Climate Change SCIENCE INSTITUTE

Newsletter

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

JULY 2012

LETTER FROM CCSI LEADERSHIP

CCSI colleagues,

We are pleased to announce that Dr. John Sanseverino will assume the role of CCSI Project Manager on July 30th, 2012. John is currently wrapping up his assignment as Director of Programs for the Tennessee Solar Institute at The University of Tennessee-Knoxville (UTK). Prior to that, he was Managing Director of the Center for Environmental Biotechnology at UTK. John brings unique experience to the CCSI role with his scientific background (Ph.D. in Biology) and roles with two institutes at UTK. The project manager position in CCSI will be focusing on technical issues such as strategic planning, communication, integration, branding, and helping with BER program management. We will continue to manage the operational aspects of CCSI (e.g., 2040 building, vehicles, materials, etc) via the line organizations and our excellent administrative assistants. We will introduce John at one of the first available 3x5's and he will begin to meet each of you so that he can learn about our science.

We are grateful for the help of Shelaine Hetrick over the past few months in her role as interim project manager. We wish her the best as she rotates back to a full-time focus for the DOE Water Power Program at ORNL.

Jim, Gary, and Ben

CCSI colleagues,

I have enjoyed serving as the Interim-*part-time* CCSI Project Manager. This opportunity has allowed me to learn more about your research and the pleasure of making new friends. I have learned a great deal in the past few months and I will be able to apply that knowledge to future interactions and hopefully future joint-endeavors. Thanks for everything and hopefully I'll still get an occasional picnic invitation,
~ Shelaine Hetrick

FULL MEMBERSHIP OF CCSI SCIENCE ADVISORY BOARD

We are pleased to announce the full membership of the Science Advisory Board (SAB) for the Oak Ridge Climate Change Science Institute (CCSI).

The membership has been expanded to twelve allowing for three SAB members for each of the Research Themes: I. Earth System Modeling, II. Data Integration, Dissemination & Informatics, III. Terrestrial Ecosystem & Carbon Cycle Science and IV. Impacts, Adaptation & Vulnerability. We are especially grateful to Jeff Kiehl and Kevin Gurney who have rotated off the SAB. We appreciate their participation and insights.

Sara Graves from the University of Alabama at Huntsville will serve as the SAB Board Chair until the 2013 meeting.

Members represent a breath of organizations: NOAA Climate Program Office, Princeton University, NCAR Climate and Global Dynamics Division, CIESIN (Center for International Earth Science Information Network), U.S. Geological Society, University of Alabama at Huntsville, Ohio State University, Duke University, University of California, Pacific Northwest National Laboratory, University of Maryland and Stanford University.

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Highlighted Researcher COLLEEN IVERSEN

Colleen Iversen grew up on 25 acres of reclaimed farmland in central Michigan. Both of Colleen's parents were hydrogeologists with the State of Michigan. Years of family vacations that explored caves, mountains, rock outcroppings, and road cuts at the edge of busy highways helped her to realize two important things about her future career: (1) she would be a scientist, because the natural world was fascinating to her, and (2) she would *never* be a geologist. She attended Dansville 'Agricultural' Schools for K-12 before going on to major in biology and minor in environmental science at Hope College. Colleen completed an MS in wetland ecology at the University of Notre Dame, and then moved south to pursue a PhD in ecology and evolutionary biology at the University of Tennessee under the direction of Rich Norby.

What does Colleen do in her free time? She says she doesn't have any free time. Instead, she has a lovely 20-month-old son named Grant. Her husband, Jim, stays home with Grant full time, which Colleen is grateful for. Colleen and her family enjoy spending time exploring their backyard, and Jim and Grant have traveled with Colleen to scientific conferences across the country.

Colleen conducted her PhD research at the ORNL FACE site, where she focused on the causes and consequences of increased fine-root production under elevated [CO_2]. Colleen stayed on at ORNL for her post-doc, where she helped to plan and supervise the harvest of roots and soil at the conclusion of the FACE experiment in 2009. Colleen transitioned to ORNL staff in 2010, and was excited to continue working with her immediate colleagues, as well as to join new projects and interact with new empirical scientists and modelers.

Colleen is currently working on two projects associated with the Terrestrial Ecosystem Sciences Science Focus Area, including the Partitioning in Soils (PiTS) experiment, which is intended to improve the carbon partitioning regimes routines in existing models through directed field observations and manipulations, and the Spruce and Peatland Responses Under Climatic and Environmental change (SPRUCE) experiment, which is being developed to assess the response of northern peatland ecosystems to warming and elevated [CO_2]. In PiTS and SPRUCE, Colleen's research is focused on belowground dynamics, specifically the responses of fine roots to changing environmental conditions and the interplay between fine roots and soil carbon and nitrogen cycling. Colleen is also a part of the vegetation team working on the Next-Generation Ecosystem Experiment (NGEE) in the Arctic, where the goal is to increase our confidence in climate projections in high-latitude regions by improving our understanding and model representation of important ecosystem processes in those regions. She is excited to apply her knowledge of roots to improve our understanding of interplay between soil processes and the relatively understudied rooting systems in Alaska. Colleen also inherited a project examining switch grass nutrient-use efficiency from Chuck Garten when he retired, and she is the point of contact for the future NEON site to be located in the Walker Branch watershed.

