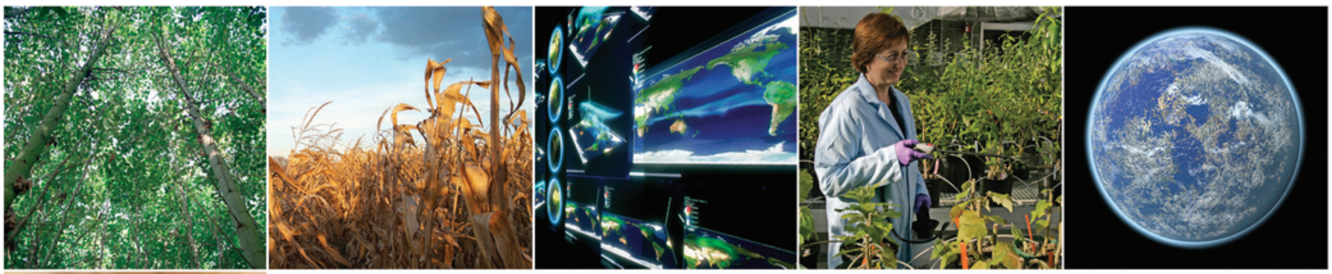
Biological and Environmental Research

December 2007



ORNL 07-G01494/abh

Annual Report FY 2007

Oak Ridge National Laboratory (ORNL) conducts basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership in key areas of science; increase the availability of clean, abundant energy; restore and protect the environment; and contribute to national security.

Foreword

Scientists and engineers in the Biological and Environmental Sciences Directorate at the Oak Ridge National Laboratory (ORNL) perform research that leads to new knowledge and technologies in areas of critical importance to the nation, such as energy security, climate change, environmental management, and homeland and national security. Our work is supported primarily by the Department of Energy's (DOE) Office of Science through the Office of Biological and Environmental Research. In addition, we perform research and development supported by other offices of DOE as well as by other federal and state institutions and by the private sector.

The Directorate consists of the Biosciences Division and the Environmental Sciences Division, and our programs often involve researchers from across ORNL working in interdisciplinary teams. We manage a number of DOE research facilities and data archives, including

- the Mouse Genetics User Facility,
- the Center for Structural Molecular Biology,
- the Oak Ridge Integrated Field Challenge,
- one of the Free Air CO_2 Enrichment facilities,
- the Atmospheric Radiation Measurement Program Data Archive,
- the Carbon Dioxide Information Analysis Center, and
- the Oak Ridge National Environmental Research Park.

Our research seeks to understand biological systems and their relationship to the environment and to human health, to understand microbial communities and microbe-plant interactions in biogeochemical cycling, to unravel the multiple-scale processes that control contaminant fate and transport in the subsurface, to measure and forecast ecosystem change, to understand global climate change, and to develop highly effective diagnostic and therapeutic techniques based on fusing nanotechnology with biology from the molecular to the systems level.

We are leading a research consortium to which DOE awarded in June 2007 one of three bioenergy research centers—the BioEnergy Science Center (BESC). BESC is headquartered at ORNL, located in the Joint Institute for Biological Sciences building constructed by the State of Tennessee. The mission of BESC is to make revolutionary advances in understanding and overcoming the recalcitrance of biomass to conversion into sugars, enabling the production of biofuels and thereby displacing a significant amount of imported petroleum.

We are proud of the essential contributions of our researchers and facilities to the work of the Intergovernmental Panel on Climate Change (IPCC) that won the Nobel Peace Prize for 2007, along with former Vice-President Al Gore. Much of the IPCC report was written or reviewed by researchers from ORNL, and many of the computer simulations that underlie the IPCC findings were conducted at the National Center for Computational Sciences located at ORNL.

This report features selected highlights of research conducted by our scientists and engineers during FY 2007. It also summarizes the recognition and awards received by these researchers. You can learn more about the Biological and Environmental Sciences Directorate by visiting our web site (http://www.ornl.gov/sci/, click on "Biological Systems").

Reinhold C. Mann

ORNL Associate Laboratory Director
Biological and Environmental Sciences
Oak Ridge National Laboratory

Research Highlights

Alternative Energy

Hydrogen production from starch and water

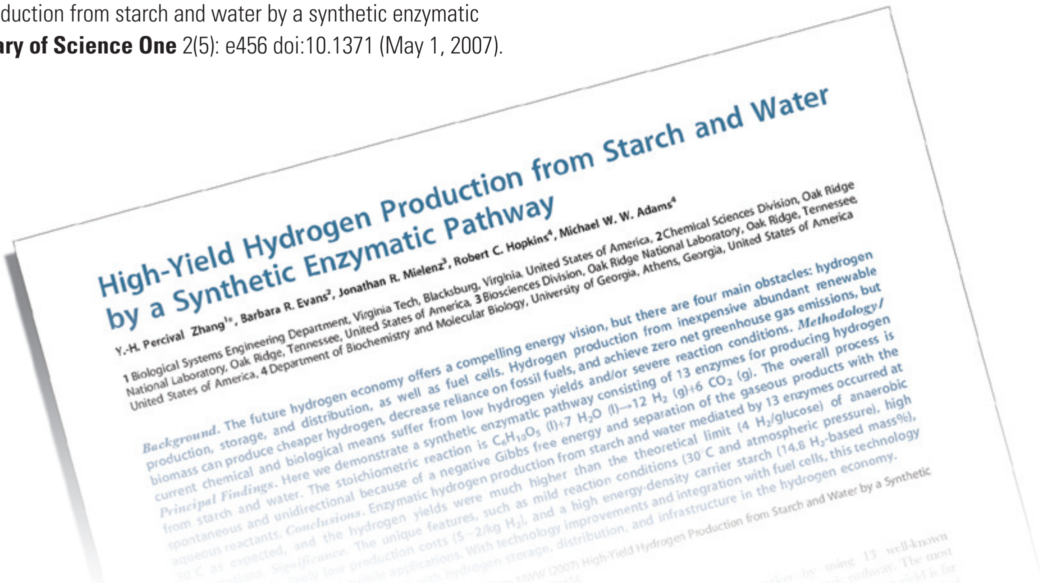
Jonathan Mielenz of ORNL's Biosciences Division was a co-author of a study on producing hydrogen from starch and water.

A promising process using a novel enzymatic reaction to produce hydrogen from starch and water was outlined in an article in *Public Library of Science* by ORNL's Jonathan Mielenz and Barbara Evans, collaborator Percival Zhang from Virginia Tech, and researchers at the University of Georgia. With improvement of the technology and integration with fuel cells, this pathway would be suitable for mobile applications and could help solve the challenges associated with hydrogen storage, distribution, and infrastructure in a hydrogen economy.

Using biomass as a hydrogen feedstock can yield cheaper hydrogen, but conventional methods for reacting biomass to produce hydrogen have been plagued by low hydrogen yields and require high temperatures and pressures. This research demonstrated a synthetic enzyme pathway that uses 13 enzymes to produce hydrogen from starch and water at 30°C and atmospheric pressure. The hydrogen yields were significantly higher than the theoretical limits of anaerobic fermentation.

Because starch can be distributed and stored safely, unlike gaseous or solid hydrogen, this method would address issues associated with establishing a hydrogen infrastructure. The authors of the study envision that future applications of the technology can store solid starch, react it with water to produce hydrogen, and then generate electricity from fuel cells in a single compact location.

Y.-H. P. Zhang, B. R. Evans, J. R. Mielenz, R. C. Hopkins, and M. W. W. Adams. "High-yield hydrogen production from starch and water by a synthetic enzymatic pathway," **Public Library of Science One** 2(5): e456 doi:10.1371 (May 1, 2007).



High-Yield Hydrogen Production from Starch and Water by a Synthetic Enzymatic Pathway

Y.-H. Percival Zhang[1*], Barbara R. Evans[2], Jonathan R. Mielenz[3], Robert C. Hopkins[4], Michael W. W. Adams[4]

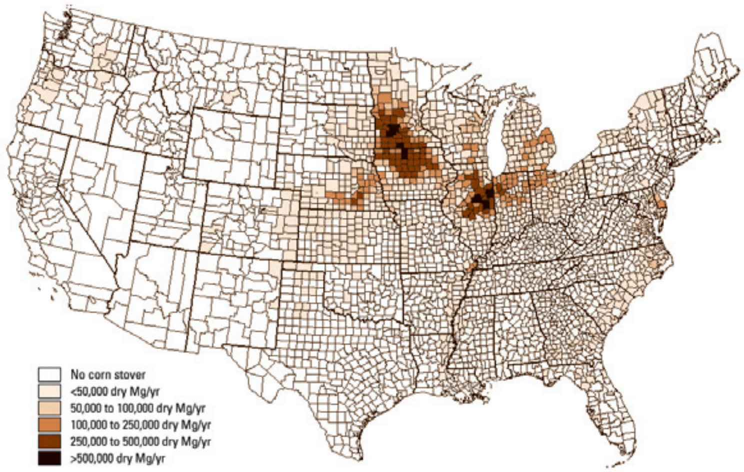
1 Biological Systems Engineering Department, Virginia Tech, Blacksburg, Virginia, United States of America, 2 Chemical Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States of America, 3 Biosciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States of America, 4 Department of Biochemistry and Molecular Biology, University of Georgia, Athens, Georgia, United States of America

Background. The future hydrogen economy offers a compelling energy vision, but there are four main obstacles: hydrogen production, storage, and distribution, as well as fuel cells. Hydrogen production from inexpensive abundant renewable biomass can produce cheaper hydrogen, decrease reliance on fossil fuels, and achieve zero net greenhouse gas emissions, but current chemical and biological means suffer from low hydrogen yields and/or severe reaction conditions. *Methodology/Principal Findings.* Here we demonstrate a synthetic enzymatic pathway consisting of 13 enzymes for producing hydrogen from starch and water. The stoichiometric reaction is $C_6H_{10}O_5$ (l)+7 H_2O (l)→12 H_2 (g)+6 CO_2 (g). The overall process is spontaneous and unidirectional because of a negative Gibbs free energy and separation of the gaseous products with the aqueous reactants. *Conclusions.* Enzymatic hydrogen production from starch and water mediated by 13 enzymes occurred at 30°C as expected, and the hydrogen yields were much higher than the theoretical limit (4 H_2/glucose) of anaerobic fermentations. *Significance.* The unique features, such as mild reaction conditions (30°C and atmospheric pressure), high hydrogen yields, likely low production costs ($~2/kg H_2), and a high energy-density carrier starch (14.8 H_2-based mass%), ... With technology improvements and integration with fuel cells, this technology ... storage, distribution, and infrastructure in the hydrogen economy.

... High-Yield Hydrogen Production from Starch and Water by a Synthetic ...

Sustainable collection of corn stover for bioenergy

Corn stover is potentially a significant source of cellulose for ethanol, but there are concerns that harvesting it might increase erosion and degrade soil quality. A team of ecologists, engineers, and economists, including members of the Environmental Sciences Division, analyzed the amount of stover that could be harvested for bioenergy in the United States, assuming that it would be collected only if its removal would not increase wind and rainfall erosion beyond the soil-specific tolerable erosion rate defined by the Natural Resource Conservation Service. (Stover, the aboveground part of the corn plant remaining after grain harvest, includes the stalk, leaves, and cob. It represents about half the dry mass of a corn plant at harvest.)



