Climate Change SCIENCE INSTITUTE

Newsletter

AUGUST/SEPTEMBER 2011 VOLUME 2, ISSUE 6

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

LETTER FROM CCSI LEADERSHIP

With FY11 drawing to a close, we are currently preparing the CCSI Annual Report, which allows us to take a step back and reflect upon the Institute's accomplishments. Over the past year, the Institute made substantial progress on key scientific projects, published world-class papers, demonstrated international leadership through participation in the Intergovernmental Panel on Climate Change, and still found time for a range of outreach activities. Such success reflects both the mission and values of CCSI as reflected in the Institute's Strategic Plan. In recent weeks, we've had the opportunity to showcase the past year's accomplishments through both the annual DOE BER Modeling Principal Investigator's Meeting as well as Martin Keller's annual report to BER.

The new fiscal year appears poised to deliver both challenges and opportunities for CCSI and our science. The tightening of federal budgets has implications across our entire scientific portfolio. Nevertheless, we continue to attract funding for innovative research. For example, Stan Wullschleger's recent success with the Next Generation Ecosystem Experiment proposal provides an opportunity to break new ground in integrating Arctic terrestrial ecosystem experimentation and modeling. We believe strongly that the best way for CCSI to maintain its leadership position during uncertain times is to continue to demonstrate scientific excellence and to effectively communicate our science and its value to others.

As FY12 progresses, we must think strategically to position the Institute for continued success. We're currently planning our next Science Advisory Board meeting for the end of January, which provides a valuable opportunity to reflect critically upon CCSI's trajectory. In the meantime, we will increasingly look to our theme leaders, individual PIs, and the rest of the CCSI membership for fresh ideas for fulfilling the CCSI vision.

2011 CCSI COMPUTER MODELING EXPO

During the week of September 19th, several CCSI members provided updates on our climate modeling projects to our BER sponsors through presentations and posters. In an effort to share this information more widely within the Institute, we hosted our first expo, the 2011 CCSI Computer Modeling Expo. Each PI shared their presentation and answered questions from the attendees. A reception followed to allow for poster discussions. CCSI plans to continue hosting the type of expos following other workshops and large meetings, as best as can be accommodated by competing commitments and travel schedules.

The following members presented:

Ultra High Resolution Global Simulation to Explore and Quantify Predictive Skill for Climate Means, Variability and Extremes **(Jim Hack)**
Mean state and global characteristics of the 1 degree spectral Community Atmosphere Model **(Kate Evans)**
Direct and Semi-direct Effects of Aerosols on the Climate System **(Salil Mahajan)**
Progress Towards Accelerating CAM-SE on Hybrid Multi-Core Systems **(Rick Archibald)**
Reducing uncertainties associated with terrestrial carbon cycle-climate system feedbacks: Improved Earth System Model process representations for arctic, tropical, and temperate systems **(Peter Thornton)**
Project Spotlight: Development and Early Results from an Integrated Earth System Model **(Peter Thornton)**
Future hydrological predictions: Does dynamical downscaling add any value? **(Moet Ashfaq)**
Monthly fossil fuels CO2 fluxes: Impact on atmospheric CO2 seasonal cycles and implications for models of the terrestrial biosphere **(David Erickson)**
Impact of Increasing CO2 Concentrations on Ocean pH, Ocean Mixed Layer Depth and the Sulfur Cycle Using the Community Earth System Model **(Marcia Branstetter)**
Issues in the Integrated Analysis of Interactions Among Energy, Other Built Infrastructure, and Urban Systems **(Tom Wilbanks)**
Unable to attend the Expo but presented to BER—The Carbon-Land Modeling Intercomparison Project (C-LAMP) and the International Land Model Benchmarking (I-LAMB) Project for the IPCC AR5 **(Forrest Hoffman)**

