom gives credit to Gene Willeke (head of the Institute for Environmental Sciences during Tom's graduate work) and the previous three CDIAC directors (Mike Farrell, Paul Kanciruk, and Bob Cushman) for providing him with opportunities, guidance, and perspectives over the course of his career.

As Tom reflects, he sees three primary changes that have shaped CDIAC into its current form. First, the way the CDIAC is viewed even at ORNL has dramatically changed. Data activities have now become core in our work activities. We've progressed beyond thinking "anyone can do this" to "let's leave it to the experts." Second, the ability to transmit huge amounts of data over the Internet has enabled CDIAC to respond overnight versus perhaps what previously took two months to fulfill requests for information from even the remotest parts of the globe. According to Tom, "If you compared the media we previously used (nine track tapes) to what we can currently put onto a thumb drive (1 Tb of data), you would have a stack of these tapes as high as the Washington Monument." This has allowed CDIAC to serve a significantly larger community in a fraction of the time. Third, he sees a thematic transformation. In CDIAC's early days, scientists were just trying to understand the global carbon cycle budget. Now, they are thinking about mitigation and adaptation strategies and how to verify treaties. Tom is fascinated to see how this program has evolved from an effort of basic understanding to more of the policy arena.

As technology has progressed, it is no longer sufficient to just deliver the data. Now CDIAC's customers want to know the quality of the data being delivered – quantify the uncertainty. In addition, there is a big push for CDIAC to provide model-ready data in formats that lend themselves to be directly used by a particular model or for cross-cutting integrated activities. The data is not just being provided to an individual anymore, rather, it is being provided to research activities and model teams such as teams working on the IPCC AR5.

In the near term, Tom is looking at what he considers to be some of the next big environmental issues (such as ocean acidification) and trying to poise CDIAC to be a key data repository. He is also positioning CDIAC to venture into new areas such as carbon management data to assist in answering questions like "can you manage carbon in a terrestrial ecosystem?" Tom says that they will continue to develop web based data interfaces to make it easier for users to find, understand, and download the data they need for their particular applications. This drives CDIAC's involvement in metadata standards development.

What role does your research play in climate change research?

"Our data center, CDIAC, serves as the primary climate change data repository for DOE. CDIAC responds to roughly 350,000 requests annually from users worldwide. Our data and products are used in classrooms, models, and policy exercises and are

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BODEN (CONT.)

often cited in newspapers, journals, and media broadcasts."

Who is the customer for your research?

"Our primary audience is fellow climate change researchers but the real answer is "everyone". Our customers range from Nobel Prize winners to elementary students working on science projects. Very cool!"

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

"I was trained as an ecologist. Ecology is a branch of science concerned with the interrelationships of organisms, including humans, and their environment. Climate change is truly an ecological challenge, and I feel very fortunate to be able to apply my training to such an interesting and contemporary environmental issue."

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

"One day in the not too distant future, we will hear updates on the nightly news or weather channel (i.e., WeatherBug style) about greenhouse gas (GHG) levels, and we will have measurements from space to substantiate atmospheric GHG levels and emissions contributions from nations and regions."

CSSEF KICKS OFF

The Climate Science for a Sustainable Energy Future (CSSEF) is a collaborative project among Oak Ridge, Argonne, Brookhaven, Lawrence Berkeley, Lawrence Livermore, Pacific Northwest, and Sandia national laboratories together with the National Center for Atmospheric Research. The project recently received FY11 funding from the Office of Biological and Environmental Research (BER) with the potential for four out-year funding through FY15. The goal of CSSEF is to transform the climate model development and testing process and thereby accelerate the development of the Community Earth System Model's sixth-generation version, CESM3, scheduled to be released for predictive simulation in the 5 to 10 year time frame.

Four research themes are addressed in the project:

1) A focused effort for converting observational data sets into specialized, multi-variable data sets for model testing and improvement.
2) Development of model development testbeds in which model components and sub-models can be rapidly prototyped and evaluated.
3) Research to enhance numerical methods and computational science research focused on enabling climate models that use future computing architectures.
4) Research to enhance efforts in uncertainty quantification for climate model simulations and predictions.