Available corn stover < $33 Mg^{-1} under current tillage practices (54 million Mg yr^{-1}).

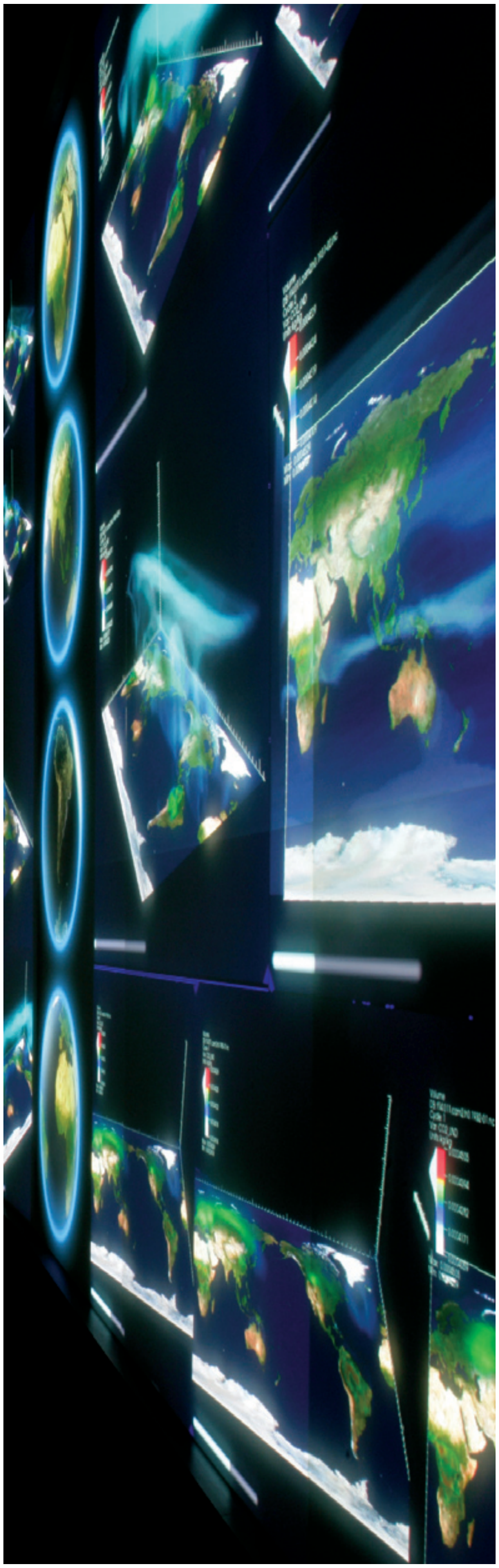
The researchers concluded that 30% of the corn stover currently produced in the United States (or ~54 million dry metric tons per year) could be collected for less than $33/dry metric ton, using existing equipment and without undue increases in soil erosion. Using cellulosic ethanol technologies under development, this much corn stover could produce more ethanol than is currently produced using corn grain (~4 billion gallons in 2005). If no-till practices were used in all U.S. corn production, the harvestable corn stover would double. That much stover could produce more than twice the ethanol currently produced with grain. In three regions of the country, the collectable supply was sufficiently concentrated to support the establishment of large (million ton/year) biorefineries.

R. L. Graham, R. Nelson, J. Sheehan, R. D. Perlack, and L. L. Wright. "Current and potential U.S. corn stover supplies," **Agronomy Journal** 99: 1–1 (2007), doi:10.2134/agronj2005.0222.

Carbon Cycling and Climate Change

Biomass heat and biochemical energy in climate-prediction models

Vegetation stores energy in two ways: physical heat energy is stored as plants absorb heat during the day (to be released when temperatures drop) and biochemical energy is stored in chemical bonds via photosynthesis (and released later during respiration). Currently, climate models do not account for biomass heat and biochemical energy storage in modeling land-source energy balances. Doing so would improve the accuracy of their calculations of surface temperature, according to a study conducted by researchers from the Environmental Sciences Division, the National Oceanic and Atmospheric Administration, and the University of Missouri.



The study relied on data collected at an AmeriFlux site in a forest in central Missouri and computer simulations using the model FAPIS (Fluxes and Pools Integrated Simulator). The researchers ran FAPIS with and without heat and energy storages. They found that when the biomass energy storage data were included, the simulations agreed well with the measured conditions at the site. Without those terms represented, however, the performance of the model deteriorated for all predicted surface energy fluxes. Without the biomass processes represented, the model overestimated daytime surface temperatures by up to 1°C and underestimated nighttime temperatures by up to 2°C.

The main finding was that biomass heat and biochemical energy storage significantly influences land surface heat fluxes and temperatures and must be considered in studies of land–atmosphere interactions and climate modeling. Vegetation distributions are changing significantly on local, regional, and global scales, and variations in heat and energy storage associated with the changes may be contributing to local and regional climate trends. Vegetation change is expected to continue into the foreseeable future. With vegetation energy storage processes properly represented, climate models may improve their past climate representation and future climate prediction.

L. Gu, T. Meyers, S. G. Pallardy, P. J. Hanson, B. Yang, M. Heuer, K. P. Hosman, Q. Liu, J. S. Riggs, D. Sluss, and S. D. Wullschleger. "Influences of biomass heat and biochemical energy storages on the land surface fluxes and radiative temperature," **Journal of Geophysical Research–Atmosphere** 112: D02107 (2007), doi:10.1029/2006JD007425.

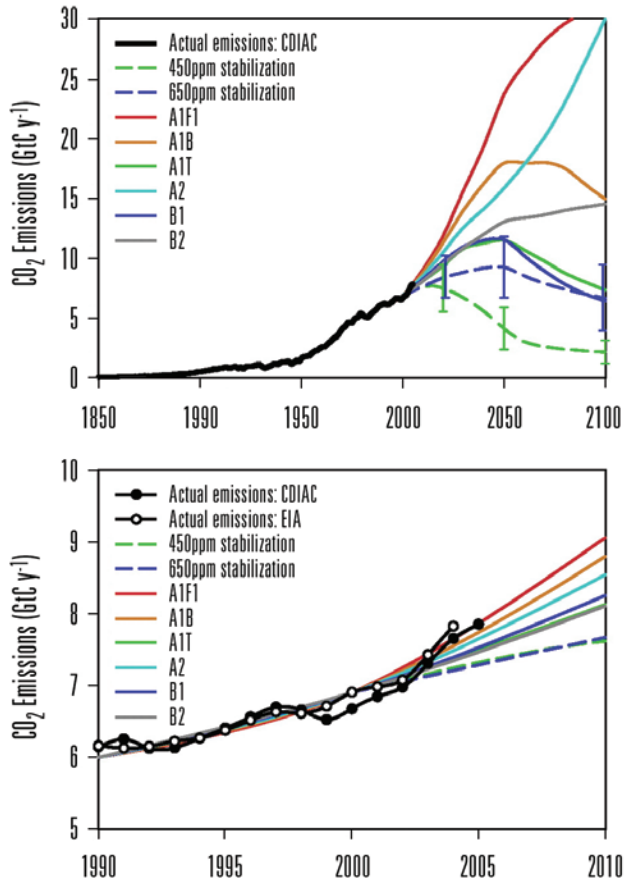
Global and regional drivers of accelerating CO_2 emissions

A team of researchers including Gregg Marland of the Environmental Sciences Division has found that worldwide emissions of man-made CO_2 are rising faster than even the worst-case predictions made by scientists. The increase in CO_2 emissions, which averaged 1.1% per year from 1990 to 1999, leaped to over 3% per year from 2000 to 2004. No region is decarbonizing its energy supply.

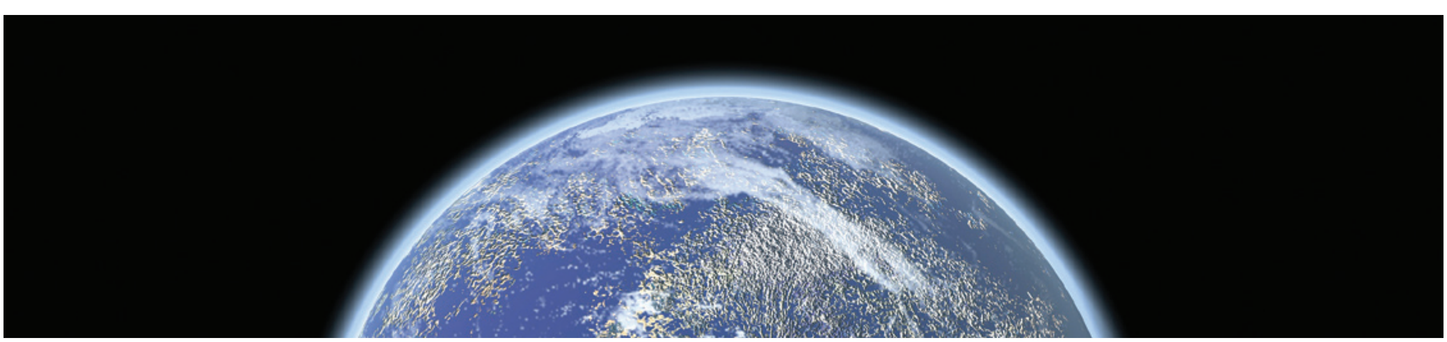
The study, published in the *Proceedings of the National Academy of Sciences*, divided the world into nine regions and analyzed population trends, economic factors, and energy-related data for each region. The paper included data from ORNL's Carbon Dioxide Information and Analysis Center and identified rising fossil fuel emissions as the dominant cause of the CO_2 increase in the atmosphere. Developed nations, representing 20% of the world's population, accounted for 59% of global human CO_2 emissions in 2004. Developing nations, including those with rapidly expanding economies, were responsible for just 41% of total emissions in 2004, but they contributed 73% of the increase in emissions for that year. Emissions from the developed countries have leveled off from previous years, but emissions from China and India, in particular, have boomed along with their economies.

Even the most fossil-fuel-intensive scenarios developed by the Intergovernmental Panel on Climate Change have underestimated the rapid increase in CO_2 levels since 2000. The researchers attribute the observed trends to the increasing energy intensity of economic activity and the carbon intensity of energy sources.

M. R. Raupach, G. Marland, P. Ciais, C. Le Quéré, J. G. Canadell, G. Klepper, and C. B. Field. "Global and regional drivers of accelerating CO_2 emissions," **Proc. Natl. Acad. Sci.** 104: 10288–93 (2007).

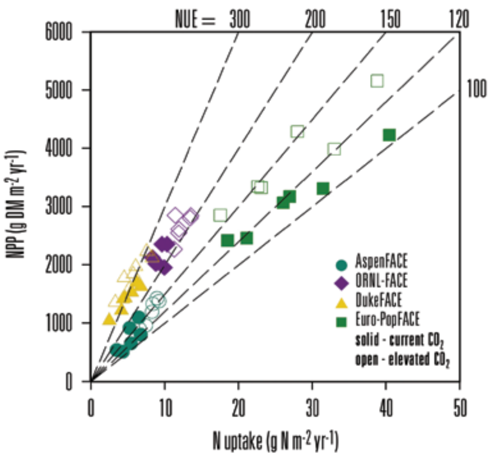


(Top) Paths of CO_2 emissions envisioned by the Intergovernmental Panel on Climate Change in 2000. (Bottom) Recent estimates from the Carbon Dioxide Information Analysis Center show the current path of emissions at the very high end of scenarios developed in only a few years and show two alternate paths that would lead to stabilization of atmospheric CO_2.