In addition, four posters were presented:
Using Eddy-Flux Site Measurements to Examine the Performance of CLM-CN at High Latitudes **(Jeff Nichols for Mac Post)**
Development and analysis of a high-resolution spectral Community Atmosphere Model (CAM4) **(Kate Evans)**
Computer Performance of the Community Earth System Model **(Pat Worley)**
Data Workflow in Support of the Ultra High Resolution Global Climate Simulation Project (Valentine Anantharaj)

Inside this issue:

Dan Hayes ……2
Calendar ……3
New Staff……3
Fossil Fuels Project ……4
Publications ……6
Job Opportunities ……6

Highlighted Researcher DAN HAYES

Dan is from upstate New York, a native of Rochester. Dan received his PhD in Forest Science from Oregon State University, his MS in Forest Resources from the University of Maine, and a dual BS in Resource Management and Environmental and Forest Biology from the State University of New York (SUNY). He spent his last four years as a postdoctoral research fellow at the University of Alaska's Institute of Arctic Biology in Fairbanks before coming to ORNL. Dan likes to spend his free time doing lots of outdoor recreation with his family which includes two energetic boys (2 and 5 years old).

Dan Hayes, originally trained as a forester, became more interested in the science aspects during his postdoctoral research fellowship. He was able to take part in some NASA projects which enabled a broader view of forest ecology, leading to a natural progression for him into the more global climate issues. "Fairbanks was the ideal place for me at that point since climate change had become such a large topic," states Dan. As he continued to develop his interest in terrestrial vegetation and its role in climate change, his advisor, Dave McGuire, suggested he become involved in the North American Carbon Program (NACP). It was through his NACP work that Dan had his first connection with ORNL, including working closely with Mac Post and Bob Cook.

Joining ORNL in 2010, Dan has continued his work with NACP where he compares model results versus inventory for the continental carbon scale budget as well as modeling and arctic ecology issues.

Dan won a grant through NASA's New Investigator Program titled "Diagnosis and attribution of the contemporary North American sink for atmospheric CO_2: the role of disturbance and land use change" which will run through 2013. In addition, he is also looking forward to engaging on the NGEE Arctic project's computer modeling activities as it begins to ramp up in FY12. Also on Dan's radar will be participation on the new model intercomparison project, MsTMIP (Multi-Scale Synthesis and Intercomparison Project) and education and outreach related to the arctic as well as local outreach through the Great Smoky Mountain Institute at Tremont.

What role does your research play in climate change research?

"In general, I am interested in research questions related to the terrestrial carbon cycle – its operating mechanisms, driving forces and feedbacks to climate. Why is this important? In recent decades only about half of anthropogenic CO_2 emissions remain in the atmosphere, with the rest being sequestered about equally between land and ocean sinks. But these sinks are neither permanent nor fixed; whether or not they will continue to operate in the future is a research question with critical implications. My research is based on linking data and observations on ecosystem processes with scaling techniques using remote sensing and modeling tools to better understand regional-to-global scale terrestrial carbon cycle dynamics in an attempt to reduce uncertainty about, and improve predictions of, their future role in global climate change."

Who is the customer for your research?

"Ideally, that would be the human race; the current and future operation of the terrestrial carbon sink has critical consequences for life on Earth. The weakening or disappearance of this sink would accelerate the build-up of greenhouse gases in the atmosphere, putting further pressure on emissions reductions to achieve atmospheric stabilization targets. As such, it is important to be involved in broader scientific programs through which our research findings are conveyed to decision-makers and the media. To reach a broader audience, I also try to take every opportunity to engage other groups outside of the research

VOLUME 2, ISSUE 6

HAYES(CONT.)

community through lectures and workshops for practitioners, educators and the general public. In the meantime, my research directly informs the larger community of scientists. While no one is pretending that we can predict future climate with absolute metaphysical certainty by a bunch of differential equations on a computer, one of the great aspects of the modeling tools that I work with is the ability is to develop new hypotheses and identify key knowledge gaps and uncertainties that help prioritize further research."