These four themes are mutually reinforcing and tightly coupled around three overarching research directions:

1) Development, implementation, and testing of variable-resolution methodologies that enable computationally efficient simulation of the climate system at regional scales.
2) Improvement of the representation of the hydrological cycle and quantification of the sources of certainty in its simulation.
3) Reduction and quantification of uncertainties in carbon cycle and other biogeochemical feedbacks in the terrestrial ecosystem.

The CSSEF project will be structured to first deploy expertise in the research theme areas across the development of the atmosphere, ocean, sea ice, and land surface model components, and later to the fully coupled system.

The project will be led by six science team leads spread across the various national laboratories and NCAR in support of Dorothy Koch (DOE Program Manager).

The CSSEF project addresses the DOE Office of Biological and Environmental Research's Long-Term Measure to *"Deliver improved scientific data and models about the potential response of the Earth's climate and terrestrial biosphere to increased greenhouse gas levels for policy makers to determine safe levels of greenhouse gases in the atmosphere."*

Upcoming CCSI Seminars

Anand Patwardhan — June 17
Jim Randerson — July 25
Suraje Dessai — July 22
Christa Peters Lidard — September

Highlighted Research NGEE—ARCTIC

Experiments and observations are the hallmark of global change biology. The balance between these, however, is often debated, as is how they contribute to improved process representation in climate models. Manipulative experiments that alter temperature, rainfall, or CO_2 concentrations at ecosystem scales allow hypotheses to be tested more directly than observations. On the other hand, process studies can be incorporated into long-term observations and, thus, provide valuable insights into critical feedbacks that exist between landscapes and climate.

Stan Wullschleger and his collaborators at ORNL, Los Alamos National Laboratory (LANL), Lawrence Berkeley National Laboratory, Brookhaven National Laboratory and the University of Alaska have discussed the merits of experiments versus observations for almost a year now in support of the BER-sponsored Next-Generation Ecosystem Experiments (NGEE Arctic) project in Alaska.

Stan explains, "We started out thinking that a manipulative experiment in Alaska, one that was designed to understand the impact of air and soil warming on ecosystem feedbacks to climate would be an exciting activity."

Last fall, Stan and Chief Scientist Larry Hinzman, Director of the International Arctic Research Center at the University of Alaska Fairbanks and Cathy Wilson from LANL organized a workshop to discuss the pros and cons of conducting experiments versus observations in the Arctic.

According to Stan, "We knew that people would have various opinions, and we wanted to better understand the value of one approach over another. We wanted to listen to the experts."

The recommendation reached by 45 subject matter experts who attended the workshop was that while sophisticated experiments could be conducted in the Alaska tundra, those would be expensive, logistically challenging, and might still not address issues of how processes play out over a very dynamic landscape.

Stan emphasized that "workshop participants helped clarify the idea that while climate change – most notably warmer temperatures in the Arctic – will impact chemical, physical, and biological processes important to carbon fluxes from thawing permafrost, that process-level knowledge would be useful only if we could place those processes in a landscape perspective. This meant understanding not only the processes of CO_2 and CH_4 fluxes, but also how those processes played out across a landscape that was literally coming apart at the seams due to permafrost and ice-wedge degrada-

The Arctic has emerged as an important focal point for the study of climate change. Characterized by its heterogeneous landscape and vast amounts of carbon stored in permafrost, this region is already experiencing rapid changes in climate, particularly temperature. It is a fragile landscape and highly sensitive to future environmental change. It is also a region that is critical to understanding how complex systems will respond to a changing climate and how processes underlying those changes can be represented in climate models. Improving climate prediction in high-latitude ecosystems will require understanding permafrost and snow dynamics and the many cascading impacts of a changing geophysical system on vegetation, subsurface processes, land-atmospheric interactions, and landscape processes.