CALENDAR

Ecological Society of America (Portland, OR)	5-10 Aug2012
NCDC Metadata Workshop (Ashville, NC)	14-16 Aug2012
SciDAC3 Principal Investigators' meeting (Rockville, MD)	10-12 Sep 2012
ForestSAT 2012 (Corvallis, OR)	11-14 Sep 2012
DOE Integrated Water Cycle Workshop (Washington DC)	24-26 Sep2012
American Geophysical Union (San Francisco, CA)	3-7 Dec 2012
(AMS Annual Meeting (Austin, TX)	6-10 Jan 2013

IVERSEN (CONT.)

What role does your research play in climate change research?

"I am interested in the interplay between below-ground plant responses to atmospheric and climatic change and the potential feedbacks to the atmosphere from changes in ecosystem carbon and nitrogen cycling. Soils are an important component of the global carbon cycle, and climate-induced changes in the decomposition of soil carbon stored over long time periods in cold, anoxic environments such as wetlands and the arctic tundra, may provide a significant positive feedback to global climate change. The interface between plants and the soil system are fine plant roots (i.e., ephemeral roots with a narrow diameter), which are an important component of ecosystem carbon and nutrient cycling. Fine-root production can contribute one-third of annual plant production, and fine roots are responsible for the uptake of nutrient and water, and therefore directly mediate the survival and growth of plants that take up atmospheric [CO_2] via photosynthesis."

Who is the customer for your research?

"My research is mainly supported by the Department of Energy, Office of Biological and Environmental Science. My goal is to publish research that contributes to the scientific community by improving our understanding of important ecosystem processes that can help models to better project future climate conditions. While I have an important responsibility to provide timely and excellent research for my sponsors, it is also my responsibility to communicate my research to the public in the form of press releases, radio interviews, and public tours of our large-scale field experiments."

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

"Climate change is the largest environmental and social issue of our time, and important decisions on the interaction between humans and the global environment will happen during my lifetime. As a citizen, climate change is one of my largest concerns. As a scientist, I see my role as one of fundamental ecological research that advances our understanding of important ecosystem processes, and feedbacks between land surfaces and the climate system. New insights or additional information on these processes contribute to the parameterization or testing of ecosystem and landscape models, which helps the modeling community to better project future climates. These model simulations should help decision makers to better understand the risks associated with current decisions that will affect future climates and human society."

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

"I hope that the future of climate change research will be one of connection—among geographic locations, among empirical scientists and modelers, and between professional and citizen scientists. A network of observations and experiments that span large geographic regions (e.g., NEON), can help us to better scale small-scale measurements to landscape and global scales. Continuing improvements in interactions between empirical scientists and modelers can help in the design of relevant research to advance our understanding of future climates. Observations and input from citizen scientists around the world can both improve our scientific understanding by filling gaps in spatial and temporal data sets, but can also advance our scientific cause by engaging others in our goal to understand the natural world. In addition to better connectivity among regions and people, technological advances in sensors, automated analyzers, and experimental manipulation of intact ecosystems can also improve our understanding and quantification of ecosystem responses to changing environmental conditions."

NATIONAL PUBLIC RADIO

DIALOGUE: CLIMATE CHANGE IN TENNESSEE

In Tennessee, it can be hard to relate to stories about climate change. After all, there are no glaciers to recede, no polar caps to melt, and no coastlines threatened by rising sea levels. So what *are* the signs of climate change in the Volunteer State? Three panelists join WUOT's Brandon Hollingsworth for an examination of climate research in Tennessee, and the possible effects of climate shifts on the state's ecology, economy and people.

Joining us from the studios of NPR member station WVPE in Elkhart, Indiana, is **Virginia Dale**. She's a climate researcher with Oak Ridge National Laboratory. **Ben Preston** is the Deputy Director of the Climate Change Science Institute at ORNL. **Scott Holladay** is a fellow in energy and environmental policy at the Howard H. Baker Center in Knoxville..

Podcast available: http://wuot.org/mt/

CCSI WELCOMES NEW STAFF

Harold A. Shanafield III was recently hired as an Environmental Informatics Developer. I spend my time working for the DAAC (FLUXNET), ARM and NHAAP projects primarily doing database and web development. I started out in what seems like a long, long time ago in a galaxy far, far away with a double major in Biology and Environmental Science at Northwestern University. After that I rode out the halcyon days of the dot.com revolution in Austin, TX working as a developer and program manager for a startup software company. After a suitable professional sabbatical to get married, I returned to school and graduated from the University of Tennessee with a master's in Statistics and Systems Biology with a concentration in Bioinformatics. My graduate research focused on protein domain identification using hidden Markov models. In my free time I enjoy swimming, playing basketball and rebuilding the LEGO sets my three children enjoy taking apart.