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

"Climate change represents the foremost global-scale, scientific and socio-political challenge of our time. As a scientist, the opportunity to contribute to such a high impact knowledge-base is a powerful motivation. My interest in climate change research stems from a natural progression in my studies, from being trained as a forester in undergraduate school, but all the while being more interested in the science than the practice (or, I went on to graduate school because I was too lazy to get a "real" job). As a graduate student working on remote sensing and modeling projects, I could put what I had learned about ecology into a broader context (i.e. "seeing the forest for the trees"). It all came together as a post-doc in Alaska studying high-latitude ecosystems, where (1) climate change is occurring fastest; (2) the ecosystems are most sensitive to climate change; and (3) the controlling processes are least understood in terms of their representation in Earth system models."

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

"Since arriving at ORNL about a year ago, I have glimpsed the future of climate change research right here in the CCSI. Climate change is increasingly being recognized as a scientific problem that cuts across many subjects, integrating social, economic and political components with the physical and natural sciences. To have a multi-disciplinary group made up of many of the world's top scientists in close collaboration "under one roof" makes for a very exciting future for climate change research."

NEW STAFF

Ben Mayer recently joined the Computational Earth Sciences Group as a software engineer. Prior to ORNL, Ben worked on supercomputer technology tracking for the National Atmospheric Research Center (NCAR) in Boulder. He received his MS and BS in Computer Science, both from the University of Minnesota—Minneapolis. Ben will be assisting with CESM development tasks on the Hi-Res Modeling project and with the automating workflow for running Daymet on tiled geography.

CALENDAR

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
AGU Fall Meeting (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 FOSSIL FUEL EMISSIONS PROJECT

In its early years, CDIAC's fossil fuel efforts were focused largely on generating a "global estimate" of the amount of carbon dioxide (CO_2) released from burning fossil fuels such as coal. While this has always been a core CDIAC activity because of its relevance and importance to carbon cycle research, the Fossil Fuel Emissions Project has evolved over time to address new scientific questions and to satisfy a growing number of users worldwide. One extension has been to produce emission estimates at finer spatial and temporal resolutions (e.g., monthly estimates versus annual estimates, state-level estimates).

The core "global estimate" and national estimates produced by CDIAC each year come from data assembled by the United Nations in New York. These UN energy statistics are obtained through questionnaires submitted by member countries and from international reporting groups. The CDIAC team processes the UN data to check for quality and consistency and applies appropriate oxidation rates and carbon coefficients to estimate the amount of carbon for some defined time period.

Armed with these time series, researchers can draw correlations between the CO_2 emissions and significant world events. One such event, the global financial crisis (GFC) which began in 2008, is the subject of a recently submitted *Nature Geosciences* paper: "CO_2 Emissions Rebound after the Global Financial Crisis." Two of the paper's authors have ties to CCSI: Tom Boden and Gregg Marland (now at Appalachian State University).

Three significant findings were identified in the paper:

1. According to CDIAC's latest fossil fuel estimates, global emissions in 2010 exceeded 9 billion tons of carbon for the first time reversing the drop seen in 2009 due to the GFC,

