

## LETTER FROM CCSI LEADERSHIP

The FY2011 budget situation appears to be relatively stable. We won't know real details for another two to three weeks, but it appears that BER's climate change research program will be OK for this year.

Jim and Dave are visiting our BER Program Managers this week briefing them on our advanced simulation projects. They will also be discussing a draft prospectus for a new Modeling SFA (Scientific Focus Area) that will integrate many of our modeling projects and connect with the Terrestrial Ecosystem SFA.

Gary travelled to NCDC during February with Jeff Nichols and Martin Keller to discuss potential collaborations with Tom Karl, Scott Hausman, Otis Brown, Dave Easterling, and several others. There was strong interest from Scott and his colleagues to spend a day at ORNL in the near future for a focused discussion on integrating observational and simulation data.

Many of you are arranging for summer students, and that represents a marvelous opportunity to mentor future scientists. We will have limited office space so please keep Mary informed. Once our special spaces are full, additional students will have to be housed in your offices, or common spaces.

## DR. PRESTON GOES TO CAPITOL HILL

On February 16-17, Benjamin Preston participated in Climate Science Day on the Hill. The event was organized by 10 scientific societies as a non-partisan opportunity for scientists of many disciplines to build relationships and provide Members of Congress access to the best possible climate science. Preston paired up with Manuel Lerdau of the University of Virginia to visit staff from five Tennessee and Virginia Congressional offices: Rep. Eric Cantor (VA), Rep. Rob Wittman (TN), Rep. Stephen Fincher (TN), Rep. Robert Hurt (VA), and Sen. Bob

Corker (TN). As Climate Science Day coincided with Congressional debate on



*Figure 1. Climate Science Days on the Hill. (From left to right) Manuel Lerdau, University of Virginia; Representative Robert Hurt; Benjamin Preston, ORNL; Caitlin Buzzas, American Meteorological Society*

the FY2011 budget, including a raucous open rule debate in the House of Representatives, the visits were brief. Nevertheless, staff were generally enthusiastic about science and its increasing role in informing public policy. While this enthusiasm did not necessarily translate into uniform acknowledgement of anthropogenic climate change, the issue of energy security was a common concern, with several offices projecting that energy policy is soon likely to rise to the top of the legislative agenda.

## ARM ARCHIVE POSTER TAKES 2ND PLACE AT ASR SCIENCE TEAM MEETING

The Atmospheric System Research (ASR) Program Science Team Meeting was held March 28-April 1, and brought together over 300 ASR researchers, Atmospheric Radiation Measurement (ARM) Climate Research Facility infrastructure members, and selected leading scientists to review progress and plan future directions of ASR research. The poster "Big Data Systems at the ARM Archive I: Interactive Visualization Opportunities," presented by lead author Giri Palanisamy won Second Place "People's Choice" poster award. The poster is on display in a CCSI first floor poster case. Congratulations to all of the authors: Giri Palanisamy, Raymond McCord, J. Mather, P. Kollias, I. Jo, Pete Eby, Karen Gibson, E. Stephan, M. Jensen.

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## Highlighted Researcher

## THOMAS WILBANKS



Since Tom began graduate school, he has been interested in technology changes that make a difference in doing sustainable development in a way that is good for both nature and society. Tom's BA in social sciences is from Trinity University, and his MA and PhD in geography are from Syracuse University. After a few years on the faculty at Syracuse, Tom moved to the University of Oklahoma (OU) where he was a Research Fellow in the Science and Public Policy Program and an Associate Professor and Chair in the Department of Geography. While at OU, he co-authored a couple of books on energy technology assessment. During the energy crisis of the 1970s, he was invited to ORNL to present some of his research. He eventually started his ORNL career full-time in 1978 after a summer research visit in 1977 and several months of part-time transition. "I thought it was an interesting opportunity to do something different," stated Tom, at a pivotal time when DOE was being formed, and opportunities for ORNL in technology assessment and policy analysis were likely to grow. Since energy technology was changing so quickly, Tom felt that the integration of social and natural sciences in the realm of energy supply technologies and energy efficiency would have a significant impact. "By coming to ORNL, I could focus on issues rather than academic disciplines. I could have one foot in the world of research and one in the world of practice – ORNL is perfect for this."