Findings on nitrogen uptake in elevated CO_2 challenge assumptions

Predictions of how forests will respond to climatic change will be improved by including feedback between carbon and nitrogen cycles. To provide better data for climate change simulations, nitrogen uptake and nitrogen-use efficiency were measured in four Free-Air Carbon Dioxide Enrichment (FACE) experiments in forest stands,one of which is on the ORNL site.



At three of the four FACE sites analyzed, nitrogen uptake increased under higher CO_2 conditions.

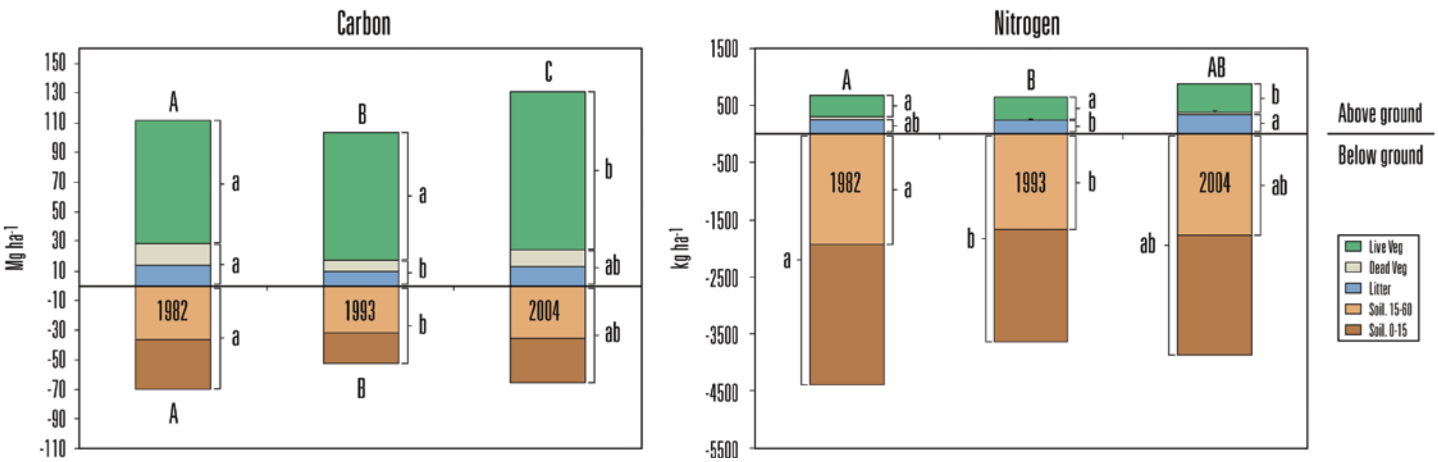
Nitrogen availability affects forest productivity, and a lack of nitrogen may constrain increases in net primary production (NPP) otherwise expected to result as concentrations of atmospheric CO_2 rise. Sustaining increased forest NPP in elevated CO_2 requires some combination of increased nitrogen uptake from the soil and more efficient use of the nitrogen already assimilated by trees. A research team including Richard Norby of the Environmental Sciences Division and Colleen Iversen of the University of Tennessee analyzed the response of nitrogen uptake and nitrogen-use efficiency to elevated CO_2 (~550 ppm) in a forested area. Although lack of available nitrogen strongly limited tree growth and forest NPP at two of the sites, nitrogen uptake increased under elevated CO_2. Nitrogen-use efficiency increased under elevated CO_2 at the most productive site, where nitrogen was not limited.

The analysis shows that larger quantities of carbon entering the belowground system when CO_2 is elevated result in greater nitrogen uptake even in ecosystems where nitrogen is limited. Some combination of increasing fine-root production, increased rates of soil organic matter decomposition, and increased allocation of carbon to mycorrhizal fungi is likely to account for the increased nitrogen uptake. Biogeochemical models must be reformulated to include carbon transfers belowground that result in additional nitrogen uptake when the atmosphere contains more CO_2.

A. C. Finzi, R. J. Norby, C. Calfapietra, A. Gallet-Budynek. B. Gielen, W. E. Holmes, M. R. Hoosbeek, C. M. Iversen, R. B. Jackson, M. E. Kubiske, J. Ledford, M. Liberloo, R. Oren, A. Polle, S. Pritchard, D. R. Zak, W. H. Schlesinger, and R. Ceulemans. "Increases in nitrogen uptake rather than nitrogen-use efficiency support higher rates of temperate forest productivity under elevated CO_2," **Proc. Natl. Acad. Sci.** 104: 14014–19, 2007.

Large decade-scale variations in soil carbon and nitrogen

Concentrations of carbon and nitrogen in soils are important factors in climate change because soil carbon pools are so large and because soil nitrogen affects soil fertility and productivity. Data on soil carbon and nitrogen are limited, though, and are obtained mostly from selected sites on which long-term records of soil changes are available, such as the Walker Branch Watershed on the ORNL reservation. Repeated measurements of carbon and nitrogen concentrations in the forest soil at 10-year intervals from 1972 to 2004 on the Walker Branch Watershed show steady carbon and nitrogen increases in the vegetation but surprisingly large variations in the soil concentrations. (The increases in aboveground carbon and nitrogen are the result of long-term increases in the biomass of the tree stand in this second-growth forest, much of which was previously farmland.) Although researchers can account for most of the fluctuation in soil carbon content, the causes of the changes in soil nitrogen are unclear.



Average ecosystem carbon and nitrogen fell between 1982 and 1993. By 2004, the decline was reversed.

A team of researchers including Dale Johnson, now of the University of Nevada and formerly of ORNL, and Donald Todd and Patrick Mulholland of the Environmental Sciences Division compared soil carbon and nitrogen measurements obtained in four samplings during the 32-year period with previously measured carbon and nitrogen fluxes and with changes in ecosystem carbon and nitrogen pools during the same period. Soil carbon and nitrogen increased significantly from 1972 to 2004, particularly between 1972 and 1982. They declined between 1982 and 1993, a period coinciding with a severe drought in the region. By 2004, the decline was reversed and the nitrogen content increased to near 1982 values.

The soil carbon changes could be approximately accounted for by previously measured litterfall and soil CO_2-carbon fluxes. However, the changes in soil nitrogen could not be accounted for by leaching, increments in vegetation, laboratory bias, changes during sample storage, or reasonable estimates of field sampling errors. The researchers concluded that, although carbon and nitrogen pools in vegetation generally increased steadily over the sampling period, changes in carbon and nitrogen pools in the soil on Walker Branch Watershed are highly variable in both space and time, and there is no unidirectional trend over the time period of the study. The results suggest that soil carbon and nitrogen may be more responsive than previously thought to annual- to decadal-scale variations in weather conditions.

D. W. Johnson, D. E. Todd, Jr., C. F. Trettin, and J. S. Sedinger. "Soil carbon and nitrogen changes in forests of Walker Branch Watershed, 1972 to 2004," **Soil Science Society of America Journal** 71: 1639–46 (2007).

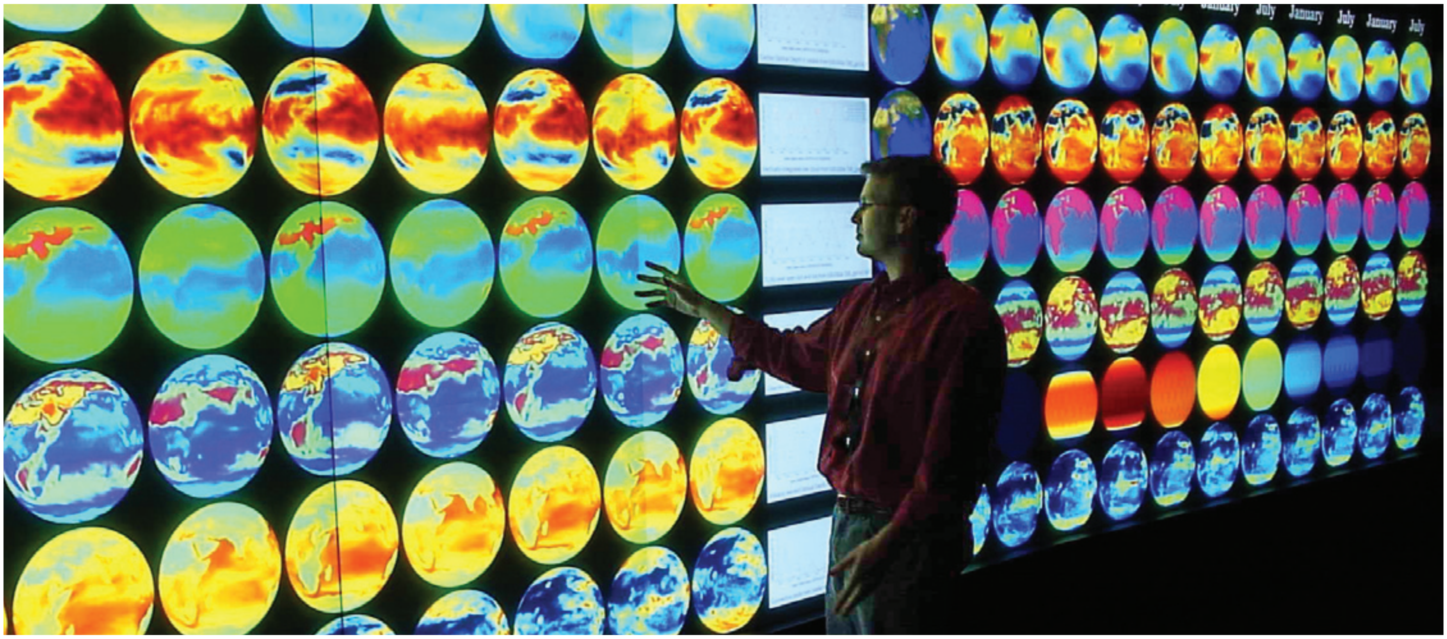
ORNL researchers contribute to IPCC Nobel Peace Prize

ORNL researchers and facilities made significant contributions to the work of the Intergovernmental Panel on Climate Change (IPCC) that won the Nobel Peace Prize for 2007 along with former Vice-President Al Gore. The IPCC, sponsored by the United Nations and World Meteorological Organization, is part of an international effort to assess the realities and effects of human-induced global climate change.

Tom Wilbanks, Environmental Sciences Division researcher and ORNL Corporate Fellow, was a coordinating lead author for the IPCC Working Group II Fourth Assessment Report on climate change impacts, adaptation, and vulnerabilities. Wilbanks was lead author for Chapter 7, "Industry, Settlement, and Society," and for the Summary for Policymakers and Technical Summary. The Environmental Sciences Division's Paul Hanson, Virginia Dale, and Gregg Marland also supported the IPCC research as reviewers or with other contributions. ORNL Corporate Fellow David Greene was the lead author on four transportation-related chapters.

ORNL's Center for Computational Sciences ran the huge, complex computer simulations undergirding the IPCC research and provided infrastructure for more than a third of the total U.S. contribution to the IPCC report. ORNL also is part of the Earth System Grid, which distributes IPCC data.

IPPC Chairman Rajendra K. Pachauri noted in a letter to participants, "This makes all of you a Nobel laureate."