Sujithkumar Nair joined as a Postdoctoral Research Associate in April 2012 under Dr. Benjamin Preston. His research involves climate change impact, vulnerability and adaptability analysis of agro-ecosystems. Sujithkumar Nair received his PhD in Environmental Sciences with specialization in Environmental Economics from the Ohio State University in 2010. His dissertation research was focused on integrated watershed economic modeling for spatial targeting of conservation management options for reducing non-point source pollution load to water resources. He is trained to handle both biophysical and economic modeling. Before joining ORNL, he worked as a postdoctoral researcher at University of Tennessee for one year, where he conducted research on conservation prioritization in East Tennessee watersheds. He holds a BS in Agricultural Sciences and MS in Agricultural Economics from India. He also worked 5 years as an Agricultural Economist in an interdisciplinary research group in Indian Agricultural Research Institute, New Delhi, India, where he was involved in analysis of regional land use changes and its impact on regional food and environmental security.

Jitendra (Jitu) Kumar is a research staff member in Terrestrial Systems Modeling Group in Environmental Sciences Division. He is working on modeling of thermal, hydrological and biogeochemical processes and their interactions with terrestrial biosphere in fine to global scale climate systems. He is also working on development of data analytics algorithms and tools for analysis and synthesis of large scale Earth Science data sets.

Jitu was a Post-doctoral research associate in Computational Earth Science Group at ORNL (2010-2012) working on several hydrologic flow and reactive transport modeling and data analytics projects. He received his PhD is Civil and Environmental Engineering from North Carolina State University (2010) where his work focused on development and application of parallel optimization algorithms and inverse modeling techniques using high performance computing for environmental engineering problems. He also received his MS in Water Resources Engineering from Indian Institute of Technology Kanpur, India (2006) and BS in Civil Engineering from Muzaffarpur Institute of Technology, India (2004).

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

Highlighted Research

UV-CDAT

Ultra-scale Visualization – Climate Data Analysis Tools (UV-CDAT) developing new capabilities in Climate Data Analysis

Working directly with BER climate science analysis projects, we have developed and begun deployment of climate data analysis tools useful to a wide variety of stakeholders, including scientists, policymakers, and the general public. Members of the UV-CDAT project with other institutions and universities in researching data discovery, management, visualization, workflow analysis, and provenance. All work is accomplished under DOE open-source guidelines and in close collaboration with the project's stakeholders, domain researchers, and scientists. The UV-CDAT project is developing new capabilities, and more scalable techniques in climate data analysis, including:

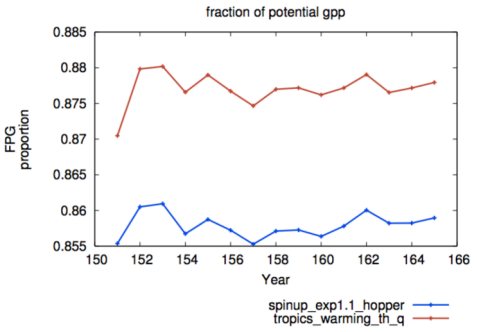
- Alternative parallel streaming statistics and analysis pipelines
  - Data parallelism
  - Task parallelism
  - Visualization parallelism
- Optimized parallel input/output (I/O)
- Remote interactive execution
- Advanced intercomparison visualization
- Data provenance processing and capture
- Interfaces for scientists
  - Workflow data analysis and visualization construction tools
  - Visualization interfaces

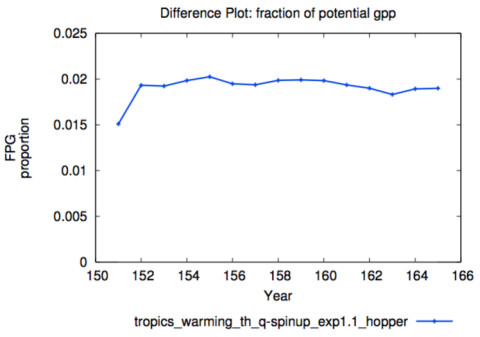
The UV-CDAT team consists of researchers and scientists with diverse domain knowledge in data analysis, visualization, and climate science. The UV-CDAT project is lead by Dean N. Williams and Dave Bader of Lawrence Livermore National Laboratory (LLNL); Galen Shipman of Oak Ridge National Laboratory (ORNL); Phil Jones of Los Alamos National Laboratory (LANL), Claudio Silva of Polytechnic Institute of New York University (NYU-Poly); and Berk Geveci of Kitware, Inc.
The Oak Ridge UV-CDAT team is made up of experts in data analysis and parallel computing including Blake Haugen (Intern), Ross Miller (NCCS), Brian Smith (NCCS), Galen Shipman (CCSD), and Chad Steed (CSED). Working closely with climate scientists David Erickson (CSMD), Dan Ricciuto (ESD), and Peter Thornton (ESD) the ORNL UV-CDAT team has focused on two primary efforts, parallel data analysis to substantially decrease time-to-solution for common climate data analysis workloads and a visual analytics based ensemble data analysis environment (EDEN) providing new capabilities in intuitive user-interfaces for data analysis.