Tom Wilbanks' involvement in climate change science began in earnest in the early 1990s, stemming from his earlier work in energy and environmental management. His climate change research started with an Association of American Geographers project on how local action can make a difference in dealing with global climate change. This led to an invitation to become part of the First U.S. National Climate Change Impacts Assessment (completed in 2000) and involvement in the Intergovernmental Panel on Climate Change (IPCC).

Tom remains involved with development of the Third U.S. National Climate Assessment (due out in June 2013) and with IPCC, for which he is a coordinating lead author in the 5th Assessment Report (due out in September 2014) for a chapter that integrates adaptation, mitigation, and sustainable development. He is also active with the National Academies of Science (NAS) and the U.S. Global Change Research Program (specifically in the area of strategic planning). A part of his IPCC work led to a 2007 Nobel Prize for Peace, being formally recognized as a Co-Laureate (along with David Greene of ORNL). He is a member of the NAS committee on America's Climate Choices and chaired the panel that produced a 2010 report, *Adapting to the Impacts of Climate Change*, which has led to opportunities to serve as a spokesperson for the adaptation science community. "Adaptation is not just a planning exercise. There is a sci-

ence to it," stated Tom as he describes this aspect of his work in the Impacts, Adaptation and Vulnerability research theme of CCSI.

For a number of years, Tom has been supporting the DOE Office of Science Integrated Assessment Research Program, concentrating mainly on strategies for enhancing the capacities of integrated assessment research to address climate change impact and adaptation issues. He is currently participating in the RIAM (Regional Integrated Assessment Model) project, with his efforts focused on climate change/energy sector relationships and on approaches for analyzing adaptation issues in regional integrated assessment modeling. He is a leader in improving understandings of the effects of climate change on energy production and use in the U.S. He is also involved in another ORNL-led activity, CARRI (Community and Regional Resilience Institute), which focuses on how to improve community resilience. In its first two years, this project worked in partnership with three Southeastern communities—Charleston, SC; Gulfport, MS; and Memphis, TN—and this year is developing the prototype of a generic web-based community resilience system for use by other communities across the U.S.

Tom also receives funding from the National Oceanic and Atmospheric Administration (NOAA) to assist them in understanding how to connect climate science and climate

services – understanding what people need from climate science, what climate science has to offer, and how most effectively to deliver relevant knowledge and data. This includes understanding the science foundations of decision support, such as informatics and visualization.

Tom has been the recipient of several awards and has been a Corporate Fellow for a quarter of a century, chairing the ORNL Corporate Fellow Council for eight of those years. He has been a leader in ORNL's developing country programs since 1982 which have led more than 70 projects in 40 countries and involved more than 100 staff members across ORNL. Beyond his project work, Tom is extensively involved in research, writing and publications, including a pending paper on how transformational energy technology breakthroughs can be accelerated. He also published a paper with his son last year on sustainable development and how the Internet can be leveraged to engage more people globally in achieving sustainability.

According to Tom, he feels lucky to be in the middle of a number of interesting and relevant topics where his expertise is in high demand.

### What role does your research play in climate change research?

"My climate change research grew out of long-term interests in how nature-society balances affect sustainable development

and how that balance is related to technological change. By the early 1990s, it was becoming clear that climate change was going to be a major issue for such nature-society balances and, therefore, for sustainable development. Over the years since then, I have done a lot of research on possible climate change impacts on human and human-managed systems, both in the U.S. and the developing world; on adaptive responses to concerns about climate change; on how geographic scale matters in understanding impacts and responses (i.e., local/regional/global); and on how decisions are made and implemented to address the challenges of climate change. Through this research and a variety of work on associated committees, panels, and large assessment efforts – from IPCC to US national assessments to NAS/NRC committees and

panels – I think I have had some impact on the emergence of climate change impact/adaptation/vulnerability (IAV) research as a full partner in climate science.”