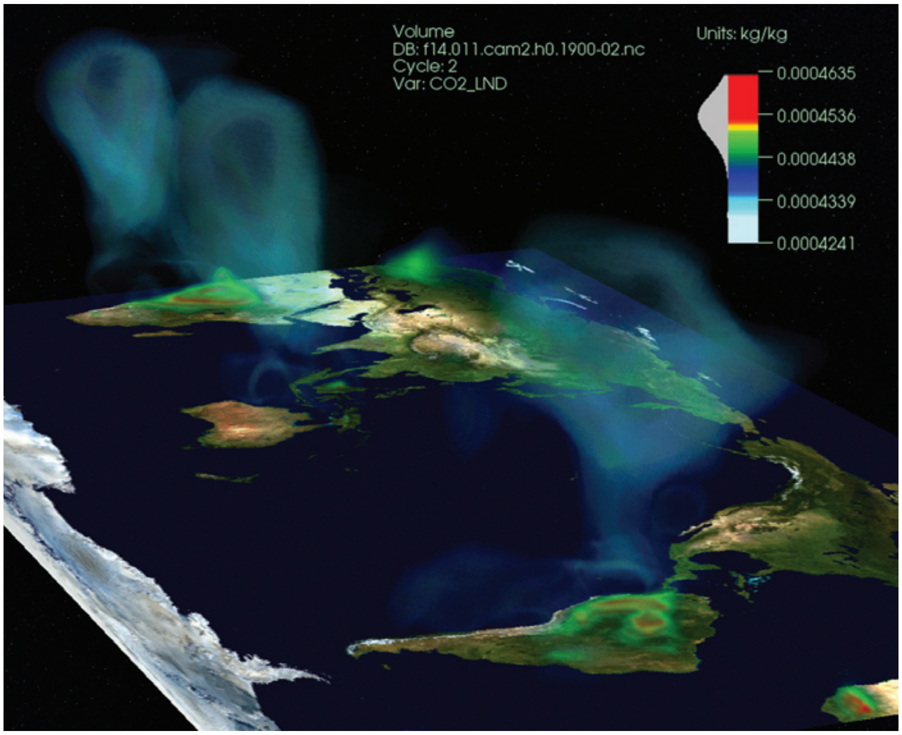


Visualizations of climate change simulation at the Center for Computational Sciences at ORNL.

ORNL leads DOE climate change simulations underlying IPCC studies

Computational simulation has become the key tool for developing climate change predictions and scenarios. ORNL leads DOE's climate modeling effort by providing modeling expertise and technical and management direction. John Drake of ORNL was a principal investigator for a SciDAC (Scientific Discoverty through Advanced Computing) effort that developed the third generation of the Community Climate System Model (CCSM), the preeminent model used for global climate simulation. Drake and Phillip Jones of Los Alamos National Laboratory led the team of a dozen researchers who developed and improved the performance of CCSM—a global model that simulates past, present, and future climates of the planet—to enable it to take full advantage of terascale computers. The two detailed the work of their team in an article in *SciDAC Review*.

CCSM3 was used for most of the modeling done in the United States that provided a scientific basis for the fourth Intergovernmental Panel on Climate Change (IPCC) report released in 2007. IPCC and former U.S. Vice-President Al Gore shared the Nobel Peace Prize in 2007 for their work on climate change.



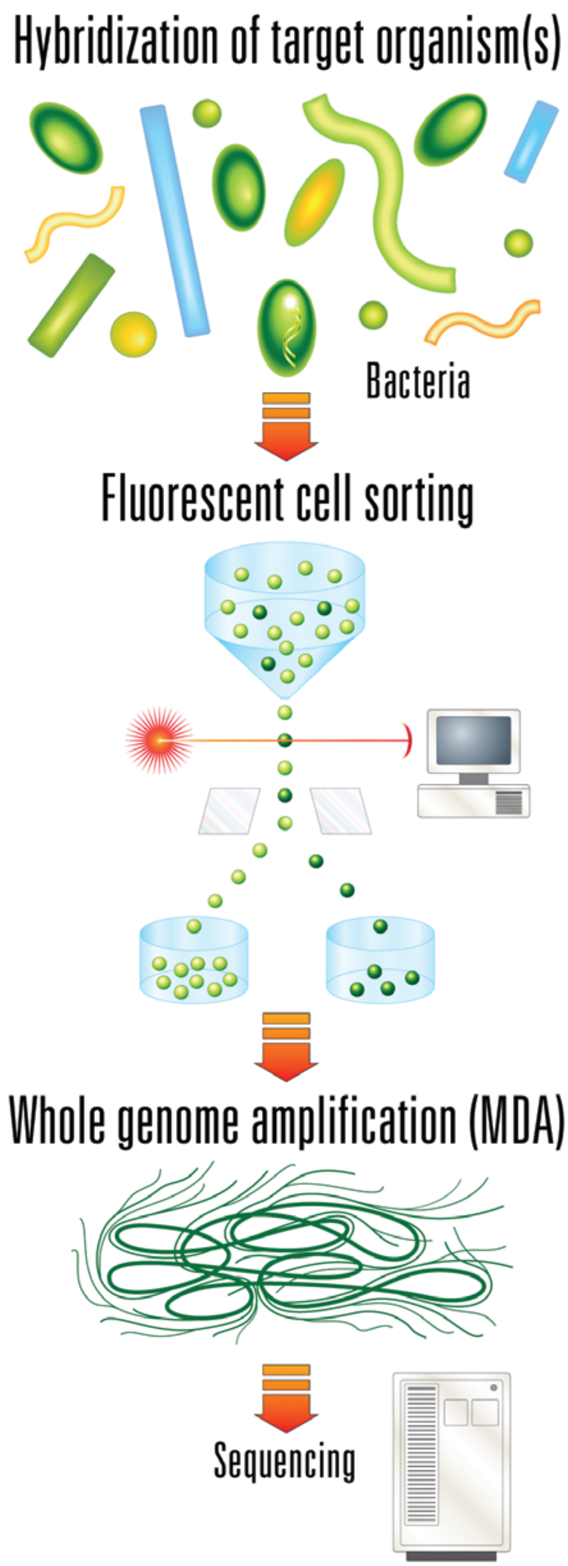
A visualization of a CCSM simulation of atmospheric CO_2 originating from land surfaces for February 1990.

Drake is also the principal investigator for SciDAC's project to develop the fourth generation of the CCSM. CSSM4 will be an "Earth system model," fully simulating the interplay among the physical, climate, and biogeochemical processes that influence the Earth's climate system. The team hopes to have a new version of CCSM ready for use when petascale computers become available, expected in 2009. Drake works closely with ORNL's Environmental Sciences Division, and the funding for ORNL's climate modeling program comes from DOE-BER through the BES Directorate.

J. Drake and P. Jones. "Developing models for predictive climate science," **SciDAC Review** 44–53, Spring 2007.

Biogeochemistry

Access to genomes of low-abundance organisms



Most soil microbial communities contain a large number of species that, although they may be represented by a relatively small number of cells, have important ecological roles. Obtaining and analyzing genomic information specific to these unabundant species by conventional methods is difficult, and approaches that can tap into their genomic information are needed to enable more comprehensive studies.

A team of researchers including Martin Keller of the Biosciences Division has achieved the first isolation and partial genomic sequencing of bacterial cells belonging to the TM7 phylum, a group for which there are no laboratory cultures. The team used cell separation via fluorescence in situ hybridization and flow cytometry, followed by amplification and sequencing of a fraction of the genomic DNA.

The cells were isolated from a soil sample taken from a site in Ramona, California. The TM7 species was targeted because it inhabits a wide range of environments, from soil to activated sludge, to termites, to the human oral cavity, and because much previous research has attempted to gain insight into the TM7 physiology. Microbiological characterization of soil communities is considerably more difficult than characterization in other environments. Thus the approach used in this research can be applied to a broad range of other organisms. It can obtain a larger portion of the genome of a target microbe, more quickly, than any other existing approach. Improvements to this method should allow sequencing of a larger fraction of the genome, starting with a single cell, and open the way to cultivation and study of other rare organisms.

M. Podar, C. B. Abulencia, M. Walcher, D. Hutchison, K. Zengler, J. A. Garcia, T. Holland, D. Cotton, L. Hauser, and M. Keller. "Targeted access to the geonomes of low-abundance organisms in complex microbial communities," **Applied and Environmental Microbiology** 73 (10): 3205–14 (May 2007), doi:10.1128/AEM.02985-06.

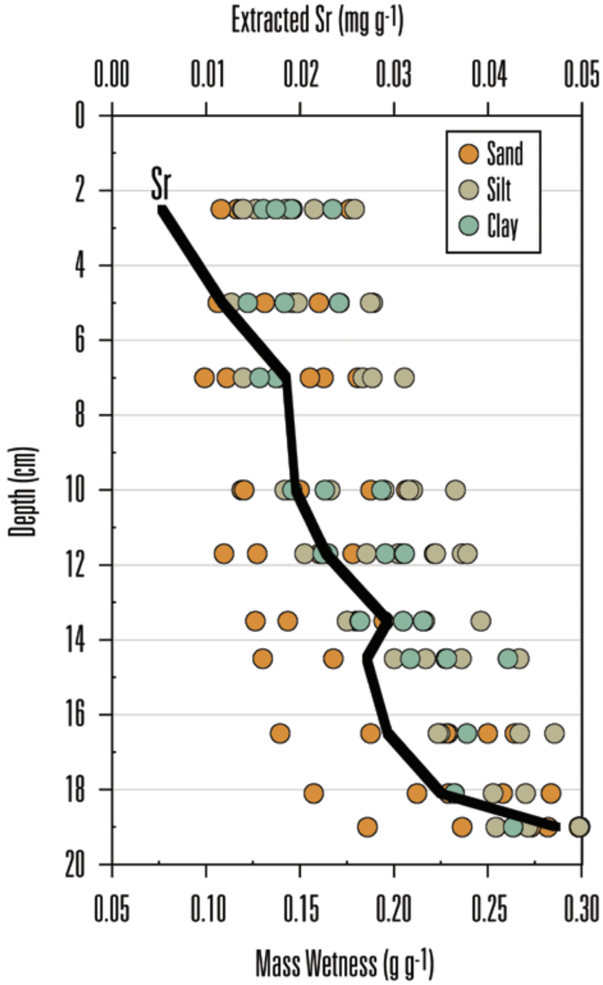
Fate and transport of Sr^{2+} in Hanford sediments

Strontium-90 and co-disposed organic contaminants have migrated into the vadose zone beneath leaking storage tanks at DOE's Hanford Reservation. Uncertainties about the relationship between water content, particle size, and sorption hinder accurate prediction of contaminant mobility. A research team including members of the Environmental Sciences Division investigated whether hydrological processes in layered, partially saturated sediments influenced the geochemistry and the transport of Sr^{2+} and $SrEDTA^{2-}$.

Experiments introduced Sr^{2+} into a partially saturated layered, heterogeneous sediment core. Displacement of Sr^{2+} through the core resulted in less retardation and more irreversible sorption than was seen in saturated, repacked columns; and model results suggested that a significant reservoir (49%) of immobile water was present during transport through the heterogeneous layered sediments. Disassembly and analysis of the core showed that sorbed Sr^{2+} was associated with dry, sandy sediments. Strontium was found to be unequally distributed among carbonates (49%), ion exchange sites (37%), and oxides (14%). The implication of the findings was that dry, coarse, and carbonaceous sediments may be effective "sinks" for contaminant species in the Hanford vadose zone.