Our efforts in parallel data analysis have been primarily focused on developing a set of parallel command line tools using the parallel NetCDF library. Below is a list of current features supported:

- Command line control allows for easy integration with various workflows
- Computes Average Map for a set of input files
- Computes Average Map of the difference between two sets of input files
- Computes Average value of specified quantity in specified geographic region
- Computes frequency distribution for a set of input files
- Computes frequency distribution for a given set of months/years/variables
- Accepts standard NetCDF files for input
- Outputs summary statistics in NetCDF format
- Developing new routines to create communicators based on NUMA domains on HPC systems. This will enable HPC nodes to open files in parallel and then use individual cores to process variables in parallel

The plots below are samples generated from parallel analysis routines run on a standard workstation requiring less than 45 minutes to complete. Similar analysis using traditional tools currently takes over 12 hours to complete on similar hardware.



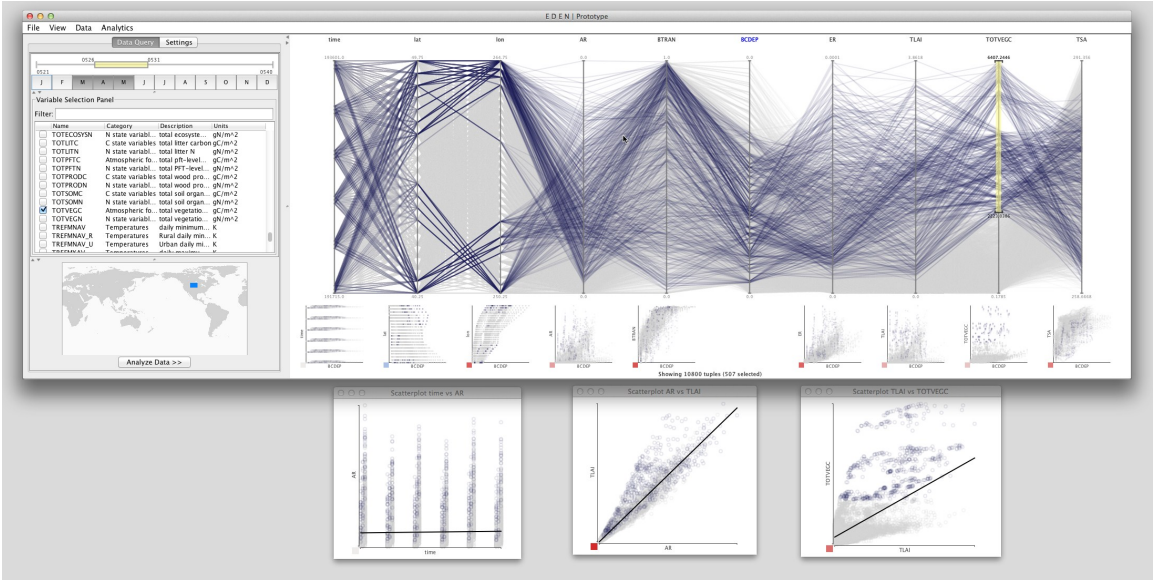


UV-CDAT (CONT.)

One challenge faced by climate scientists is analyzing ensembles of climate model runs, common in a variety of studies such as uncertainty quantification. The second major aim of the ORNL UV-CDAT team is to develop intuitive user-interfaces to enable exploratory analysis of both single climate model runs and ensembles studies. Our current efforts have resulted in a toolkit that we have dubbed "EDEN" which currently provides analysis capabilities for both point-based ensemble data and global CLM4 model simulations.

