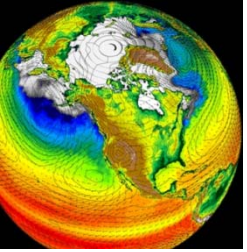
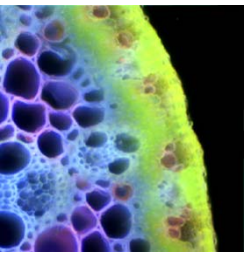
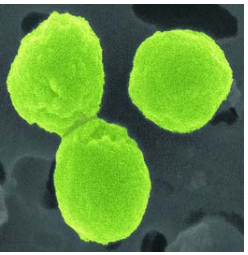


# BER Advisory Committee Meeting

# September 1, 2009

# Climate & Environmental Science Division Update

J. Michael Kuperberg, Ph.D.

Acting Director

Climate & Environmental Science Division

# National Laboratory Science Focus Area Update

- Science Focus Areas (SFAs) include:
  - Climate Change Forcing
  - Climate Change Response
  - Climate Change Modeling
  - Climate Change Mitigation

  } Climate Science Plan
- May 2009 — Science Plans received
- July 9-11, 2009--merit review by external panel
  - 15 panelists from a range of disciplines & institutions
- August 2009—findings and recommendations communicated to lab
  - four decision categories: accept, accept with revisions, revise and resubmit, and reject
  - Triennial review schedule established based on opportunities and need
- Subsurface Biogeochemistry ] Environmental Remediation Science Plan

# Updates on CESD Solicitations

- CLOSED SOLICITATIONS
  - 09-15 Climate Modeling: Simulation at Regional Scale
    - Improve the fidelity of regional climate variability and change simulation
    - Results: 72 applications were received, 17 were funded (Σ = $6.8M)
  - LAB 09-06 Climate Change Modeling
    - Resolution of uncertainties due to climate forcings and feedbacks
    - Results: 7 proposals were received, 3 were funded (Σ = $13M)
  - LAB 08-30 Environmental Remediation Sciences Program
    - Scientific Focus Area: fate and transport of transuranic contaminants
    - Results: 5 proposals were received, 1 was funded ($1.2M)
- ACTIVE SOLICITATIONS
  - 09-07 Environmental Remediation Sciences Program
    - Annual call for fate & transport science for DOE-relevant contaminants
    - Results: 107 applications were received, reviews in process
  - LAB 09-16 Climate Change Research in Terrestrial Ecosystems
    - Engineering approaches to the experimental manipulation of temperature and carbon dioxide concentration in terrestrial ecosystems
    - Status – Closed 7/29/09; 4 full proposals, awards in FY 2010

# Workshop – Next Generation Ecosystem Experiment

- **Several planning meetings with BERAC members – Jim Ehleringer and Jim Tiedje**
- **<u>Criteria</u>:**
  - **In ecosystems that are important globally with respect to potential feedbacks to climate change.**
  - **In ecosystems that are expected to be sensitive to climate change.**
  - **With ecosystem–climate change combinations that have been relatively understudied.**
  - **The location/technology needs to be feasible**
- **<u>Science Priorities—warming & elevated CO2</u> (using criteria above):**
  - **Tropical forest**
  - **Tropical savanna (grassland)**
  - **Boreal forest**
  - **Arctic tundra ◄ this one seems most feasible in near term (ca. 2 years)**

# Workshop – Next Generation Ecosystem Experiment (2)

## RECENT PLANNING ACTIVITIES

**Salt Lake City workshop (hosted by Jim Ehleringer – thank you)**

**Exceptional group of tundra ecologists and large-scale ecosystem experimentalists gathered for a full day of input/discussion:**

**Charles Greer (NRC Canada), John Hobbie (Marine Biological Lab), Dave Lipson (SDSU), Knute Nadelhoffer (U. Michigan), Steve Oberbauer (Florida International U.), Walt Oechel (SDSU), Ted Schuur (U. Florida), Suzanne Simard (U. British Columbia), Gus Shaver (Marine Biological Lab), Kathleen Treseder (UC Irvine), Michael Keller (USFS- NEON), Cheryl Kuske (LANL), Paul Hanson (ORNL), Keith Lewin (BNL), Margaret Torn (LBNL) (rapporteur)**

# Workshop – Next Generation Ecosystem Experiment (3)

- **A warming/elevated CO2 experiment in arctic tundra would be very important to climate change research**
- **The experiment could be built around the high-level question: *What is the overall climate change feedback potential in the arctic? – it could be very large, and involve albedo, CH4, and CO2, at least***
- **"Active layer" thickness and hydrology would be central**
- **The what, how and when of treatments & measurements will be critical**
- **Wide community participation to be facilitated**
- **Next steps**
  - **Technology solicitation**
  - **BER consolidates input and continues working with the community**