2. China is now clearly the world's largest fossil-fuel emitter, well

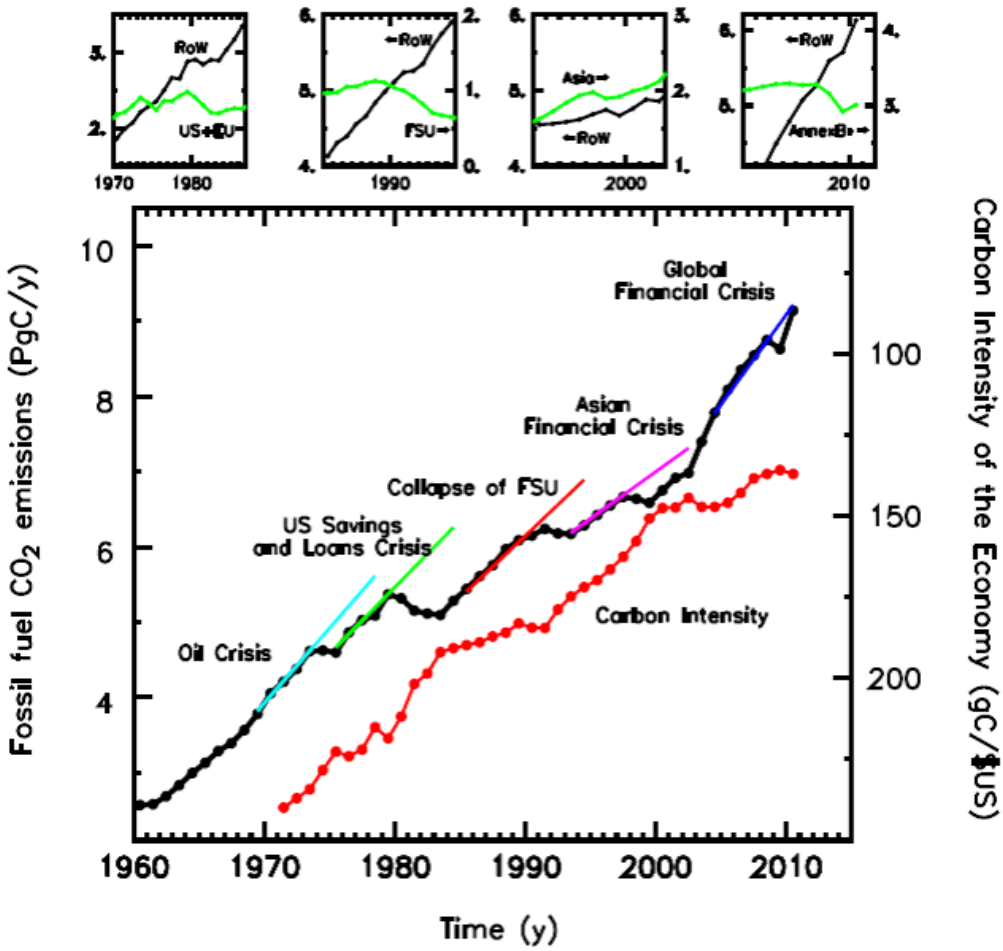

Figure 1. Emissions of CO_2 from fossil-fuel combustion and cement production for the world (PgC/yr; black) and the carbon intensity of world GDP (gC per 2000 US dollars at constant prices; red curve, inverted axis). The effect of the most important recent financial crises on global CO_2 emissions are highlighted in the figure by showing a linear trend fitted to the five years prior to the beginning of the crisis; the oil crisis (1973), the US savings and loans crisis (1979), the collapse of the Former Soviet Union (FSU; 1989), the Asian financial crisis (1997) and the recent Global Financial Crisis (2008). The top panels show CO_2 emissions for the regions mot affected by each financial crisis and the Rest of the World (RoW) in PgC/y. The EU15 only is plotted on the top left panel. Asia includes Brunei, China, Hong Kong, India, Indonesia, Japan, Laos, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand, and Vietnam. The Annex B countries include all countries with Kyoto commitments (Supplementary Methods).

FOSSIL FUEL EMISSIONS PROJECT (CONT.)

surpassing the U.S., and

3. Developing countries are now emitting more than developed countries, both in terms of absolute emissions and embodied emissions (i.e., consumption of energy and goods) (Figure 2).

From an emissions standpoint, the GFC would appear to be over, as emissions have begun to rise following the decline which started in 2008. However, while emissions from U.S. and Europe declined during this time period, emissions from China and India were not impacted. Figure 1 illustrates the impacts on global CO_2 emissions from historical financial crises and political events. As stated in the paper, "Many saw the GFC as an opportunity to move the global economy away from a high emission trajectory. Our results provide no indication that this is happening, and further, indicate that the GFC has been quite different from previous global crises."