Ensemble Data Analysis using Visual Analytics

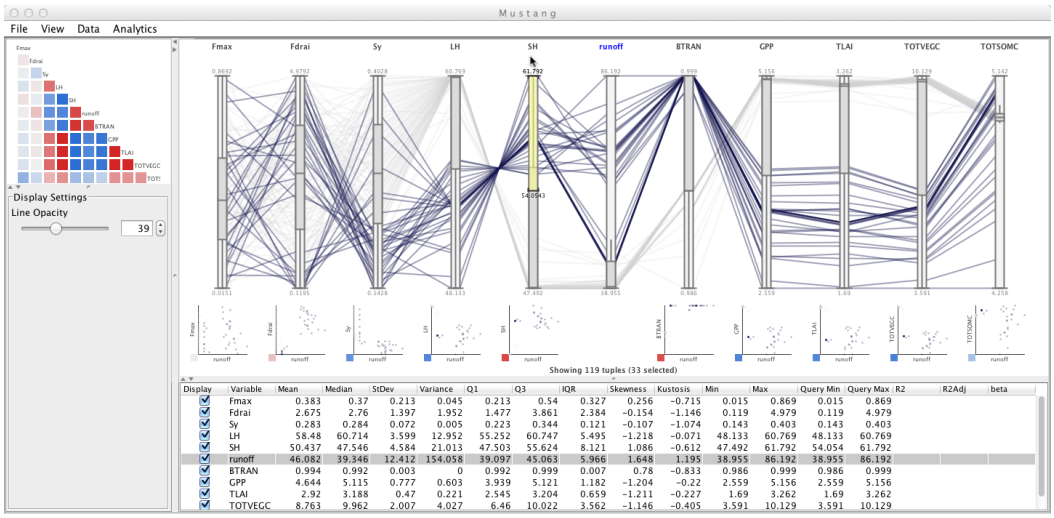
- Developed the EDEN toolkit for interactive analysis for both point-based ensemble data and global CLM4 model simulations.
- Two tools have been developed in collaboration with CLM4 researchers active in the CSSEF project. The first tool is for analysis of the point-based tabular datasets. The second tool is for analysis of global CLM4 datasets which are stored in the NetCDF format.
- It is important to note that the features of these tools have been developed in collaboration with the CLM4 domain experts. These experts have found the tools useful and have even co-authored a paper with the UV-CDAT team on the use of the tools in a real-world climate study. The experts have noted that the EDEN tools foster shorter knowledge discovery timeframes that the traditional diagnostic packages that are available for CLM.
- Initiated disclosure and site hosting for open sourcing these two tools.
- Global CLM4 Tool:



- The current application features an enhanced set of features for querying polylines in the parallel coordinate interface.
- New color schemes have been developed for the overall interface.
- The scatterplots beneath the parallel coordinate axes can be clicked to cause a new window to display with the selected scatterplot.
- All views are linked so that brushings in one display are propagated to the other views appropriately.

UV-CDAT (CONT.)

Point based tool for ensemble analysis:



Display	Variable	Mean	Median	StDev	Variance	Q1	Q3	IQR	Skewness	Kustosis	Min	Max	Query Min	Query Max	R2	R2Adj	beta
☑	Fmax	0.383	0.37	0.213	0.045	0.213	0.54	0.327	0.256	-0.715	0.015	0.869	0.015	0.869			
☑	Fdrai	2.675	2.76	1.397	1.952	1.477	3.861	2.384	-0.154	-1.146	0.119	4.979	0.119	4.979			
☑	Sy	0.283	0.284	0.072	0.005	0.223	0.344	0.121	-0.107	-1.074	0.143	0.403	0.143	0.403			
☑	LH	58.48	60.714	3.599	12.952	55.252	60.747	5.495	-1.218	-0.071	48.133	60.769	48.133	60.769			
☑	SH	50.437	47.546	4.584	21.013	47.503	55.624	8.121	1.086	-0.612	47.492	61.792	54.054	61.792			
☑	runoff	46.082	39.346	12.412	154.058	39.097	45.063	5.966	1.648	1.195	38.955	86.192	38.955	86.192			
☑	BTRAN	0.994	0.992	0.003	0	0.992	0.999	0.007	0.78	-0.833	0.986	0.999	0.986	0.999			
☑	GPP	4.644	5.115	0.777	0.603	3.939	5.121	1.182	-1.204	-0.22	2.559	5.156	2.559	5.156			
☑	TLAI	2.92	3.188	0.47	0.221	2.545	3.204	0.659	-1.211	-0.227	1.69	3.262	1.69	3.262			
☑	TOTVEGC	8.763	9.962	2.007	4.027	6.46	10.022	3.562	-1.146	-0.405	3.591	10.129	3.591	10.129			

This tool is used for analyzing smaller point-based datasets (typically comma separated value, CSV, files). In our analysis, the datasets include both model parameters (inputs) and simulations (outputs). We have focused on using this tool for conducting sensitivity analysis and uncertainty quantification.

The tool includes all the above-mentioned features plus a correlation matrix that is presented as a left hand panel that highlights strong correlations by encoding the correlation coefficients as colors. The color scale used applies more saturated colors to the stronger correlations where blue shades indicate negative and red shades indicate positive correlations.

The tool also provides statistical calculations for the data in the form of a table panel at the bottom of the display. This table is linked to the visualizations such that selections of rows in the table are reflected by the shading and layout of the parallel coordinate visualization plot.