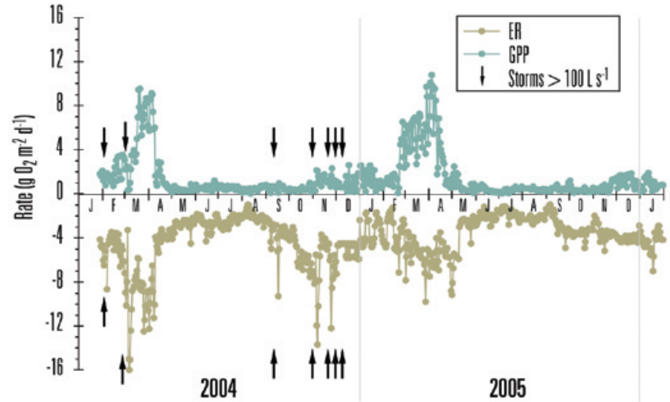
M. N. Pace, M. A. Mayes, P. M. Jardine, L. D. McKay, X. L. Yin, T. L. Mehlhorn, Q. Liu, and H. Gürleyük. "Transport of Sr^{2+} and $SrEDTA^{2+}$ in partially-saturated and heterogeneous sediments," **Journal of Contaminant Hydrology** 91: 267–87 (2006), doi:10.1016/j.jconhyd.2006.11.006.

Core dissection shows that sorbed Sr^{2+} is associated with dry, sandy sediments.



Hydrologic variability and forest phenology have large effects on stream biological processes

Investigations of stream ecosystem metabolism in Walker Branch Watershed, in the Oak Ridge National Environmental Research Park, show that hydrologic variability and seasonal changes in the canopy of the adjacent forest have large effects on biological processes in streams. By measuring the metabolism of the entire stream continuously over a 2-year period, using high-frequency measurements of dissolved oxygen, researchers were able to identify several important temporal scales of variation that result in changes in metabolism rates of more than an order of magnitude. They included seasonal peaks in stream primary production and total respiration resulting from high light levels in early spring prior to leaf emergence and input of leaves in autumn. They also included short-term (days to weeks) and long-term (annual) variations in metabolism caused by the frequency and size of storms, which scour out algae but deliver fresh organic matter to stream ecosystems. The results offer one of the most detailed examinations of temporal variations in stream processes and the effect of hydrological variations to date. These findings are important because models of future climatic change predict changes in forest phenology (the timing of spring leaf emergence and autumn leaf-fall) and leaf chemistry (affecting biological consumption of leaves in streams) and considerably more hydrologic variability as precipitation patterns become more extreme.



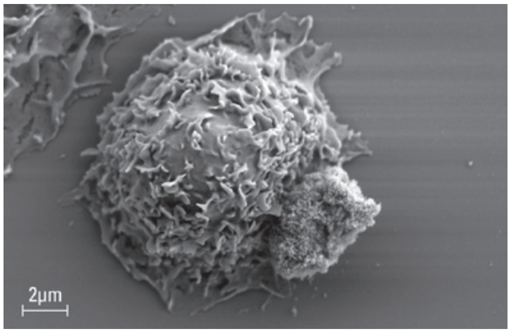
The gross primary production (GPP) and ecosystem respiration (ER) rates measured continuously in Walker Branch varied by more than an order of magnitude, suggesting that increased hydrologic variability and changes in forest phenology may have large effects on the metabolism of stream ecosystems.

B. J. Roberts, P. J. Mulholland, and W. R. Hill. "Multiple scales of temporal variability in ecosystem metabolism rates: Results from 2 years of continuous monitoring in a forested headwater stream," **Ecosystems** 10 (4): 588–606 (2007) (DOI: 10.1007/s10021-007-9059-2).

Systems Biology

In-vivo study shows no evidence that engineered nanomaterials cause adverse pulmonary effects

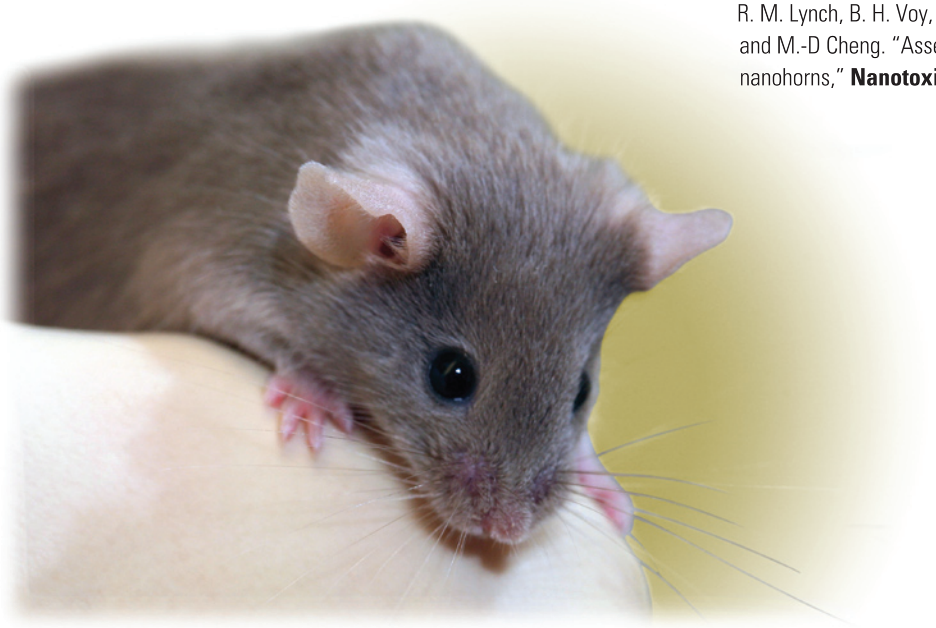
Previous studies have suggested that single-walled carbon nanotubes (SWCNTs) may pose a pulmonary health hazard. A research team led by Meng-Dawn Cheng and several members of the Biosciences and Environmental Sciences Divisions investigated the pulmonary toxicity of single-walled carbon nanohorns (SWCNHs), a relatively new carbon-based nanomaterial that is structurally similar to SWCNTs, and found no evidence of sustained adverse pulmonary effects.



Single-walled carbon nanohorns.

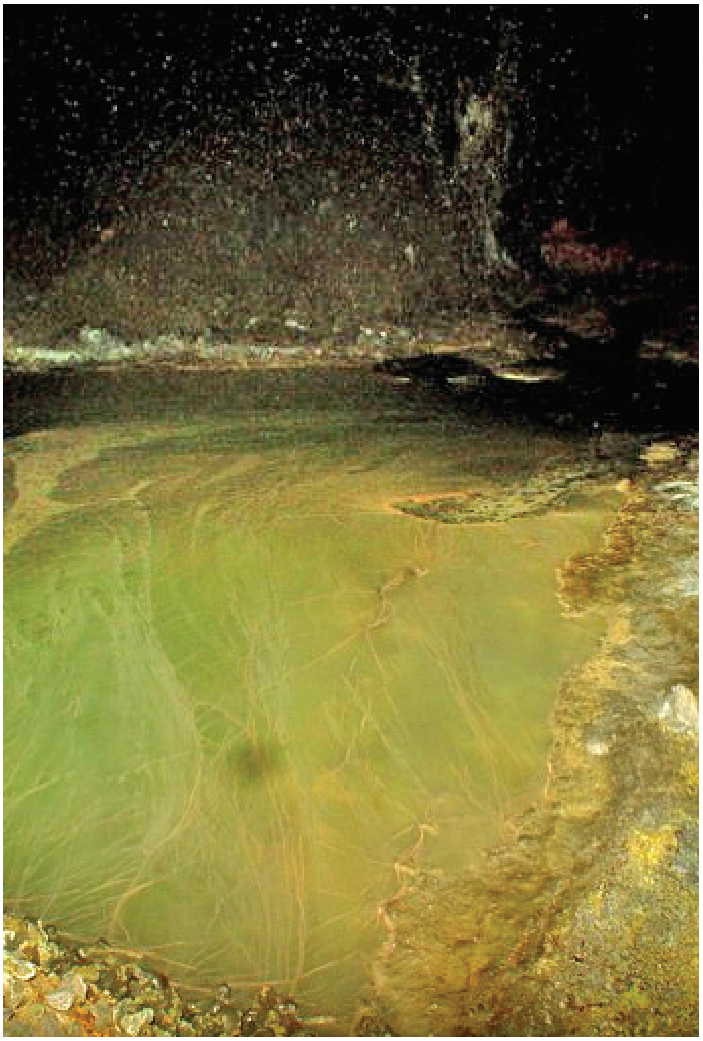
Mice were exposed to a very high dose, 30 μg per mouse (or roughly 100 mg per 73 kg person), of surfactant-suspended SWCNHs or an equal volume of a control by pharyngeal aspiration. They were then sacrificed and analyzed either 24 hours or 7 days following the exposure. Neutrophil counts and cytokine analysis of bronchoalveolar fluid showed a mild inflammatory response in mice examined shortly (24 hours) after exposure and no inflammation in those examined 7 days after exposure. Out of 22 cytokines and chemokines assayed, only 5 showed the early inflammatory response, and none showed a sustained (7-day) response. While statistically weak, whole-lung microarray analysis demonstrated that SWCNH exposure did not lead to robust changes in gene expression. Finally, histological analysis showed no evidence of granuloma formation or early fibrosis that was a significant contrast in phenotypic response to the exposure of SWCNTs. Given the high dose level intentionally used in the experiments, these combined results suggest that SWCNH is a relatively innocuous nanomaterial when delivered to mice in vivo using aspiration as a delivery mechanism. The results suggest that responses to the exposure of carbon-based nanostructures may be more complicated than previously thought, and in-vitro (or cell line-based) study may be insufficient to provide an accurate picture about the health implications of the nanostructures. The results also echo many recent suggestions by experts supporting the need for systematic research into underlying mechanisms of interaction.

R. M. Lynch, B. H. Voy, D. F. Glass, S. M. Mahurin, A. M. Saxton, R. L. Donnell, and M.-D Cheng. "Assessing the pulmonary toxicity of single-walled carbon nanohorns," **Nanotoxicology** 1 (2): 157–66 (June 2007).



Study of acid-loving mine-dwelling microbes provides clues about genetic diversity

Microbes are the most abundant organisms, but there is little understanding of the mechanisms and forces behind their genetic diversification. A study conducted by Bob Hettich, Nathan C. VerBerkmoes, and Manesh B. Shah of ORNL and colleagues at the University of California–Berkeley, the Joint Genome Institute, and Lawrence Livermore National Laboratory suggests that microbial populations exchange large blocks of genetic material as a way of adapting to harsh environments.



Leptosprillium bacteria living in acidic stream.

The study found that closely related strains of Leptosprillium bacteria living in highly acidic streams in an old mine exchange strings of chromosomes of up to hundreds of kilobases. It is the first observation of large genetic exchange in a microbial community in nature. The research approach combined metagenomics (sequencing the genes of the community of microbes) and "shotgun" proteomics (identifying the range of proteins found in specific microbes within the community). Mass spectrometry conducted at ORNL was essential in enabling the team to differentiate among peptides (small chains of amino acids) that differ by as little as one amino acid. ORNL's Biosciences Division provided bioinformatics expertise to analyze the massive data sets. The combination of mass spectrometry and extensive reconstruction of genomes from community genomic data sets at UC–Berkeley was a key to the effort. One of the most important aspects of the work is that it demonstrates the capability to identify a large fraction of the proteins found in an individual organism and distinguish them from proteins in a closely related organism.