#### **Who is the customer for your research?**

“Well, first of all, the world. We do our professional work to try to make the world a better place, now and in the years to come. To me, a little idealism is a part of why a national laboratory is a good place to do issue-oriented fundamental research. A second answer is the world of knowledge and learning. We do research to enrich that world. A third answer is that, over the years, I have had funding from DOE, USAID, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, Environmental Protection Agency, National Science Foundation, and oth-

er agencies; and I have worked with a host of partners in academia, government, industry, and non-governmental organizations. The best relationships have tended to be long-term collaborations between researchers and users where we learn together, share the loads together, and help each other to make progress in solving the problems that we all care about.”

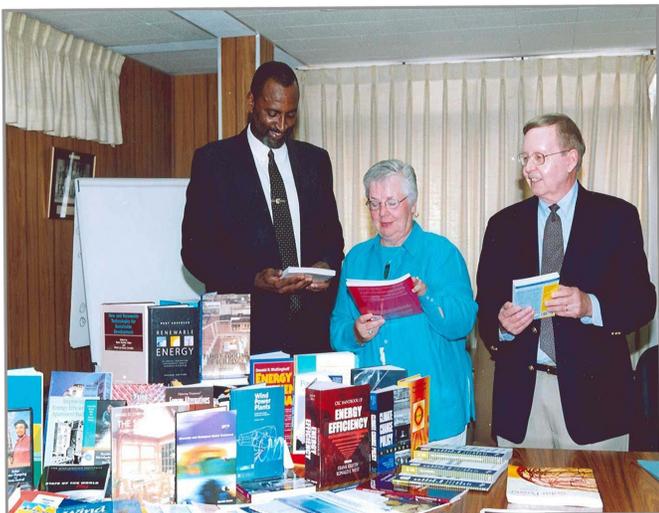
#### **Why is it important to you, personally, to become involved in climate change research?**

“Climate change research is important because the challenges posed by impacts of climate change are very real and potentially very disruptive to things that we care about in this world. Climate change is the kind of very large, complex, enormously broad and multidisciplinary, technology and economy-related problem rooted in both science and behavior for which national laboratories exist to take on. For a person like me, a social scientist interested in roles of technology development, it challenges us to accelerate technological innovation and development globally in order to fix the problem within a few decades in ways that are sustainable, affordable, and socially acceptable – so that the impacts are moderated before they become alarming. We cannot do that with the technologies currently on hand for either greenhouse gas emission

reduction or adapting to severe climate change impacts.”

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

“I think that as climate change impacts continue to emerge, with a growing number of extreme weather-related events, the focus on climate change *consequences and responses* is sure to increase—the “so what” of climate change. As a research challenge, I think we will be increasing our attention on a number of issues that have been hard to address with computational limitations, such as multiple drivers of impacts and responses, feedbacks, and “tipping points,” and I think this is a major opportunity for CCSI. Meanwhile, I think that the role of *observations* of climate change will become more important in climate change research and a growing partner with model-based projections of the future, as we increase our capacity to compare modeled system behavior with observed system behavior in a context of climate *change*, not just climate *variation*. And I think that improving connections between climate change science and users of that science will grow as a research need and opportunity.”



**Figure 2.** Wilbanks joins the U.S. Ambassador to the Eastern Caribbean in presenting a basic clean energy library to the new Renewable Energy Centre, established in Barbados with ORNL's assistance.