Publications: Chad A. Steed, Galen Shipman, Peter Thornton, Daniel Ricciuto, David Erickson, and Marcia Branstetter. "Practical Application of Parallel Coordinates for Climate Model Analysis." In *Proceedings of the International Conference on Computer Science*, June 2012, pp. 877-886. DOI: 10.1016/j.procs.2012.04.094.

CLAUDIO SILVA— APRIL SEMINAR SPEAKER

Claudio Silva is a Professor of computer science and engineering at the Polytechnic Institute of NYU. Between 2003 and 2011, he worked at University of Utah. Before joining Utah in 2003, he has held positions at industrial and government labs (IBM, AT&T, Sandia, LLNL) where he has led a number of large research and development efforts. He has coauthored 170 publications, served on 80 international program committees and five editorial boards, and chaired or organized a number of major conferences, including the IEEE Visualization conference. His research focus on visualization, provenance analytics, scientific data management, geometry processing, and related areas. The techniques and software that his group has developed are used throughout the world in both academic and industrial settings. His work received academic and industrial awards. In particular, he received IBM Faculty Awards in 2005, 2006, and 2007, and best paper awards at IEEE Visualization 2007, IEEE Shape Modeling International 2008, the 2010 Eurographics Educator Program, EuroVis 2011, and EGPGV 2011. In 2009, the VisTrails Provenance Plugin for Autodesk Maya received an Utah Innovation Award. His work is funded by grants from the NSF, NIH, DOE, IBM, and ExxonMobil.

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Recent Research Highlights

EXTENDED GROWING SEASONS WERE DEMONSTRATED FOR WOODY PLANTS FOR WARMER FUTURE CLIMATES

Objective

- Evaluate the influence of warming climates on the annual growth cycle of a variety of eastern tree species.

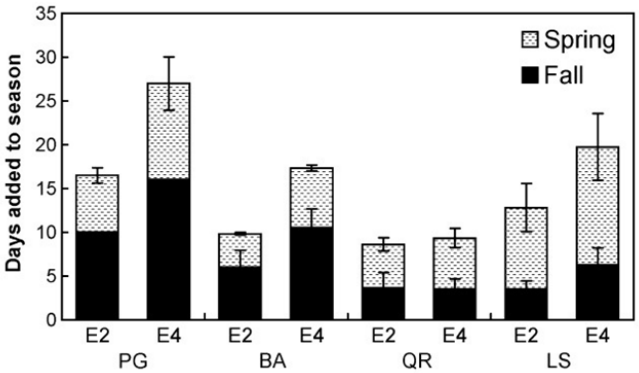
New Science

- A 4-year field experiment exposed four tree species to air temperatures +2 and +4 ° C above ambient controls.
- Impacts of year-round warming on bud burst (BB), stem expansion, senescence, and abscission were evaluated in relation to species and latitude of origin.
- Leaves emerged earlier in all species by an average of 4–9 days at +2 ° C and 6–14 days at +4 ° C. In autumn, chlorophyll was retained an average of 4 and 7 days longer in +2 and +4 ° C
- Growing seasons in the warmer atmospheres averaged 5–18 days (+2° C) and 6–28 days (+4° C) longer, with the least impact in oaks.

Significance

- Warming alone extends the growing season in spring and fall. These results will help us provide quantitative model projects of ecosystem response to warming.

Gunderson et al. (2012) *Global Change Biology* 18::2008-2025
Contact: Paul J. Hanson, 865-574-5361, hansonpj@ornl.gov
Funding: DOE Office of Science



Mean extension of the growing season in E2 (+2 ° C) and E4 (+4 ° C) atmospheric warming based on multiyear observations. Error bars are standard error of the mean. Aspen = PG, Birch = BA, Oak = QR, Sweetgum = LS

PARAMETER ESTIMATION FOR MODELS OF LIGNINOLYTIC AND CELLULOLYTIC ENZYME KINETICS

Objective

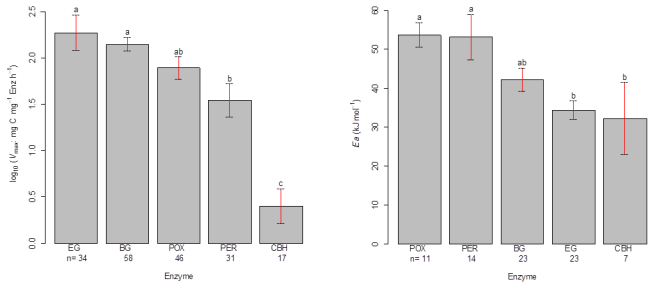
- Provide well-documented enzymatic parameters for application in enzyme-driven soil organic carbon (SOC) decomposition models by compiling a database of kinetic parameters for typical ligninases and cellulases through a literature search and data synthesis.