This research helps extend studies of laboratory-cultivated microbes into more complex real-world microbial communities. The knowledge gained from the research aids understanding of how the exchange of genetic materials helps organisms adapt and evolve and is expected to lead to advances in human health and environmental bioremediation.

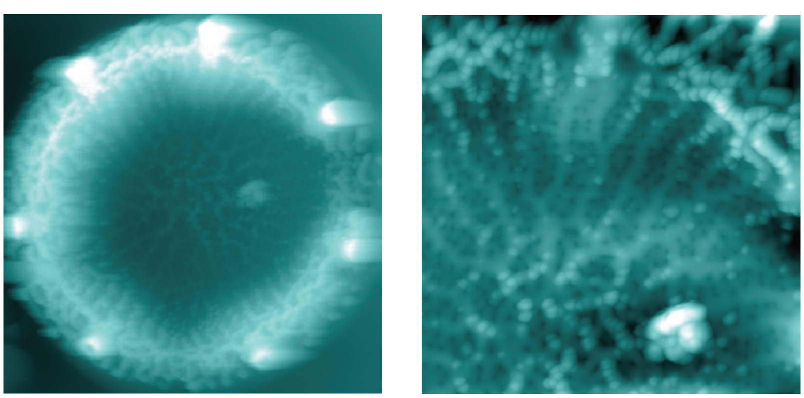
I. Lo, V. J. Denef, N. C. VerBerkmoes, M. B. Shah, D. Goltsman, G. DiBartolo, G. W. Tyson, E. E. Allen, R. J. Ram, J. C. Detter, P. Richardson, M. P. Thelen, R. L. Hettich, and J. F. Banfield. "Strain-resolved community proteomics reveals recombining genomes of acidophilic bacteria," **Nature** 446, doi: 10.1038/nature 05624 (March 2007).

Nanoscale control of morphology and structure in diatom cell wall formation

The single-cell algae called diatoms produce complex three-dimensional nanoscale and microscale silica structures in their cell walls with high fidelity and in enormous numbers via biological replication. Because the quality of the structures produced biologically exceeds the quality of structures synthesized in the laboratory, diatoms are being considered as a possible model for developing processes for synthesizing nanomaterials.

Mitch Doktycz and David Allison of the Biological Sciences Division are members of a research team that combined biological manipulation and advanced microscopy techniques to examine silica cell wall formation in the diatom *Thalassiosira pseudonana*. This combination of tools was essential to correlating the formation of structural intermediates with the genes and proteins involved in the process. The results will enable modeling of the structural process and aid in developing approaches to controllably alter wall structure. Because instructions for silica structure formation are embedded in the diatom genome, it may be possible to develop gene manipulation techniques to enable the use of diatoms as a direct source of tailored nanostructured materials. The study represents a benchmark for measurement science and a significant advancement in the understanding of biosilification processes.

M. Hildebrand, E. York, J. I. Kelz, A. K. Davis, L. G. Frigeri, D. P. Allison, and M. J. Doktycz. "Nanoscale control of silica morphology and three-dimensional structure during diatom cell wall formation," **J. Mater. Res.** 21 (10): 2689–98 (October 2006).



(Left) Transmission electron microscopy image of T. pseudonana valve, highlighting structure of ribs and nanopores.

(Right) Scanning electron microscopy image of outer valve surface.

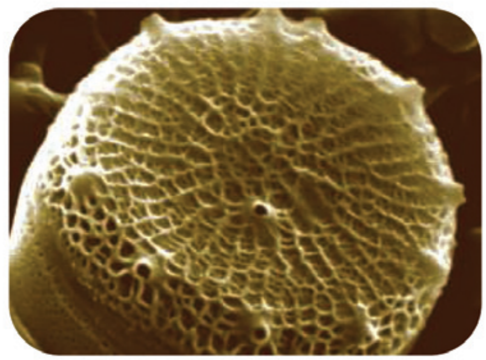
EDITORS' CHOICE

EDITED BY GILBERT CHIN AND JAKE YESTON

MATERIALS SCIENCE

Small and Strong

The intricate silica cell walls fabricated by the unicellular algae known as diatoms are highly porous and are produced with high fidelity. Diatoms have therefore been viewed as a possible platform for nanostructured materials synthesis. Hildebrand *et al.* have probed cell wall synthesis in the nanostructured form of *Thalassiosira pseudonana,* an organism whose genome has recently been sequenced. They studied a series of structural intermediates to unravel the chemical formation sequence and to ascertain when certain proteins come into play. At the earliest stages, they observed an outline of the valve with silica ribs radiating from the center. The rim structure then thickens, followed by a thickening of the rest of the valve structure. As the ribs form and fuse together, they give rise to a nanoporous structure with larger, more irregular pores than those formed earlier in the process. These observations confirm that the structure of *T. pseudonana* has been optimized to maximize strength with minimized material requirements, all the while allowing for the uptake and efflux of metabolites during this process. The authors hope in the long term to replicate and control many of these features through modification of the genome or through mixing of an appropriate array of polypeptides and polyamines to foster silica polymerization in vitro. — MSL



***T. pseudonana* cell wall.**

J. Mater. Res. **21**, 2689 (2006).

24 NOVEMBER 2006 VOL 314 **SCIENCE**
www.sciencemag.org *Published by AAAS*

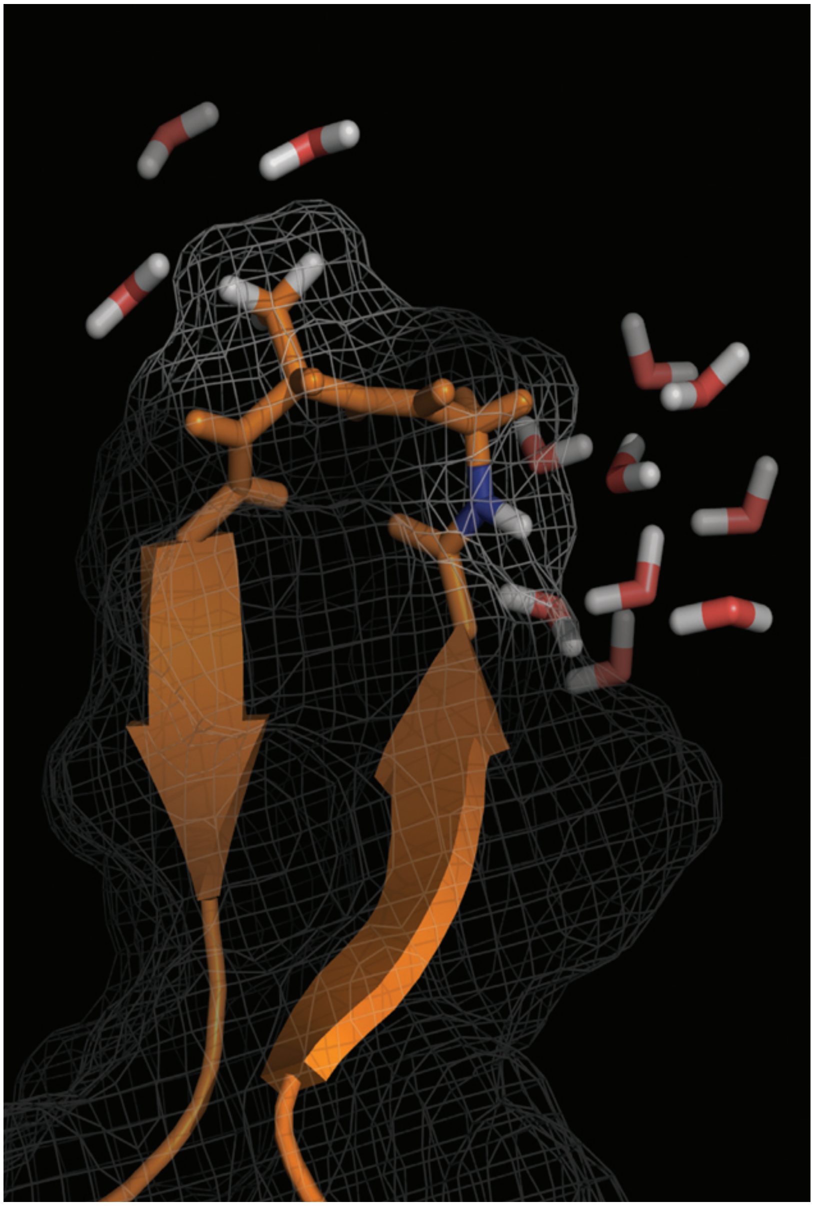
Unlocking the secrets of protein folding

The genetic code is translated into thousands of unique functional three-dimensional protein architectures. Misfolded proteins are not just useless to the organism they inhabit but sometimes lethal. Scientists have never been able to unravel the mystery of how proteins fold, but a research team led by a member of the Biosciences Division has used supercomputing to reveal a significant clue as to how proteins take shape.

A protein is a string of amino acids, and the sequence of the amino acids determines its structure. The computer simulation research showed that the folding of a certain small chain of amino acids (a peptide) is determined largely by how parts of the peptide react with water. Specifically, there is a difference in the way small and large hydrophobic portions of the chain behave when surrounded by water. When water molecules confront a large hydrophobic area, they are repelled from its surface, creating a drying effect. The simulations show that the drying effect determines the structure the peptide adopts.

The simulations were of about a microsecond of a peptide's life. To simulate folding of a complete functional protein requires modeling a protein many times larger and for times lasting for milliseconds instead of microseconds. Ultimately, being able to accurately simulate folding will greatly advance understanding of protein function and will enable revolutionary advances in fields such as drug design, bioenergy, and nanotechnology.

I. Daidone, M. B. Ulmschneider, A. Di Nola, A. Amadei, and J. C. Smith. "Dehydration-driven solvent exposure of hydrophobic surfaces as a driving force in peptide folding," **Proc. Natl. Acad. Sci. USA** 104 (39): 15230–5, (September 25, 2007).



Computer simulation of a peptide in action.