## Highlighted Research DATA VISUALIZATION & ANALYSIS

An ongoing challenge in climate change research is how to assimilate the vast amounts of data holistically and be able to identify meaningful patterns, trends and anomalies. They rely on visual data analysis – a combination of visualization, data mining and statistics – to study what they have found. Several events over the past few years have created an urgent need for improved visual data analysis: the growth of data size and its complexity (unprecedented spatial and temporal resolution, particularly resulting from high-resolution simulations), the proliferation of parallel computational platforms, and the need for a large, global community of climate scientists to share data and software. Scientists face many challenges in improving visual data analysis including the modification of tools and algorithms from their current serial form to effectively use parallel computing platforms and data I/O infrastructure. Algorithms must be capable of illustrating relationships for up to hundreds of runs produced in a single ensemble or comparison of up to hundreds of individual ensemble runs. The tools and algorithms must be able to illustrate the relationships between variables in time-evolving data, compare simulated and observed data, and compare data that exist on different grid types and have different resolutions. The ultimate challenge is being able to capture these capabilities and deploy a standalone application, preferably ones which scientists are already using instead of creating a completely new application.

In late FY2010, DOE's Office of Biological and Environmental Research funded the Visual Data Exploration and Analysis of Ultra-Large Climate Data project, a three-year collaborative project led by Lawrence Berkeley National Laboratory (LBNL) in partnership with ORNL and Lawrence Livermore National Laboratory (LLNL), with the primary goal being to develop tools for analyzing these large volumes of data as well as advanced software applications for data

discovery, management, visualization, and analysis. Several ORNL researchers are directly involved in two of the three project's primary thrusts:

Software Engineering and Integration (deploying tools and technologies for use by the climate science community), led locally by Sean Ahern and Statistical Technology Adaptation (extending and adapting statistical algorithms for use in climate science problems), led locally by George Ostrouchov.

This project is tightly coupled with the Earth System Grid (ESG) which integrates supercomputers with large-scale data and analysis servers located at numerous national labs and research centers to create a powerful environment for next-generation climate research. Access to ESG is provided through a system of federated Data Gateways that collectively allow access to massive data and services for climate global and regional models, IPCC research, and analysis and visualization software. ORNL is home to one of the seven ESG Gateways. Part of ESG's success lies in the ability to effectively visualize the data once it is available. Therefore, Ahern is working with the ORNL ESG project team (led by Galen Shipman) to modify

ESG's architecture so that it can function in parallel.

To understand the task at hand, one must have an appreciation for the volume of complexity generated in climate research. Being that climate scientists are interested in temporal phenomena – decadal or monthly trends—the corresponding data has a tremendous number of time steps. Additionally, climate scientists routinely run multivariate simulations producing detailed interactions among many variables and, thus, a large amount of data. (see example in Figure 3 below) “We are really pushing the boundary on what is considered state-of-the-art for multivariate analysis,” stated Ahern. One of the techniques being pursued by the team is the “gluing” together of several existing software packages.

A high-resolution climate simulation can generate upwards of 1,000 TB of data. At 100 MBps, it would take over four months to be able to look at a petabyte of data. As stated earlier, this is due in part to the existing algorithms being mostly serial. “To provide useful tools to the climate community, we need to look at how we can utilize parallel analy-