New Science

- The maximum specific enzyme activity (V_{max}) was log-normal distributed, with no significant difference in V_{max} exhibited between enzymes originating from bacteria or fungi.
- Ligninases had higher activation energy (*Ea*) and lower optimum pH (pH_{opt}). An increase or decrease of 1.1–1.7 pH units from pH_{opt} would reduce V_{max} by 50%.
- V_{max} from lab measurements with purified enzymes were 1–2 orders of magnitude higher than those under field conditions.

Significance

- The developed kinetic parameters add to our understanding of key ligninolytic and cellulolytic enzyme kinetics essential for modeling the decomposition of plant litter and soil organic matter.



Wang G., Post WM; Mayes, MA; Frerichs, JT,; Jagadamma S. (2012) *Soil Biology and Biochemistry* 48:28-38.

Contact: Gangsheng Wang, 865-574-7615, wangg@ornl.gov
Funding: LDRD Program of ORNL

Recent Research Highlights

UNIQUE ^{14}C-TRACER WAS USED TO EVALUATE AND IMPROVE A MODEL OF SUBSURFACE DISSOLVED ORGANIC MATTER (DOM) TRANSPORT

Objective

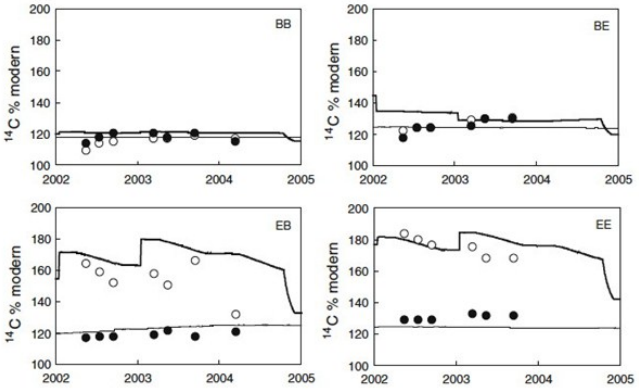
- Apply EBIS-Oak Ridge data to DyDOC model evaluation and testing to verify transport mechanisms within soils.

New Science

- The DyDOC model simulated the soil carbon cycle of a deciduous forest using extensive EBIS data
- Model data analysis showed that soil C turnover within organic horizons produce DOM (46 gC m^{-2} y^{-1}) that was predominantly hydrophobic. The DOM was nearly all adsorbed in the A- and B-horizons.
- Sorbed DOM was mineralized quickly, but a fraction (11 gC m^{-2} y^{-1}) produced mineral-associated stable SOM pools with mean residence times of 100–200 years.

Significance

- Combined model-data analysis provided a powerful approach for defining and resolving important soil carbon cycling mechanisms.



Example data (points) model (lines) agreement for a range of soil horizons (i.e., soil depths).

Tipping E. et al (2012) *Biogeochemistry* 108:91-107
Contact: Paul J. Hanson, 865-574-5361, hansonpj@ornl.gov
Funding: DOE Office of Science, Biological and Environmental Research

NORTH AMERICAN CARBON PROGRAM (NACP) REGIONAL INTERIM SYNTHESIS: TERRESTRIAL BIOSPHERIC MODEL INTERCOMPARISON

Objective

- To evaluate the state-of-the-science in estimating the strength of the North American CO_2 sink estimated by terrestrial biosphere models (TBMs).

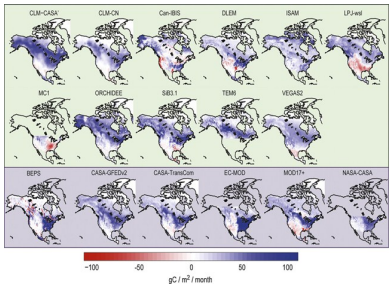
New Science

- Intercomparisons were done by grouping models by their photosynthetic formulation, treatment of soil carbon dynamics, and whether they considered fire disturbances and land-use change, transient CO_2 and N deposition forcing.
- TBMs predicted annual net ecosystem production (NEP) over a range from −0.7 to +1.7 PgC yr−1 for prognostic models and −0.3 to +2.2 PgC yr−1 for diagnostic models.
- Overall average NEP of +0.65 PgC yr−1 for North America.
- Estimates of gross primary production and heterotrophic respiration for North America varied considerably 12.2 and 32.9 PgC yr−1 (prognostic models) and 5.6 and 13.2 PgC yr−1 (diagnostic models).

Significance

- The study revealed large variation in TBM estimates of long-term mean NEP and discrepancies in the magnitude and timing of the seasonal cycle from model structural and model driver data differences.