Figure 1. *Thermokarst features in the Arctic (irregular depressions of marshy hollows and small hummocks formed as ice-rich permafrost thaws).*

In addressing this challenge, the NGEE project will describe how experiments, observations, and process models can quantify the response of physical, ecological, and biogeochemical processes to atmospheric and climatic change across molecular to landscape scales. The focus is on interactions that drive ecosystem-climate feedbacks through greenhouse gas fluxes and changes in surface energy balance. The project will focus on the causes and consequences of permafrost degradation where warmer temperatures in the Arctic are already causing ice wedges to melt, ground subsidence, and transformation of the landscape with thermokarst features increasingly dotting the landscape (Figure 1). These "features of the future" hold consequences for carbon, nitrogen, energy, and water dynamics, all of which will be considered in NGEE.

NGEE (CONT.)

tion, subsidence, changes in water distribution, and vegetation dynamics driven by these landscape-scale dynamics."

Armed with these insights, Stan and almost 50 staff scientists and faculty from national laboratories and strategic universities are now writing a proposal due to BER Program managers on June 15, 2011. The research they are proposing will come in two stages, with an initial two-year Phase 1 scope of work that, if successful, would lead to a decade-long Phase 2 of the project. Two sites in Alaska have been initially selected for field research: Barrow on the North Slope and Council on the Seward Peninsula.

Stan believes that "these sites will provide all the opportunities we need to develop a predictive understanding of landscape dynamics and then how those dynamics shape important feedbacks between Arctic ecosystems and climate. We need this information to incorporate into models."

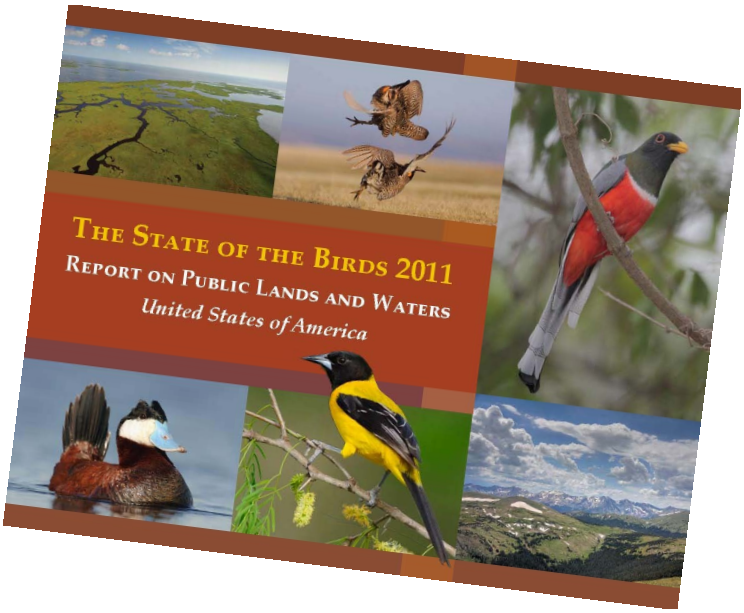
Stan is quick to point out that NGEE objective is consistent with the overarching goals of the CCSI, one of which is to improve process-representation in support of improved prediction and reduced uncertainty in climate models. The NGEE project is committed to the ultimate goal of providing the underpinning science, coupled process understanding, and data to inform the development of a new generation of high resolution arctic terrestrial ecosystem simulation capabilities.

Figure 2. *David Graham and other scientists observe permafrost tunnel at USACE Permafrost Tunnel Research Facility, Fairbanks, Alaska.*