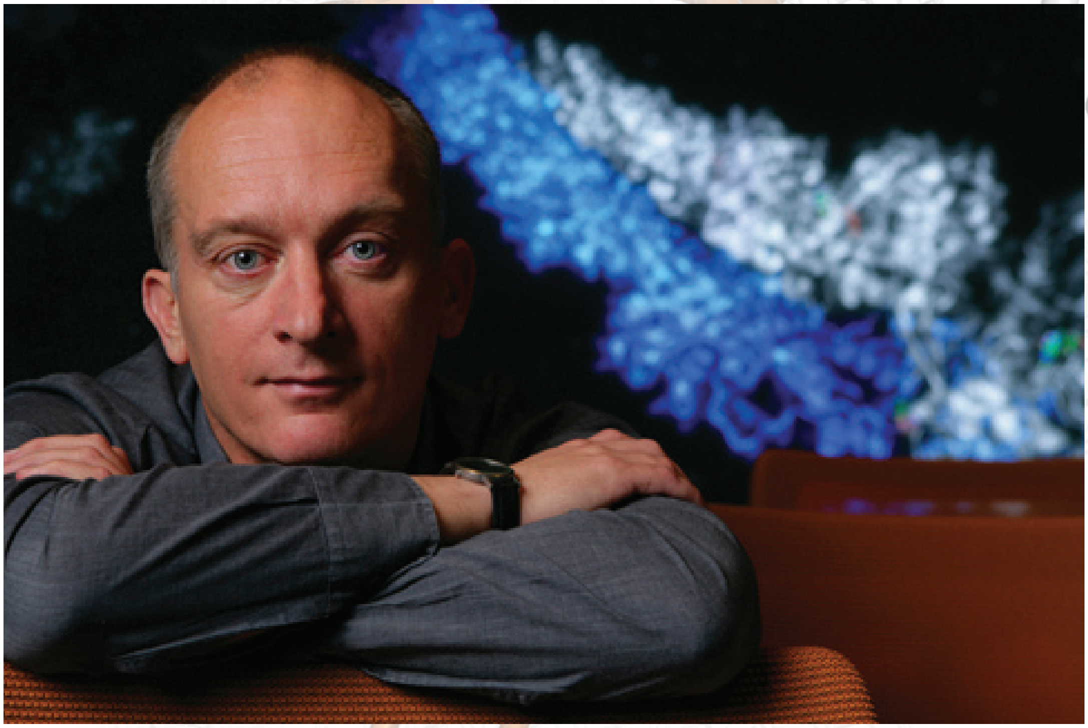
Simulations reveal protein vibrations in crystal

Most of the body's work is done by proteins, and understanding how these tiny machines work together is a major focus of research in the biological sciences. A Biosciences Division researcher headed an international collaboration that performed the first all-atom lattice-dynamical computer simulation of how proteins vibrate in a crystal. The simulation describes the forces and vibrations (internal movements) involved in protein crystals, which are well suited to detailed study because they are an environment in which the proteins are highly ordered.

The study of molecular-scale lattice dynamics—how the units of a crystal vibrate in relationship to each other—may shed light on how proteins in cells interact with one another. A paper on the research published in *Physics Review Letters* predicts the existence and forms of protein crystal lattice modes. Recent advances in supercomputing have provided researchers with the computing power to allow calculations at the level in this study.

The computer calculations agree closely with existing experimental measurements. The challenge for the next steps is to actually determine the forms of protein vibrations experimentally to see how well the calculations predicted them. The researchers plan to use the resources of the Spallation Neutron Source to test the simulations when the appropriate instruments there are available.

L. Meinhold, F. Merzel, and J. C. Smith. "Lattice dynamics of a protein crystal," **Phys. Rev. Lett.** 99: 138101 (2007), doi:10.1103/physRevLett.99.138101.



Jeremy Smith of ORNL with a visualization of interacting proteins.

Awards and Achievements

ORNL-led team wins DOE bioenergy center

The Biological and Environmental Sciences Directorate scored a big win in being chosen to establish one of three DOE-funded bioenergy research centers that will seek new ways to produce fuels from biomass. The award was for $125 million over 5 years. The BioEnergy Science Center (BESC) will be located in the Joint Institute for Biological Sciences building, a new facility on the ORNL campus funded by the state of Tennessee.

The BESC will take advantage of the interdisciplinary expertise of the team members in biology, engineering, agricultural science, and technology commercialization to improve dedicated biomass crops, such as switchgrass and poplar trees, and develop new methods of processing plants into biofuel. The main obstacle to producing biofuels in sufficient quantities to significantly reduce U.S. gasoline consumption is that there is no cost-effective process for converting cellulosic biomass to sugars and then to alcohol. The BESC will attempt to achieve breakthroughs in cellulose conversion by pursuing two specific goals:

Joint Institute for Biological Sciences.

- Modifying plant cell walls to reduce their resistance to breakdown in order to decrease or eliminate the need for costly chemical treatment to deconstruct the cell walls. Work will focus on the poplar tree and switchgrass, a native grass that can be grown easily in most of the United States. These have been identified by DOE as model biomass crops.
- Consolidated bioprocessing, which involves the use of a single microorganism or group of organisms to break down plant matter through a one-step conversion process of biomass into biofuels.

Poplar seedlings in ORNL greenhouse.

Other BESC partners are the University of Tennessee, Dartmouth College, the University of Georgia, the Georgia Institute of Technology, the Samuel Roberts Noble Foundation, the National Renewable Energy Laboratory, and the companies ArborGen Diversa and Mascoma. Martin Keller (kellerrm@ornl.gov, 865-574-5845) will be the director for the center. The research is sponsored by the DOE Office of Science. More information is available at www.bioenergycenter.org/.

Separately, the state of Tennessee appropriated funds to build a 5 million gallon per year pilot plant in partnership with Mascoma to demonstrate switchgrass-to-ethanol conversion using state-of-art technology. This pilot will be available in 3 years to test new processes, including those developed at the BESC. For more information, see www.utbioenergy.org/TNBiofuelsInitiative/.

Bio-SANS available at HFIR for analysis of biosystems

A small-angle neutron scattering (SANS) instrument dedicated to the study of biological systems (the Bio-SANS) is among the new tools offered to researchers at the High Flux Isotope Reactor (HFIR) Cold Neutron Source completed in 2007. The 35-meter Bio-SANS is a DOE user facility for the structural biology community that will provide the most advanced capabilities in the world for analyzing the structure, function, and dynamics of biological macromolecules.

Detector tanks for the new SANS and Bio-SANS instruments at HFIR.

The cold source circulates 505 mL of supercritical liquid hydrogen maintained at 20 K at a pressure of 14.5 bar, which is expected to provide usable neutron fluxes with a maximum wavelength of 30 Å for the study of complex materials at the molecular level. It will significantly extend the number, size, and complexity of biological systems that are accessible to neutron scattering analysis. Data from Bio-SANS experiments will provide biological scientists the tools to build a detailed understanding of the internal structure of complex biological systems and study their responses to changing conditions.

The Center for Structural Molecular Biology (CSMB) also has been established to support biological science user programs at HFIR. The new Bio-SANS will make the CSMB the world's leading scientific center and user facility for neutron-based studies of biomolecular structure and function.

NCRP National Council on Radiation Protection & Measurements

Report details knowledge about ^{137}Cs in the environment

Charles Garten of the Environmental Sciences Division is among the authors of a major report issued by the National Council on Radiation Protection and Measurements (NCRP). The report, *Cesium-137 in the Environment: Radioecology and Approaches to Assessment and Management* (NCRP 154), was authored by a committee of eight national experts. It reviews and summarizes knowledge of the sources, distribution, properties, and behavior of the radionuclide ^{137}Cs in the environment. Cesium-137 is a major concern associated with nuclear accidents, nuclear waste disposal, and nuclear weapons (including the potential for creating a "dirty bomb"). Following events that result in radioactive contamination of the environment, ^{137}Cs (which has a 30-year half-life) is frequently the most important radionuclide contributing to human radiation exposure.

The NCRP report covers specific experience at sites of past or present contamination, transport pathways to people, biogeochemistry of ^{137}Cs in terrestrial and aquatic environments, and remediation and/or management issues associated with contaminated land. This book is the most comprehensive report devoted to ^{137}Cs in the environment that NCRP has issued in 30 years. It will be useful to decision-makers, educators, scientists involved in risk assessment and contaminant modeling, and land managers involved with the management and remediation of contaminated sites.

Walter Branch Watershed is NEON core site

The Walker Branch Watershed on the Oak Ridge Reservation was selected as a core site for the National Ecological Observatory Network (NEON). NEON is a continental-scale research platform for helping researchers determine and understand the impacts of climate change, land-use change, and invasive species on the ecology of various regions of the country and track the feedbacks among the geosphere, the atmosphere, and the hydrosphere.

A radiometer atop the Walker Branch Watershed tower measures radiation from the sun and sky.

The NEON effort, sponsored by the National Science Foundation, partitions the United States into 20 ecological-climatic "domains" based on ecological variables and wind vectors. Each domain will host one instrumented NEON core site located in a wild area. (The ORNL site represents domain 7). An advanced cyber infrastructure will link all 20 geographically distributed systems of sensors and experiments into a single virtual observatory. The sites will be able to make simultaneous measurements of ecological and climatic conditions in real time at scales ranging from regional to continental. Each site will include a standard set of instruments to collect various types of eco-climatic information.

The purpose of NEON is to collect information essential to developing the scientific insight needed to manage the nation's environmental challenges. The network will record and archive environmental data for at least 30 years. The ORNL contact person for NEON is Patrick Mulholland, mulhollandpj@ornl.gov, 865-574-7304.

Genes help bioenergy crops see the light

Precisely positioned markings on the stem of a poplar tree allow scientists to measure changes in internode elongation as plants are exposed to different qualities of light.

Scientists in the Environmental Sciences Division, led by Jerry Tuskan, Udaya Kalluri, and Stan Wullschleger, captured $1 million in funding for plant genetics research in the FY 2007 DOE Genomics: GTL program solicitation, "Plant Feedstock Genomics for Bioenergy." The winning proposal, to be funded over 3 years, focused on using emerging tools of functional genomics to understand the molecular controls on crown architecture in hybrid poplar trees.

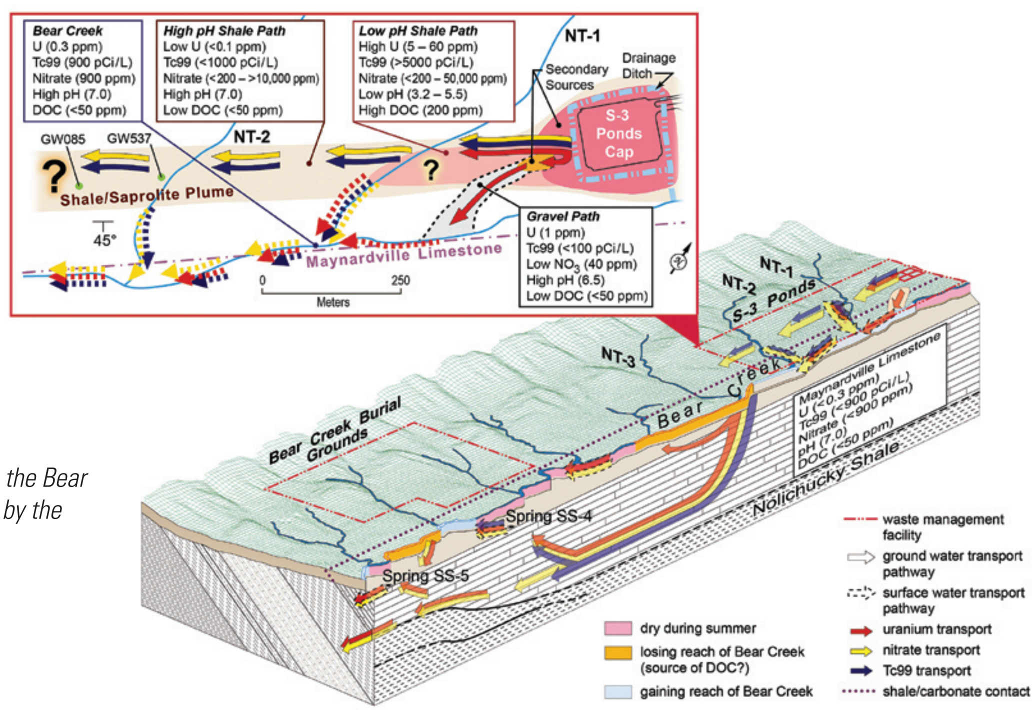
Plant biologists at ORNL have a long track record of conducting research in bioenergy crops, including the poplar tree and switchgrass; and this research was possible primarily because ORNL's scientists possess a novel set of skills in physiology, genetics, and molecular biology. In addition, Tuskan and his colleagues had earlier participated with the DOE/BER Joint Genome Institute to sequence the black cottonwood *(Populus trichocarpa)* genome (results published in *Science,* September 2006), an achievement that placed them in a strong position to undertake this unique research. Their proposal was one of only eleven selected by the joint DOE/U.S. Department of Agriculture review panel.