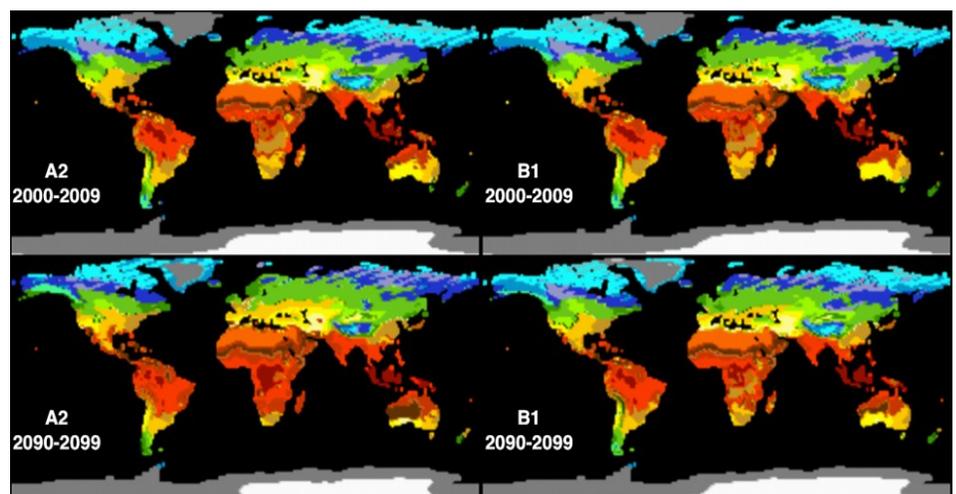


Figure 3. A multivariate classification capability under development in VisIt was demonstrated by comparing the ecological impact of two climate scenarios. A2 is roughly status quo and B1 is approximately the Kyoto agreement. Colors are Holdridge life zones that define multivariate atmospheric conditions, which drive local ecology.

L. R. Holdridge, Determination of world plant formations from simple climatic data, *Science* 105 (2727) (1947) 367–368.

## DATA VISUALIZATION & ANALYSIS (CONT.)

sis,” explained Ahern, “to break it apart temporally versus spatially.” Doing parallel analysis is no easy task, and while there is ample experience in other areas such as astrophysics and fusion, there is only sparse experience in implementing parallel analysis for climate change science. This project team is truly pushing science and tools in directions that it has not been pushed before—requiring collaborations that are wider than previously established.

Ahern, along with team member Dave Pugmire, are using VisIt (a leading parallel visualization and graphical analysis tool) and R (a complex package for statistical computing and graphical analysis) for the analysis and visual data exploration applications. The ORNL team is also collaborating with industrial partners such as [Kitware](#), who produces the Visualization Toolkit (VTK), an open-source software system that forms the underpinning for many visualization systems.

Ultimately, this project will result in

parallel software packages working together seamlessly—parallel R working with parallel VisIt. The long-term implications of this work extend well beyond climate change. “This is truly exciting, since what we create for climate change can be applied to many other science domains,” stated Sean. “We will be able to analyze old data and see things that we were previously unable to see and at a speed and scalability that we previously could not attain.”

A portion of this project is the collaboration with statisticians to select and organize the data into events and phenomena that are similar. This means grouping data segments based on functional data analysis, a recent development in statistics. Variability attribution is another statistical thread focused on answering questions such as “What causes are responsible for the variability?” and “How can variability be partitioned among the causes?” Work in this thrust area also includes feature extraction and tracking, characterization of rare events and accounting for spatial

dependence in extremes analysis.

Introducing statistical analysis into a combined R and VisIt tool will be a “first” and is expected to lead to some very interesting visualization discoveries. According to Ostrouchov, “The marriage of R and VisIt will bring statistical tools to this problem that will allow climate scientists to essentially classify parts of a simulation to look at representative examples of events. If something happens very rarely, you want to see that too...these tools will direct you to those events.”

While this project is still in its infancy, both Ahern and Ostrouchov believe that they are well on their way to making some exciting discoveries and contributions that will revolutionize visual data exploration and analysis, arming climate scientists with essential tools in understanding and explaining their results and the potential local and global impacts.

### CALENDAR

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

# REDESIGNED CCSI WEBSITE LAUNCHED

CCSI has launched its redesigned website which can still be accessed via the previous site's URL ([climatechangescience.ornl.gov](http://climatechangescience.ornl.gov)) as well as [ccsi.ornl.gov](http://ccsi.ornl.gov).

Built on a Drupal platform, the site can be easily and quickly updated with new content on a more real-time basis than the previous site.