CALENDAR

Colorado Conference on Earth System Governance (CSU, Fort Collins, CO)……17-20 May 2011
Conference on Adaptation to Climate Change in Low-Income Countries (Washington, DC) ……18-19 May 2011
World Environmental and Water Resource Conference (Palm Springs, CA)……22-26 May 2011
Impact Assessment and Responsible Development for Infrastructure, Business and Industry (Puebla, Mexico) ……28 May - 4 June 2011
Resilient Cities (Bonn, Germany) ……3-5 June 2011
Anand Patwardhan [Indian Institute of Technology—Bombay] (ORNL) ……17 June 2011
16th Annual CESM Workshop (Boulder, CO) ……20-23 June 2011
2011 SciDAC Conference (Denver, CO)……10-14 July 2011
Federation of Earth Science Information Partners Summer Meeting (Santa Fe, NM)……12-15 July 2011
TeraGrid '11 (Salt Lake City, UT)……18-21 July 2011
19th Conference on Applied Climatology (Asheville, North Carolina)……18–20 July 2011
CCSI Seminar—Suraje Dessai [University of Exeter] (ORNL) ……21 July 2011
Third International Conference on Climate Change (Rio De Janeiro, Brazil)……21-22 July 2011
CCSI Seminar—Jim Randerson (ORNL) ……25 July 2011
Community Earth System Modeling Tutorial (Boulder, CO)……1-5 August 2011
96th Annual Ecological Society of America Meeting (Austin, TX)……7-11 August 2011
Climate Science and Coastal Management Workshop (Charleston, SC) …… 8-12 August 2011
27th New Phytologist Symposium: Stoichiometric flexibility in terrestrial ecosystems under global change (Oracle, AZ)……25-28 Sept 2011
Fifth Intl. Conference on Flood Management (Tsukuba, Japan)……27-29 September 2011
ASA, CSSA, and SSSA International Annual Meetings (San Antonio, TX)……16-19 October, 2011
ICCCGW 2011: International Conference on Climate Change and Global Warming (Venice, Italy)……23-25 November 2011
Partners in Environmental Technology Technical Symposium and Workshop (Washington, DC)……29 Nov–1 Dec 2011
92nd Amer. Meteorological Society Meeting (New Orleans, LA)……22-26 January 2012
AAAS Annual Meeting (Vancouver, Canada)……16-20 Feb 2012
2012 Ocean Sciences Meeting (Salt Lake City, UT)……20–24 February 2012

MODIS LAND PRODUCT USED IN STATE OF THE BIRDS 2011 REPORT



The State of the Birds 2011, which was released on May 3rd by the Departments of Interior and Agriculture, was based in part on MODIS Land Products, created under the management of CCSI member Suresh SanthanaVannan.

The bird species distribution maps that serve as the basis for the report were derived from statistical models that included many environmental driver variables including the MODIS NDVI product. The ORNL DAAC's MODIS Web service was used by staff of the Cornell Lab of Ornithology to obtain point based MODIS data for ~150,000 sites in the conterminous U.S. This bird distribution modeling activity originated from an NSF-DataONE collaboration between the Cornell Lab of Ornithology, the ORNL DAAC, and the NSF-Funded TeraGrid computing resources project. Other collaborators included Bob Cook and Bruce Wilson (both CCSI members) as well as Line Pouchard and John Cobb.

Press releases and additional information are available from the following Web sites:

State of the Birds 2011 Report (see p. 44 for the acknowledgment of the ORNL DAAC):
http://www.stateofthebirds.org/ http://www.stateofthebirds.org/SOTB_20110504-1200-WEB.pdf

Secretary of Agriculture Press Release

Secretary of Interior Press Release

A library of bird distribution maps is available from the Lab of Ornithology's eBird project

CCSI WELCOMES NEW STAFF

Sandra Solands has joined the CCSI as the Institute's senior administrative assistant. Sandra was previously the senior administrative assistant for the Fuel Cell Technologies Program Manager and Energy Storage Program Manager under the Sustainable Transportation Program. Sandra has been with ORNL since 2004 and has over 30 years of administration experience.

IN THE NEWS

In May at the annual meeting, Pat Mulholland is slated to receive the 2011 Award of Excellence, their highest honor, from the North American Benthological Society (NABS).

Don't forget to check out the redesigned CCSI website.
ccsi.ornl.gov

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CCSI WELCOMES 2011 SUMMER STUDENTS

As summer approaches, CCSI will be welcoming several students identified below along with the tasks they will undertake while at ORNL. Many of these students are part of the Higher Education Research Experiences (HERE) program at ORNL whose goal is to provide opportunities to participate in research in a broad range of science and engineering activities related to basic sciences, energy, and the environment. Below is a listing of the students along with their focus for this summer.

