

# The State of BER

## February 16, 2012

**Sharlene Weatherwax**  
Associate Director of Science  
Biological and Environmental Research



U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

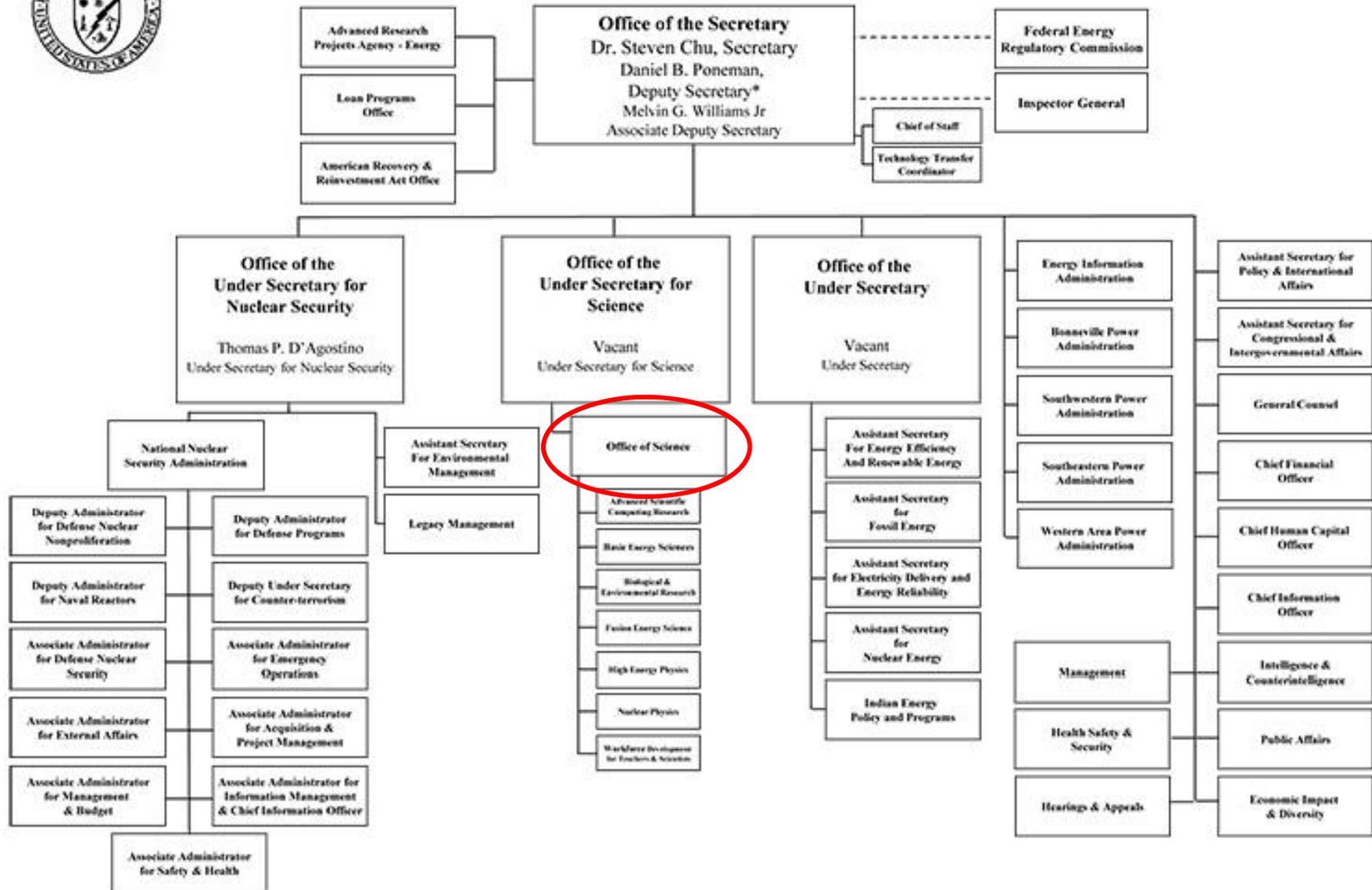
Office of Biological  
and Environmental Research