The monthly and annual gridded fossil-fuel emission products, produced by CDIAC and CCSI staff member Bob Andres are also being used prominently including being used as baseline model data for the current IPCC scientific assessment (AR5). Other CCSI staff members are taking advantage of the product as well. Dave Erickson, Bob Andres, Forrest Hoffman, Marcia Branstetter, and others are using the monthly gridded product to evaluate the impact on atmospheric CO_2 seasonal cycles and implications for terrestrial models.

What is next for the Fossil Fuel Emissions Project? "Our next step will be to focus on robust, systematic uncertainty quantification – how good are these numbers?" stated Tom Boden, CDIAC Director. Previous studies have shown the uncertainty of the "global estimate" to be ± 10%, but growing due to increased contributions from developing countries. Before nations spend large amounts of money to reduce fossil-fuel emissions in compliance with the Kyoto Protocol, we need to know the uncertainty associated with these national inventories.

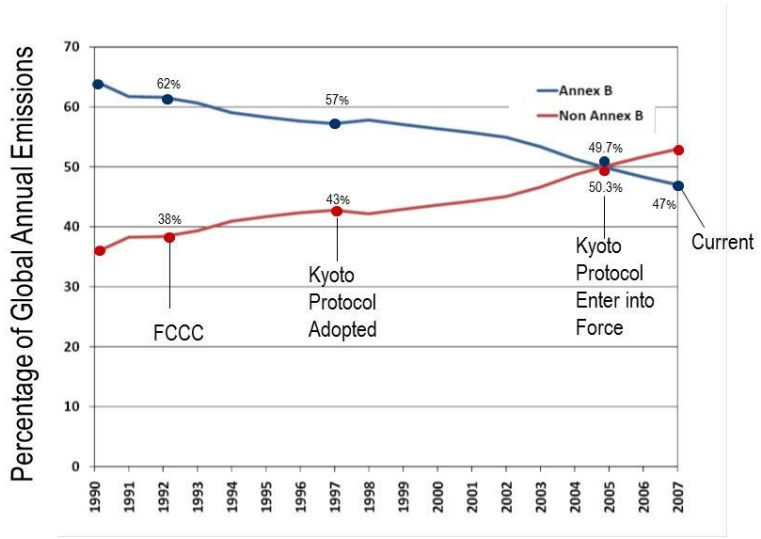

Figure 2. Carbon emissions associated with fossil fuel consumption and cement production from developing countries now exceed emissions from developed countries.

The current CCSI brochure, fact sheet, and individual project sheets are available for use when you travel to conferences and meetings. Please visit the CCSI website or Library SharePoint site.

When you give a seminar, talk, or poster, please add it to the SharePoint Library repository under "Presentations." The material will not be used without your permission, but it is helpful to have the PowerPoint on hand when leadership needs to update its CCSI overviews.

Upcoming CCSI Seminars

November 2nd
Dr. Eric Kasischke
"Feedbacks between climate, fire severity, and permafrost degradation in Alaskan black spruce forests"

November 3rd
Elizabeth Hoy
"Factors controlling carbon consumption during Alaskan wildland fires"

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 October's Edition

Highlighted Researcher: Giri Palanisamy
Highlighted Research: CSiTE

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

RECENT PUBLICATIONS

Andres R. J., J. S. Gregg, L. Losey, G. Marland and T. A. Boden, 2011: "Monthly, Global Emissions of Carbon Dioxide from Fossil Fuel Consumption," *Tellus B*, 63:309 -327, doi: 10.1111/j.1600-0889.2011.00530.x.

Ganshin, A., T. Oda, M. Saito, S. Maksyutv, V. Valsala, R. J. Andres, R. Fischer, D. Lowry, A. Lukyanov, H. Matsueda, E. G. Nisbet, M. Rigby, Y. Sawa, R. Toumi, K. Tsuboi, A. Varlagin and R. Shuravlev, 2011: A Global Coupled Eulerian-Lagrangian Model and 1 X 1 Km CO_2 Surface Flux Dataset for High-Resolution Atmospheric CO_2 Transport Simulations. *Geosci. Model Dev. Discuss.* **4**, 2047-2080.