	Number of models	Prognostic Models (min, max)	Prognostic Models mean	Number of models	Diagnostic Models (min, max)	Diagnostic Models mean
Net Ecosystem Productivity (n= 17)						
North America	9	(-0.7,1.7)	0.4	6	(-0.3, 2.2)	0.9
Boreal NA	10	(-0.2, 0.7)	0.1	4	(-0.4, 0.6)	0.1
Temperate NA	10	(-0.5, 1.1)	0.2	6	(-0.1,1.6)	0.7
Gross Primary Productivity (n =15)						
North America	8	(12.2, 32.9)	20.0	6	(12.2, 18.7)	14.8
Boreal NA	9	(2.2, 11.6)	5.7	5	(2.6, 4.4)	3.6
Temperate NA	8	(7.7, 21.3)	12.3	6	(8.2, 12.6)	10.0
Heterotrophic Respiration (n=13)						
North America	8	(5.6, 13.2)	8.2	2	(7.4,8.6)	8.2
Boreal NA	9	(1.3,4.6)	2.6	2	(2.1,2.9)	2.4
Temperate NA	9	(3.4,7.5)	4.8	3	(2.4,5.6)	4.5



Huntzinger et al (2012), . *Ecological Modelling* 232 (2012) 144-157. doi 10-1016/j.ecolmodel.2012.02.004

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Funding: DOE Office of Science, Biological and Environmental Research

Recent Research Highlights

SEASONAL PATTERN OF PHOTOSYNTHETIC CAPACITY REGULATED BY DAY LENGTH

Objective:

Improve future climate prediction by improving knowledge of fundamental controls on leaf-scale photosynthesis. Migrate new knowledge into Community Earth System Model

Approach:

•Leaf-scale measurements of photosynthetic activity for 23 tree species

•Manipulative experiment to isolate the influence of day length from influence of varying temperature

•Implementation of new algorithm in Community Land Model component of CESM, evaluation against broad panel of model performance metrics

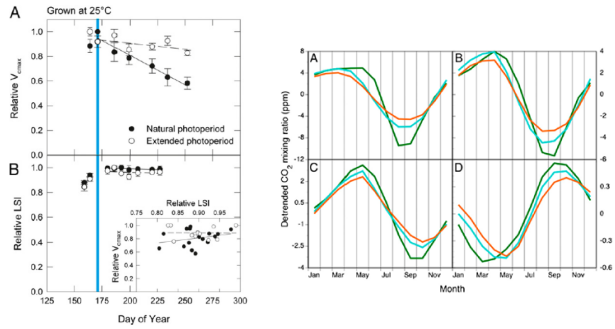
Results/Impacts:

•Photoperiod regulates leaf activity

Day length explains more seasonal variation in photosynthetic activity than does temperature, for 23 tree species

Photosynthetic capacity peaks just after summer solstice, and declines with decreasing day length, even as temperatures continue to rise and as leaves remain green

Results supported by manipulative experiment in which photosynthetic activity remained high with extended day length and constant temperature (Fig 1)

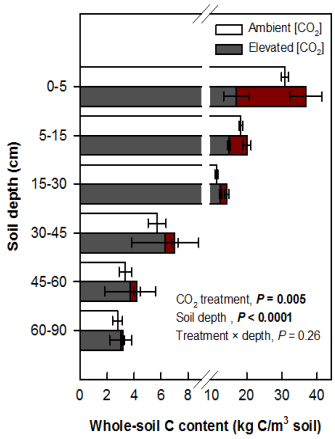


Reference: Bauerle, W. L., R. Oren, D. A. Way, S. S. Qian, P. C. Stoy, P. E. Thornton, J. D. Bowden, F. M. Hoffman and R. F. Reynolds (2012) Photoperiodic regulation of the seasonal pattern of photosynthetic capacity and the implications for carbon cycling. *Proceedings of the National Academy of Sciences* DOI: 10.1073/pnas.1119131109

FINAL FACE HARVEST REVEALS INCREASED SOIL CARBON AND NITROGEN STORAGE UNDER ELEVATED [CO_2]

- A common response of trees growing in elevated CO_2 is increased production of fine roots, especially in relatively deep soil.
- Final harvest of the Oak Ridge National Laboratory free-air CO_2-enrichment (FACE) experiment in 2009 allowed quantification of the effects of increased fine-root production and mortality on soil carbon (C) and nitrogen (N) cycling.
- Biogeochemical and isotopic analyses of soil samples to 90-cm depth revealed that elevated [CO_2] increased soil C and N contents throughout the soil profile, including in deeper soils where turnover rates of soil organic matter are reduced.
- Expanded representation of biogeochemical cycling throughout the soil profile may improve model projections of forest responses to rising atmospheric [CO_2].

Carbon fixed during fumigation with elevated [CO_2] (which was depleted in stable ^{13}C isotope, red bars) led to increased soil C content throughout the soil profile.



Citation: Iversen CM, Keller JK, Garten CT, Norby RJ (2012) Soil carbon and nitrogen cycling and storage throughout the soil profile in a sweetgum plantation after 11 years of CO_2-enrichment. ***Global Change Biology***, DOI: 10.1111/j.1365-2486.2012.02643.x.

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RECENT PUBLICATIONS

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