# Presentation outline

1. BER 101
2. FY 2012 Appropriation
3. FY2013 Request
4. Awards
5. Personnel updates



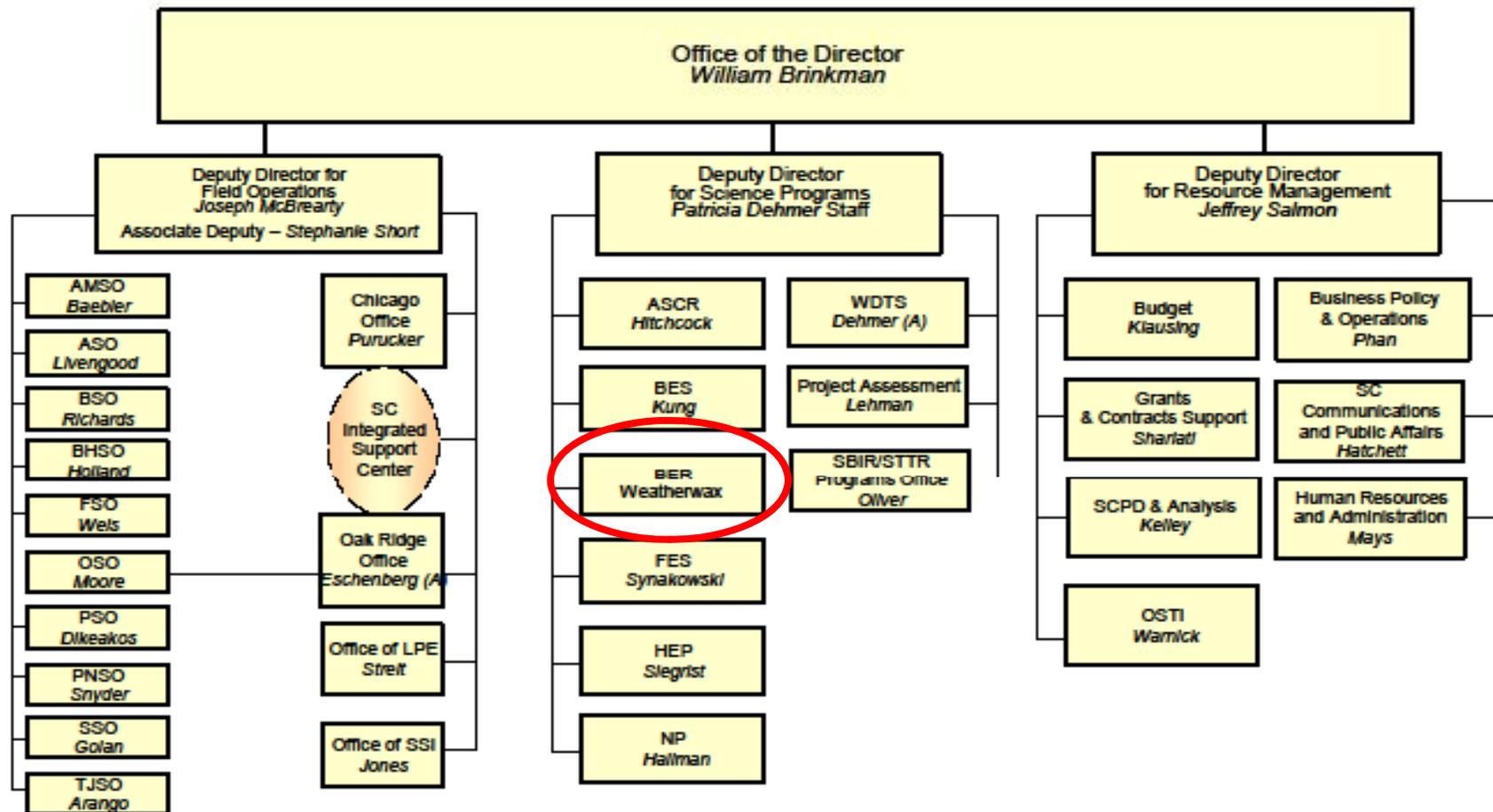
# DEPARTMENT OF ENERGY



\* The Deputy Secretary also serves as the Chief Operating Officer

06 Dec 11

# DOE Office of Science



**Office of Biological & Environmental  
Research**  
**Sharlene Weatherwax**  
 Associate Director  
 Kathy Holmes, Administrative Specialist

Associate Director Office Staff Contacts  
 Michael Riches  
 Sr. Technical Advisor  
 David Thomassen  
 Chief Scientist

**Biological Systems Science  
Division**

**Joseph Graber, Acting Director**  
 Joanne Corcoran, Program Support Specialist  
 Terry Jones, Secretary  
 Vacant Scientific Program Specialist

**Climate and Environmental  
Sciences Division**

**Gary Geernaert, Director**  
 Karen Carlson-Brown, Program Support Specialist  
 Leslie Runion, Program Support Specialist  
 Vacant, Secretary  
 Patrick Horan, Scientific Program Specialist

**Foundational & Analytical Genomic Science**  
 Joseph Graber  
 Susan Gregurick  
 Roland Hirsch  
 Arthur Katz  
 Elizabeth White  
**Vacant, Molecular Biologist**  
 Pablo Rabinowicz, IPA