# Research and collaboration highlights

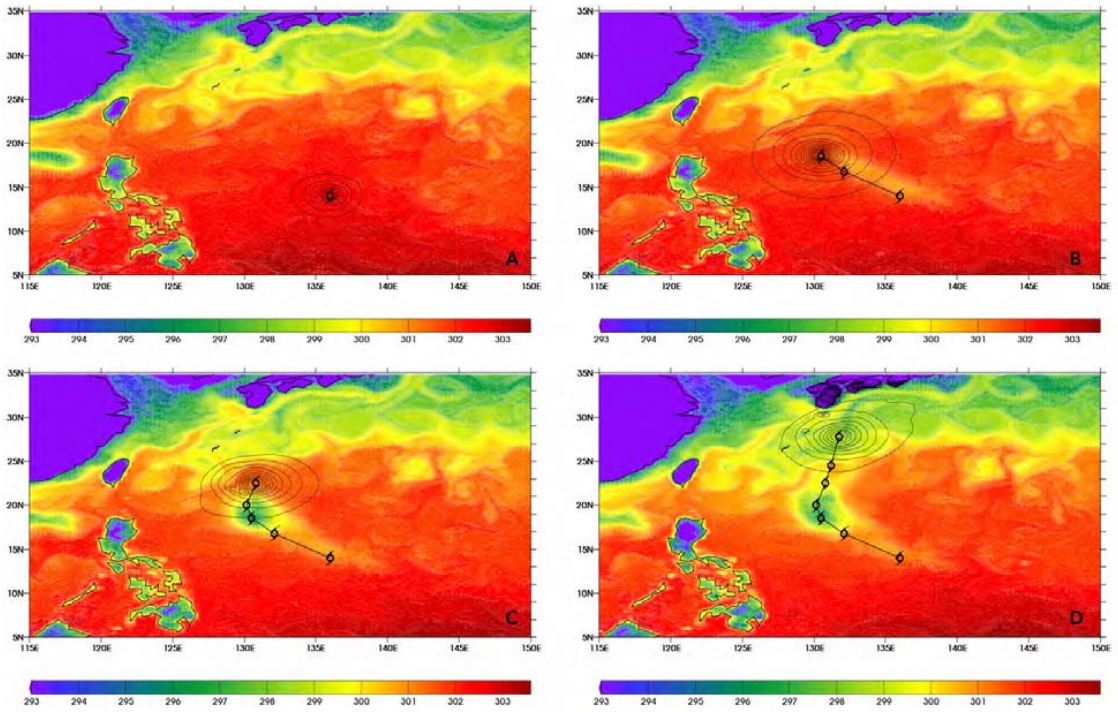
# Climate Modeling at High Resolution

## Objective

- Provide climate models that are able to represent important processes at their native scales

## Approach

- Demonstration of a ultra-high resolution CCSM simulation
- Self-generated tropical cyclone
- Sea surface temperature represented in color and surface pressure by contours
- Cold water upwelling in the storm's wake




## Impact

- Recognizing this as a need for the climate modeling community
- Application to other modeling arenas
- Leverages DOE capabilities in high performance computing

Workshop Report: SCIENTIFIC GRAND CHALLENGES: CHALLENGES IN CLIMATE CHANGE SCIENCE AND THE ROLE OF COMPUTING AT THE EXTREME SCALE
*(workshop Held November 6-7, 2008, Bethesda, MD)* http://www.sc.doe.gov/ober/ClimateReport.pdf

# Carbon cycling in mature forests

## Objective

- Provide adequate understanding of the role of terrestrial biomes in the global carbon cycle

## Approach

- We don't do a good job of representing the role of forests in the global carbon cycle
- Recent results that mature forests continue to take up carbon.
- Other results show that we don't do well representing the impact of fire and other disturbances in forest cycling of carbon.

## Impact

- New way of thinking about/modeling:
  - mature forests
  - disturbance
- Suggests different priority to be placed on such systems.

Luyssaert S., E.D. Schulze, A. Börner, A. Knohl, D. Hessenmöller, B.E. Law, P. Ciais. J.Grace. 2008. Old-growth forests as global carbon sinks. Nature 455: 213-215. doi:10.1038.