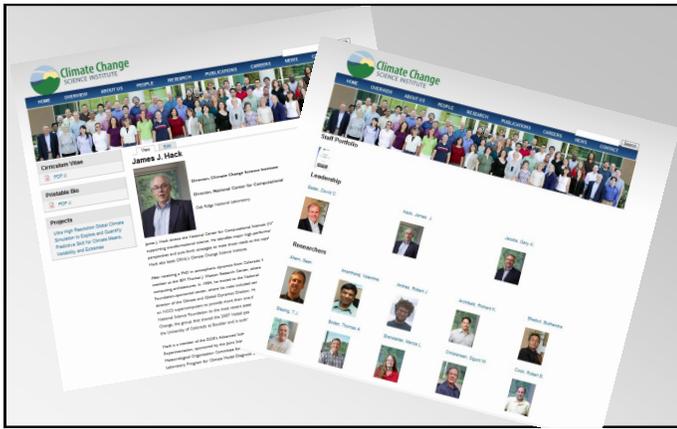


Figure 4. New People pages.

A key objective in the redesign was the interlinking of CCSI staff to their projects, projects to staff, staff to publication, publications to staff, projects to publications, publications to projects, and projects to research themes. Here is a list of some of the resources that you can access from the site:

- CCSI Fact Sheet
- CCSI Brochure
- CCSI Project Portfolio
- CCSI Staff Portfolio
- Listing of Researchers, Postdoctoral and Post-Master's Research Associates along with their photo, curriculum vitae, bi-

osketch, and a sorted listing of their publications, each linked to the actual document (Figure 4).

- Listing of projects currently sorted by research theme along with individual, printable project descriptions, links to project websites and a listing of associated publications, again, linked to the actual

document.

- General listing of publications by CCSI staff, sortable by staff member, project, publication type, and publication year.
- Listing of open CCSI positions along with printable position descriptions and links to the appropriate online application sites.
- Listing of news and formal highlights with an archive of aged items.
- Downloadable newsletters with a complete archive.
- Calendar of events potentially of interest to climate researchers.

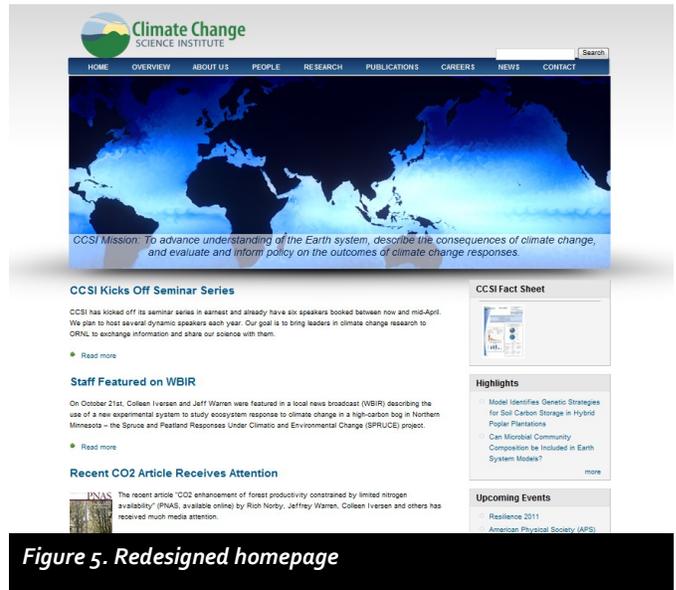


Figure 5. Redesigned homepage

- Automated contact form to obtain additional information.

Our roadmap for additional enhancements includes:

- Addition of technical staff to the People page.
- Separate page listing all projects with links to their

respective project description page.

- Listing of Research Sponsors and Partners.
- Listing of recent ORNL contributions to climate change.

Please help us keep the content fresh by emailing news topics and highlights to [climatenews@ornl.gov](mailto:climatenews@ornl.gov).