Rahul Barman	Perform software development and enhancement to support the performance of coupled climate-carbon cycle experiments using the Community Earth System Model (CESM); perform analysis to quantify and compare feedback strengths, particularly those associated with high latitude/Arctic biogeochemical processes; develop diagnostic tools to support the Carbon-Land Model Intercomparison Project version 2 (C-LAMP2).
Reid Boehm	Document, audit, and archive data sets for ongoing EDSS projects, specifically FLUXNET and the ORNL DAAC.
Jonathan Brooks	Participate in the PiTS experiment.
Claire Campbell	Explore plant-soil water relations associated with the SPRUCE and PiTS climate change experiments.
Michelle Edwards	Gather and enter information for new AmeriFlux sites into CDIAC's MS SQL Server AmeriFlux relational database.
Deborah Higdon	Conduct research on the current state of federal and private-industry wind energy information-dissemination and development efforts and produce value-added information products to be made available via the WENDI Gateway via the Metadata Clearinghouse and the WindGIS interface as well as work on data ingest for the ORNL DAAC.
Wesley Kendall	Perform software development and enhancement to support the Forest Incidence Response State and Tracking (FIRST) prototype being developed for the USDA Forest Service at ORNL and investigate parallel algorithms and parallel input/output implementations for a variety of out-of-core data mining tools being developed for the analysis of satellite imagery of U.S. forests.
Nevin Kohler	Develop and test implementation of regional and global scale carbon cycle model simulation evaluation metrics.
Andrew Lawson	Assess USDA data sets to estimate how U.S. biofuel policies affected agricultural land use trends in the U.S.
Sumang (Sam) Liu	Explore model-data assimilation approaches to improving model performance and realism and by gaining a practical understanding of GIS application for agroecosystem modeling and bioenergy sustainability research.
Aaron Marshall	Apply data mining tools to normalized difference vegetation index (NDVI) and similar observational data sets for detecting changes in vegetation productivity, including the use of distributed-memory parallel computers, use of compilers, and application of various statistical, visual data analysis, and geographical information system (GIS) software packages for the production of maps showing the magnitude and extent of vegetation changes.
Matthew Sikorski	Test and comparison of the existing web mapping service applications (Google Maps, Yahoo Maps, Bing Maps, MapQuest and OpenLayers) for heavy populated overlays (up to 4.5 million markers).
Maggie Stevens	Develop a joint research plan with Brazil focusing on Land-Use Change (LUC) analysis and modeling, assess sustainability of bioenergy crops (accounting for carbon and GHG dynamics under different land management scenarios), and facilitate exchanges and technical cooperation to improve baseline data related to sustainable performance measures and develop specific plans for cooperative research and joint publications.
Anna Sullivan	Explore climate change in the Pacific Coastal States related to hydropower and carbon emissions
Chris Wesh	Assign Digital Object Identifiers (DOIs) to all of CDIAC's oceanographic datasets and register them with a central European registry.

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Coming in May

Highlighted Researcher: Paul Hanson
Highlighted Research: DAAC

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

RECENT PUBLICATIONS

Garten C.T., Iversen C.M. and Norby R.J. "Litterfall 15N Abundance Indicates Declining Soil Nitrogen Availability in a Free-air CO_2-enrichment Experiment," *Ecology* 92:133-139, 2011.

Izaurralde, R.C., Post, W.M. and West, T.O. "Managing Carbon: Ecological Limits and Constraints. In Land Use and the Carbon Cycle: Science and Applications in Human Environment Interactions," D.G. Brown, N.H.F. French, B.C. Reed, and D.T. Robinson, editors. Cambridge University Press, 2011.

Kodra, E., K. Steinhaeuser, and A. R. Ganguly (2011), Persisting cold extremes under 21st-century warming scenarios, *Geophys. Res. Lett.,* 38, L08705, doi:10.1029/2011GL047103.

Lutz B.D., Bernhardt E.S., Roberts B.J. and Mulholland P.J. "Examining the Coupling of Carbon and Nitrogen Cycles in Appalachian Streams: The Role of Dissolved Organic Nitrogen," *Ecology* 92:720-632, doi: 10-1890/10-0899.l. (2011).

Mahajan, S., North G. R., Saravanan R., & Genton M. G. (2011). Statistical significance of trends in monthly heavy precipitation over the US. *Climate Dynamics*.

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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