# Global warming in boreal forests

## Objective

Understand effects of warming on boreal forests - a topic of importance and present ignorance

## Approach

Warmed (ambient + 5°C) black spruce plots using aboveground chambers (heated air) and belowground heating cables

## Effects of warming (air plus soil)

- Bud burst ca. 10 days earlier in the spring
- Shoot length growth was greater
- Live fine-root biomass was reduced
- Soil-surface $CO_2$ efflux was reduced

## Impact of these unique data

New insights about effects of warming on boreal forest shoot growth, root growth, and soil $CO_2$ release


Bronson DR, et al. (2008) Response of soil surface CO2 flux in a boreal forest to ecosystem warming. Global Change Biology 14:856-867
Bronson DR, et al. (2009) Effect of ecosystem warming on boreal black spruce bud burst and shoot growth. Global Change Biology 15:1534-1543

# Representing Cloud-Radiation Effects in Climate Models

## Objective

- Balance detail with model complexity in representing key processes

## Approach

- Clouds scatter & emit radiation in 3 dimensions
- Current models represent this process in 1 dimension
- Compared radiative impacts for low-level clouds using one- and three-dimensional representations

## Impact

- Simplified approach (1-D) taken by GCM's is adequate (in this case of low level clouds)
- Important implication for the software/hardware battles

•Mechem, D. B., Y. L. Kogan, M. Ovtchinnikov, A. B. Davis, K. F. Evans, and R. G. Ellingson, 2008: Multidimensional longwave forcing of boundary layer cloud systems. J. Atmos. Sci., 65, 3963-3977

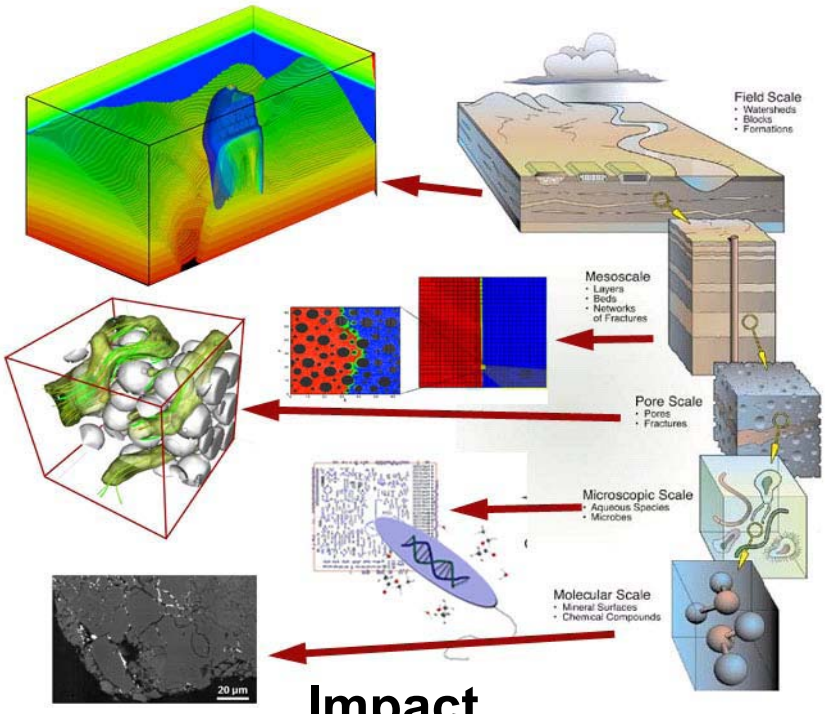
# Integration: Advanced Subsurface Computing

## Objective

- Develop the next generation simulation software to address the challenges faced by DOE's Office of Environmental Management

## Approach

- Modular toolsets that permit accurate representations of governing processes in complex environments
- Computing platform that exploits DOE assets in computing/fundamental science
- New algorithms to simulate coupled physical & biological processes
- Incorporate uncertainty analysis into simulations




## Impact

- Science-based ability to understand and predict subsurface processes
- Transparent, reliable and successful remedial actions, site closure and long-term waste management.

Scientific Opportunities to Reduce Risk in Groundwater and Soil Remediation. E Pierce et al, August 2009
http://www.em.doe.gov/pdfs/GWandS_Science%20Opp_Final_Rev%200.pdf

# ARM Climate Research Facility - update

- ARRA investments
  - Equipment upgrades will make ACRF unique and the most sophisticated atmospheric radiation measurement capability in the world
- Hosted more than 800 users, resulting in over 185 publications in the scientific literature
- Mobile facility currently deployed in the Portuguese Azores islands
- Second mobile facility under construction for deployment in 2010
- Strategic Planning update
- ACRF on Facebook!
  - Search ARM Climate Research Facility in Facebook