## CCSI WELCOMES NEW STAFF



Susan Heinz is a Technical Project Manager in the Environmental Sciences Division. She will primarily support the Environmental Data Science and Systems Group. Susan's technical background is in Geography, emphasizing management of technical scientific services projects involving earth science applications, data and information systems. Previous to joining ORNL, Susan was the Operations Manager for the

Fourteenth Coast Guard District's Maritime Domain Awareness (MDA) Program in Honolulu, Hawaii.

Previous professional experience includes positions as a Geographer and GIS Applications Specialist with GeLogics Corp., Raytheon, SAIC, Parsons Engineering, and her own company The Star Group. Sue is a Veteran with prior service in the Air Force, Air Force Reserve and Coast Guard Reserve. Educated at the University of California, Santa Barbara, she holds a Bachelor of Arts in Geography with emphasis in Remote Sensing Applications and Cartography.

# FIRST INTERFACE MEETING

Integrated Network for Terrestrial Ecosystem Research on Feedbacks to the Atmosphere and Climate (INTERFACE) is a research coordination network sponsored by the National Science Foundation and Purdue University, bringing together three groups within the global change research community:

1. Researchers conducting field experiments
2. Researchers who use ecosystem-scale models
3. Researchers working on land-atmosphere interactions in Earth system models (ESMs).

INTERFACE activities bring together these three groups to advance global environmental change research by:

- Incorporating realistic biological responses into

ESMs, and

- Facilitating the design of field experiments and computer simulations that are best suited to improving the performance of ESMs

The first meeting for this research coordination network was held February 28 - March 3 at Captiva Island, FL. Titled "How do we improve Earth system models? Integrating Earth system models, ecosystem models, experiments, and long-term data", the workshop focused on three themes:

- Nutrient interactions and limitation in global change
- Water availability and ecosystem dynamics
- Acclimation of carbon uptake and release to climate and atmospheric change.

Invited talks were presented from the perspective of Earth system modeling, ecosystem modeling, and experiments and observations under each theme, with several integrative "challenge" talks. The workshop drew a strong international group of leading researchers and students. Lively exchanges under all three themes in the plenary session carried over to breakout sessions where discussion focused on immediate, mid-term, and long-term activities that further the integration of experimental, observational and modeling research. A recurring theme was that multi-factor experiments and multi-temporal analyses are few in number, and more emphasis is required in this area to arrive at a robust body of work that can

be integrated in large-scale models. It was also noted that many models have yet to achieve a state-of-the-art integration of existing process-level knowledge from single-factor experiments. For example, new results on acclimation of respiration to changes in temperature have yet to be integrated in many Earth system or ecosystem models. CCSI researchers Rich Norby and Peter Thornton were in attendance.

The next INTERFACE workshop is scheduled for June 2011, in Keflavik, Iceland, on the topic "Nutrient constraints on the net carbon balance".

Find more information on INTERFACE at:  
<http://www.bio.purdue.edu/INTERFACE/>

# CLIMATE ARTWORK

CCSI member, Dale Kaiser, brought to our attention an interesting item on display at the "Communicating Weather and Climate" art exhibition at the recent American Meteorological

Society meeting in Seattle. "Anorak, 2011" is a hand-sewn beadwork-on-canvas creation by artist [Scott Schuldt](#) done in collaboration with climate scientist Cecilia Bitz whose research fo-

cus is Arctic sea ice. The theme for the images is the climate change effects on the Arctic. "The anorak was designed to fit Cecilia, thereby clothing the scientist in her own work."



**Figure 6.** Front View—The sea ice extent chart is the plot running across the front of the anorak. The right cuff is the temperature plot with the Keeling curve (CO<sub>2</sub>) on the left cuff. The equation on the sleeve is the function for ice softness pertaining to glacier dynamics.

Shoulder Detail—the Canadian Arctic Archipelago and Greenland.