Plants detect their position relative to other plants via sophisticated photoreceptors and then alter their growth accordingly. In a competitive light environment, such as in densely planted bioenergy plantations, biomass production is affected as plants seek to avoid limited light conditions by investing resources in height growth rather than radial stem growth. The ORNL project will study the molecular control of photoreceptors and "shade-avoidance syndrome" to clarify how height growth and internode elongation respond to changing light environments, how genes regulate the temporal and spatial control of this response, and how plant-plant competition and light environment impact the production of biomass by bioenergy crops such as hybrid poplar, especially when grown at high densities. Answers to these questions are critical to designing management systems to optimize biomass production in stands with high densities.

The Oak Ridge Integrated Field-Research Challenge

The Oak Ridge Integrated Field-Research Challenge (IFC) is one of three IFCs funded by the DOE Environmental Remediation Sciences Program. The IFCs seek to support DOE's cleanup mission and long-term stewardship responsibilities by providing new insights into the behavior of contaminants through multidisciplinary field-scale research. Initiated in 2007, the Oak Ridge IFC research focuses on determining the mechanisms and rates of immobilization or removal of contaminants of concern to DOE from subsurface environments. These contaminants travel in belowground plumes that emanate from contaminated source zones such as the former S-3 Ponds located at the Y-12 National Security Complex. Researchers will also try to determine the effectiveness of various remediation measures on the plumes.

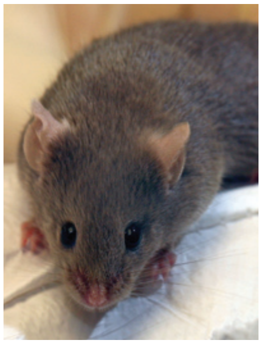
The Oak Ridge Field Research Center serves as the field laboratory for the Oak Ridge IFC. This field laboratory includes the former S-3 Ponds site (now capped and used as a parking lot) and contains a variety of contaminants of interest to DOE (uranium, technetium, nitrate, acidity, and volatile organic contaminant species), a diversity of known contaminant groundwater pathways that encompass multiple scales, and promising established and proposed field-scale manipulation tests of in situ contaminant immobilization. IFC research focuses on measuring the rates and extents of natural attenuation of three main contaminants: nitrate, uranium, and technetium. A combination of geophysical, chemical, microbial, and hydrological analytical tools allows Oak Ridge IFC researchers to identify contaminant pathways, characterize active attenuation or transition zones, and understand the dynamics and effects of groundwater recharge.



Major contaminants and flow paths in the Bear Creek Valley watershed being studied by the Oak Ridge IFC project.

Awards and Achievements

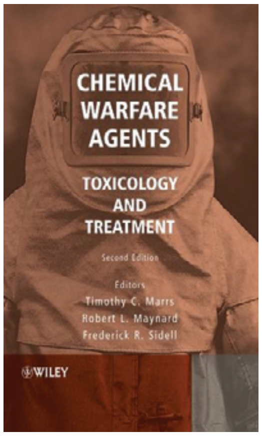
The Collaborative Cross



The Collaborative Cross is a new mouse resource arrived at by consensus of mouse geneticists seeking to develop the next-generation population to be used for systems biological investigation in the mouse. The result is a large-scale, complex, structured hybrid population derived from eight progenitor strains representing a broad sampling of mouse genetic diversity. The size and scope of the population have made ORNL a logical location for this project with the 2004 opening of the vivarium in the William L. and Lianne B. Russell Functional Genomics Laboratory. With leading support by the Ellison Medical Foundation and DOE, the production and preliminary characterization of the cross began in 2005. In collaboration with several investigators, ORNL scientists have established studies of the mice for behavior, physiology and anatomy.

In the past year, the National Institutes of Health announced that it too will support the Collaborative Cross effort with the funding of the first of several research grants to maintain production and to characterize the lines in areas of neuroscience, genomics, and cancer biology. These awards were made to Visiting Scientist Dr. David W. Threadgill of the University of North Carolina–Chapel Hill and Dr. Robert W. Williams of the University of Tennessee Health Science Center. This 5-year program will bring more than $3 million to ORNL in new funding and will foster the continued growth and adoption of this novel collaborative.

The fate of chemical warfare agents in the environment



Sylvia Talmage, Nancy Munro, and Annetta Watson of the Environmental Sciences Division are the lead authors of an invited chapter in the second edition of *Chemical Warfare Agents: Toxicology and Treatment*, published by John Wiley and Sons in the United Kingdom. Chapter 4, "The Fate of Chemical Warfare Agents in the Environment," is authored by the ORNL researchers. This chapter compiles nerve and vesicant chemical warfare agent fate reactions, as well as toxicity of agent degradation products; it represents a review of military and open literature over the past decade. The chapter clearly documents that, in the environment, chemical warfare agents undergo multiple degradation processes such as hydrolysis, oxidation, dehydration, and photolysis over time. This analysis indicates that, in most cases and given sufficient time, agents dispersed (or leaked or spilled) in humid air, moist soils, or bodies of water will degrade via environmental reactions to yield compounds usually much less toxic than the parent chemical warfare agent.

Chapter 4 summarizes agent-specific reaction chemistry and characterizes all products known to result from the degradation of nerve and vesicant chemical warfare agents as to chemical, physical, and toxic properties. A companion paper, "Chemical Warfare Agent Degradation and Decontamination," published by the same authors in *Current Organic Chemistry* (11:285-298, 2007), summarizes chemical warfare agent decontamination and the agent degradation pathways induced by decontamination materials and procedures.

The other chapter authors are the Army sponsors of the project, Joseph King of the U.S. Army Environmental Center, and Veronique Hauschild of the U.S. Army Center for Health Promotion and Preventive Medicine.

Norby is UT-Battelle Corporate Fellow

Richard J. Norby of the Environmental Sciences Division has been named a UT-Battelle Corporate Fellow. The appointment recognizes Norby as an international expert on the effects of increasing levels of atmospheric carbon dioxide on terrestrial ecosystems and as a pioneer in large-scale manipulative field experiments. Norby led the design and implementation of the ORNL Free Air Carbon Dioxide Enrichment (FACE) experiment, which has established the importance of understanding the allocation of carbon to plant root systems as an ecosystem response to elevated carbon dioxide levels. Norby is a fellow of the American Association for the Advancement of Science, Environmental Section editor of *New Phytologist*, and a board of trustees member of the New Phytologist Trust, which supports plant sciences internationally. He has served on a number of national committees, including the Science Steering Group for the North American Carbon Program, the Technical Advisory Committee for the National Institute for Global Environmental Change, and the Scientific Steering Committee for the National Science Foundation Research Coordination Network on Terrestrial Ecosystem Responses to Atmospheric and Climate Change.

Nano 50 Award recognizes Thundat's nanomechanical sensors

Thomas Thundat of the Biosciences Division was chosen by *Nanotech Briefs* magazine to receive a Nano 50 award recognizing the "top 50 technologies, products, and innovators that significantly impacted, or are expected to impact, the state of the art in nanotechnology." Thundat's Nanoscale Sciences and Devices group is developing miniature sensors based on a cantilever platform.

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Nanotech Briefs is a digital monthly magazine from the publishers of *NASA Tech Briefs* that highlights engineering breakthroughs in nanotechnology and microelectromechanical sensors. Thundat is cited for his pioneering work on nanomechanical sensors for physical, chemical, and biological detection.

Thundat is AAAS Fellow

Thomas Thundat was elected a fellow of the American Association for the Advancement of Science (AAAS). Thundat, a UT-Battelle Corporate Fellow, was recognized for his research in sensor technology and weapons detection. The AAAS Council cited his "pioneering work in developing a novel class of sensors for molecular recognition using nanomechanical sensor platforms."

Microcantilevers—microscopic devices that can be used for detecting a number of substances, including trace quantities of chemical and biological agents—are one application of nanomechanical sensors. One of Thundat's concepts uses microcantilever technology to detect minute amounts of TNT; it could be applied both to national security missions and to the reclamation of former battlefields and war zones. Thundat's work with microcantilevers has received a number of recognitions over the past several years and has won R&D 100 and Federal Laboratory Consortium awards.

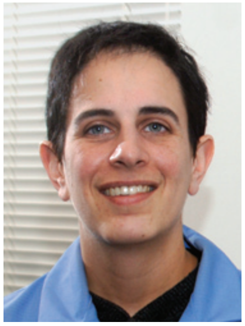
Weston and Wullschleger organize ESA sessions

Weston

Wullschleger

Environmental Sciences Division researchers organized two special sessions related to the integration of systems biology and ecology that were approved for the Ecological Society of America meeting:

- Dave Weston of the Environmental Sciences Division and Sam St. Clair of the University of California–Berkeley organized an oral session entitled "Mechanistic Underpinnings of Ecological Processes: Scaling from Genes to Ecosystems."
- Stan Wullschleger of Environmental Sciences Division, Joy Ward of the University of Kansas, and Evan DeLucia of the University of Illinois organized a symposium on "Merging Physiological Ecology and Functional Genomics."



IBANGS recognizes Dr. Elissa J. Chesler

The International Behavioral and Neural Genetics Society has presented its annual Young Scientist Award to Dr. Elissa J. Chesler of the Biosciences Division. The award was in recognition of early career accomplishments that have already had an influence on the field of behavioral and neural genetics. Chesler has more than 40 publications in the area, including papers in *Science*, *Nature Genetics*, *Nature Neuroscience,* and *Proceedings of the National Academy of Sciences*. She is a member of the National Institutes of Health-funded Integrative Neuroscience Initiative on Alcoholism Consortium on stress and alcohol addiction and has several active research grants in behavioral genetics. Chesler has presented her work at the Gordon Conference on Genes and Behavior and in the past year was an invited speaker at the Gordon Conference on Quantitative Genetics. She reviews grants for NIH, the National Science Foundation, and several international scientific agencies and has lectured in numerous short courses and symposia.

Classen chosen for Frontiers of Science Symposium

Aimee Classen of the Environmental Sciences Division was one of 60 young scientists from across scientific disciplines chosen to participate in the Kavli Frontiers of Science Symposium sponsored by the National Academy of Sciences. The symposium was "designed to provide an overview of advances and opportunities in a wide-ranging set of disciplines and to provide an opportunity for the future leaders of science to build a network with their colleagues."

Graham is panelist for MIT Energy Conference

Robin Graham of the Environmental Sciences Division participated in a panel discussion on bioenergy at the Massachusetts Institute of Technology (MIT) Energy Conference. The conference was organized by MIT graduate students. In addition to Graham, panelists were Phillip New (president of BP Global Biofuels), Mark Stower (vice-president for research and development, Broin Companies), and Doug Cameron (chief scientific officer of Khosla Ventures).

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