# ARM Facility – science accomplishments

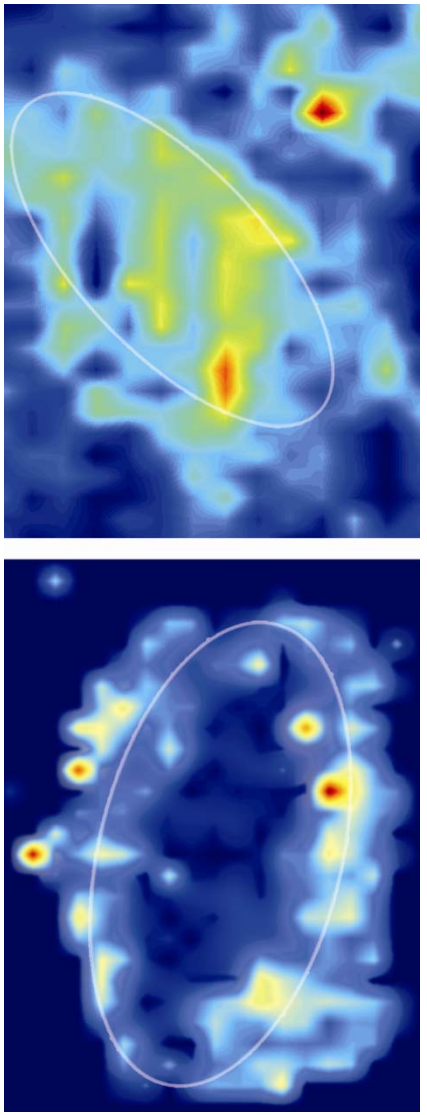
- ACRF experiments in several climatically important regions including the fixed sites and by mobile facilities, Graciosa Island in the Azores, a mountain top in Chile, and in China
- Peer reviewed experiments addressed critical science questions including carbon cycling, marine clouds, low-altitude liquid-water clouds, and climatic effects of aerosols
- Several strong collaborations with other agencies and countries were developed for the conduct of these experiments.

# Environmental Molecular Sciences Laboratory - update

- ARRA investments
  - Recapitalization of aging EMSL infrastructure and expansion with new capabilities
- Hosted approximately 500 users, resulting in over 257 publications in the scientific literature (including 11 journal covers)
- Recognitions and accomplishments
  - David Koppenaal, elected Chair-Elect for the Analytical Chemistry Division for the American Chemical Society.
  - Jean Futrell was selected for the inaugural class of American Chemical Society Fellows
  - Ravi Kukkadapu received two international honors from the Mössbauer spectroscopy community
- Implementing new plans and processes from the 2008 review
- EMSL on Facebook!
  - Search Environmental Molecular Science Laboratory in Facebook

# EMSL - Recent Scientific Highlights

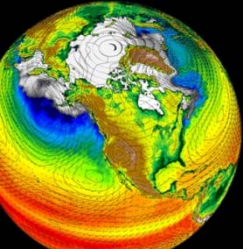
- International team – 6 institutions including Corning and three foreign universities
- Utilized EMSL surface science and imaging capabilities
- Antibody-recognition force microscopy used to map the cytochrome locations of two *Shewanella oneidensis* MR-1 surface proteins
- MtrC is spread across the cell surface (top)
  OmcA is localized at the cell-mineral interface (bottom)
- EMSL's Biogeochemistry Grand Challenge
- Understanding of the role of cytochromes in electron exchange with potential application to bioremediation

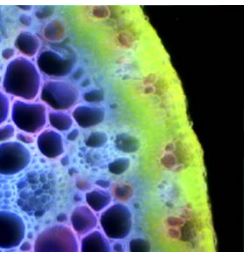
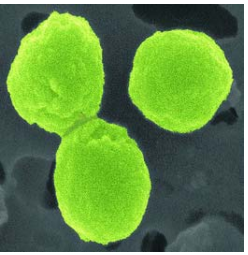


Lower BH, R Yongsunthon, L Shi, L Wildling, HJ Gruber, NS Wigginton, CL Reardon, GE Pinchuk, TC Droubay, JF Boily, and SK Lower. 2009. "Antibody Recognition Force Microscopy Shows that Outer Membrane Cytochromes OmcA and MtrC Are Expressed on the Exterior Surface of Shewanella oneidensis MR-1." Applied and Environmental Microbiology 75(9)2931-2935. DOI:10.1128/AEM.02108-08. This research was featured on the journal's May 1, 2009 cover

# Highlights & Excitement

- Personnel changes
- Science accomplishments
- SFA implementation
- ARRA investments in ACRF, EMSL and IA computing
- Deployment of the second ARM mobile facility
- Next Generation Ecosystem Experiment



# Thank you

# Questions?