Back View—A beaded map of the Arctic (with 3 different definitions of Arctic) on the shoulders locates the work geographically. Greenhouse gas molecular models are found on the hood. Arctic species (including man) tumble out of the map toward flames on the lower hem, which includes stock ticker symbols for major oil and coal corporations. On the cuffs, sleeves and front and back of the anorak are equations and plots with particular significance to Cecilia's research.

Photo Credit: <http://scottschuldt.com/anorak.html>

# AMWG MEETING

The Community Earth System Model (CESM) Atmosphere Model Working Group Meeting was held February 14th-16th at the National Center for Atmospheric Research (NCAR) in Boulder, CO. This annual meeting was attended by almost 100 representatives from DOE national laboratories as well as universities and other federal agencies.

CCSI member, Kate Evans, presented on high-resolution model development highlighting the Spectral and Spectral Element models.

There were a couple notable announcements from NCAR:

- Spectral Element will be the default for the next CESM release (anticipated this summer) and
- CAM5 (Community Atmosphere Model) option of the model is becoming more mature.



## 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](mailto:climatenews@ornl.gov)

We're on the Web!

[www.climatechangescience.ornl.gov](http://www.climatechangescience.ornl.gov)

**Coming in April**

**Highlighted Researcher:** Tom Boden  
**Highlighted Research:** NGE—Arctic



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

## RECENT PUBLICATIONS

Garten CT, DJ Brice, HF Castro, RL Graham, MA Mayes, JR Phillips, WM Post, CW Schadt, SD Wullschleger, DD Tyler, PM Jardine, JD Jastrow, R Matamala, RM Miller, KK Moran, T Vugteveen, RC Izaurrealde, AM Thomson, TO West, JE Amonette, VL Bailey, FB Metting, and JL Smith (2011) Response of "Alamo" switchgrass tissue chemistry and biomass to nitrogen fertilization in west Tennessee, USA. *Agriculture, Ecosystems, and Environment* 140: 289-297

**Jones, R.N. and Preston, B.L. (2011) Adaptation and risk management. *WIREs Climate Change*, DOI: 10.1002/wcc.97.**

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

**Norby RJ. 2011. Carbon cycling in tropical ecosystems. *New Phytologist* 189: 893-894**

Preston, B.L., Yuen, E.J., Westaway, R.M. (2011). Putting climate vulnerability on the map: a critical look at approaches, benefits, and risks. *Sustainability Science*, in press.

**Shi, X., Moa, J., Thornton, P.E., Hoffman, F.M., Post, W.M., 2011. The impact of climate, CO<sub>2</sub>, nitrogen deposition and land use change on simulated contemporary global river flow. *Geophysical Research Letters* (in press).**

Sisneros, R., Huang, J., Ostrouchov, G., and Hoffman, F. (2011) 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

**Smith, S.J., J. van Aardenne, Z. Klimont, R.J. Andres, A. Volke, and S. Delgado Arias. 2011. Anthropogenic sulfur dioxide emissions: 1850-2005. *Atmospheric Chemistry and Physics*, doi:10.5194/acp-11-1101-2011**

Warren, JM, JR Brooks, MI Dragila, FC Meinzer. 2011. "In situ separation of root hydraulic redistribution of soil water from liquid and vapor transport." *Oecologia* (In Press)

**Warren JM, Norby RJ, Wullschleger SD. 2011. Elevated CO<sub>2</sub> enhances leaf senescence during extreme drought in a temperate forest. *Tree Physiology* 31:117-130.**

Warren, JM, Pötzelsberger E, Wullschleger SD, Thornton PE, Hasenauer H, Norby RJ. 2011. Ecohydrological impact of reduced stomatal conductance in forests exposed to elevated CO<sub>2</sub>. *Ecohydrology* 4: 196-210

**Wullschleger SD, LD Hinzman and CJ Wilson (2011) Climate change experiments in high-latitude ecosystems. *EOS* (in press).**

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## CURRENT CCSI JOB OPPORTUNITIES

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