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.

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).

Graham, R. L., D. A. Elias, T. J. Phelps, et al, 2011: "Microbes in Thawing Permafrost: The Unknown Variable in the Climate Change Equation," *ISME Journal.*

Gunderson C.A., N. T. Edwards, A. V. Walker, K. H. O'Hara, C. M. Campion and P. J. Hanson, 2011: Forest Phenology and a Warmer Climate – Growing Season Extension in Relation to Climatic Provenance. *Global Change Biology.*

Iversen C. M., M. T. Murphy, M. F. Allen, J. Childs, D. M. Eissenstat, E. A. Lilleskov, T. M. Sarjala, V. L. Sloan and P. F. Sullivan, 2011: "Advancing the Use of Minirhizotrons in Wetlands," *Plant and Soil* [Available on-line: DOI 10.1007/s11104-011-0953-1.]

Jones C. D., J. K. Hughes, N. Bellouin, S. C. Hardiman, G. S. Jones, J. Knight, S. Liddicoat, F. M. O'Connor, R. J. Andres, C. Bell, K-O Boo, A. Bozzo, N. Butchart, P. Cadule, K. D. Corbin, M. Doutriaux-Boucher, P. Friedlingstein, J. Gornall, L. Gray, P. R. Halloran, G. Hurtt, W. J. Ingram, J-F. Lamarque, R. M. Law, M. Meinshausen, S. Osprey, E. J. Palin, L. Parsons Chini, T. Raddatz, M. G. Sanderson, A. A. Sellar, A. Schurer, P. Valdes, N. Wood, S. Woodward, M. Yoshioka and M. Zerroukat, 2011: "The HadGEM2-ES Implementation of CMIP5 Centennial Simulations," *Geosci. Model Dev.* 4:543-570, doi:10:5194/gmd-4-543-2011.

Nassar, R., D. B. A. Jones, S. S. Kulawik, J. R. Worden, K. W. Bowman, R. J. Andres, P. Suntharalingam, J. M. Chen, C. A. M. Brenninkmeijer,T. J. Schuck, T. J. Conway and D. E. Worthy, 2011: "Inverse Modeling Of CO_2 Sources and Sinks Using Satellite Observations of CO_2 from TES and Surface Flask Measurements," *Atmos. Chem. Phys.* 11:6029-6047, doi:10.5194/acp-11-6029-2011.

Nassar R., D. B. A. Jones, P. Suntharalingam, J. M. Chen, R. J. Andres, K. L. Wecht, R. M. Yantosca, S. S. Kulawik, K. W. Bowman, J. R. Worden, T. Machida and H. Matsueda, 2011: "Modeling Global Atmospheric CO_2 with Improved Emission Inventories and CO_2 Production from the Oxidation of Other Carbon Species," *Geoscientific Model Development.* 3:689-716.

Norby R. J. and D. R. Zak, 2011: Ecological Lessons from Free-Air CO_2 Enrichment (FACE) Experiments. Annual Review of *Ecology, Evolution, and Systematics,* 42, 181-203.

DATA PRODUCTS

Angell J., 2011: National Oceanic and Atmospheric Administration (NOAA), data contributor. Kaiser D. P., publisher, Carbon Dioxide Information Analysis Center (CDIAC) Website. Global, Hemispheric, and Zonal Temperature Deviations through 2010 Derived from a 54-Station Radiosonde Network.

Menne, M. J., C. N. Williams Jr. and R. S. Vose, 2011: National Oceanic and Atmospheric Administration/National Climatic Data Center (NOAA/NCDC), data contributors. Jackson, B., D. P. Kaiser, and L. M. Olsen, publishers, for the Carbon Dioxide Information Analysis Center (CDIAC) Website. U.S. Historical Climatology Network (NSHCN) daily temperature, precipitation, snowfall, and snow depth data from 1218 stations across the conterminous U.S. (updated through 2010).

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.

•Postdoctoral Research Associates