**Bioenergy Research Centers**  
 Cathy Ronning  
 Susan Gregurick  
 Joseph Graber  
 Michael Teresinski

**Metabolic Synthesis and Conversion**  
 Joseph Graber  
 Arthur Katz  
 Cathy Ronning

**Computational Biosciences**  
 Susan Gregurick

**Radiochemistry and Imaging**  
 Prem Srivastava  
 Dean Cole

**Radiobiology Research**  
 Noelle Metting

**Joint Genome Institute—JGI**  
 Dan Drell  
 Susan Gregurick

**Structural Biology Infrastructure**  
 Roland Hirsch

**Lab & Facility Safety**  
 Michael Teresinski

**Human Subjects**  
 Elizabeth White

**SBIR/STTR**  
 John Houghton  
 Dean Cole

**Atmospheric System Research**  
 Ashley Williamson  
**Vacant, Physical Scientist**

**Earth System Modeling**  
 Dorothy Koch

**Regional Climate Modeling**  
 Renu Joseph

**Integrated Assessment**  
 Robert Vallario

**Subsurface Biogeochemical Research**  
 Todd Anderson  
 David Lesmes  
 Paul Bayer

**Atmospheric Radiation Measurement Infrastructure**  
 Wanda Ferrell  
 Rick Petty

**Environmental Molecular Sciences Laboratory**  
 Paul Bayer

**Terrestrial Ecosystem Science**  
 Mike Kuperberg  
 Dan Stover

**Climate Information & Data Management**  
 Wanda Ferrell

**BER General Plant Projects/ General Project Equipment**  
 Paul Bayer

**SBIR/STTR**  
 Rick Petty

# Biological and Environmental Research Subprograms

## Biological Systems Science

- Genomic Science
  - *Bioenergy Research Centers*
- Radiological Sciences
- Joint Genome Institute (JGI)
- Structural Biology Infrastructure

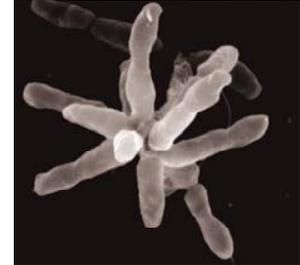
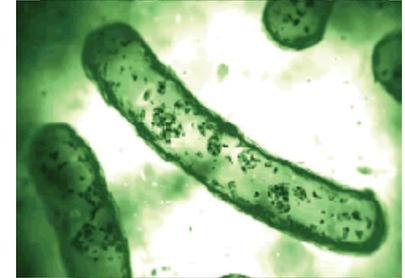
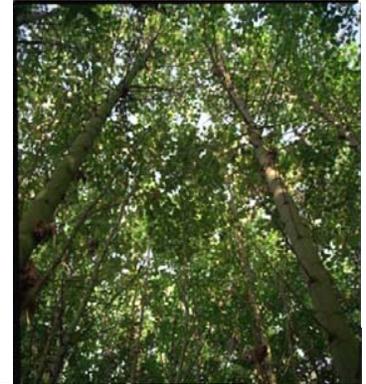
## Climate and Environmental Sciences

- Atmospheric System Research
- Environmental System Science
- Climate & Earth System Modeling
- Atmospheric Radiation Measurement (ARM) Climate Research Facility
- Environmental Molecular Sciences Laboratory (EMSL)

# Biological Systems Science

## Genomic Science

- Understand the nature of biomass recalcitrance and enable development of cellulosic biomass crops
- Discover novel microbes and enzymes for improved breakdown of biomass to component sugars
- Design and metabolic engineering of microbial systems for next generation biofuels synthesis
- Knowledgebase - A framework for data collection, integration and analysis tools to enable the simplified use of large scale genome and genome enabled information
- Bioenergy Research Centers



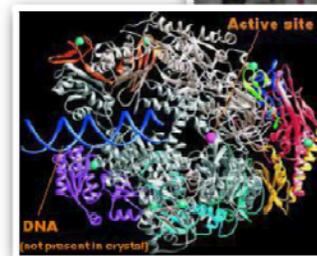
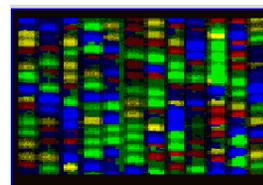
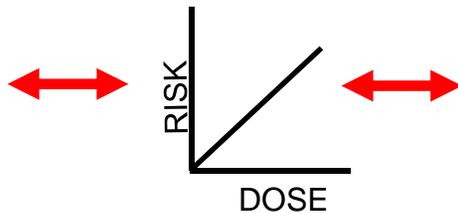
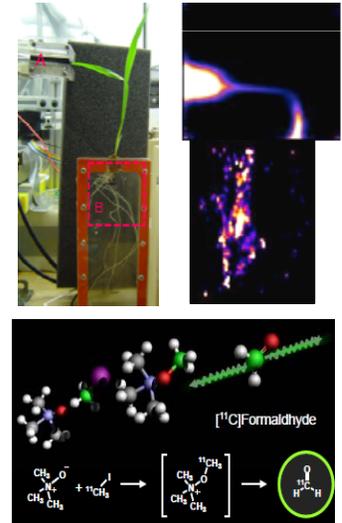
# Biological Systems Science

## Radiological Sciences

- Research in radiochemistry and radiotracer development to develop new methods for real-time, high resolution imaging of dynamic biological systems
- Systems level understanding of radiation-induced perturbations of physiological processes

## Structural Biology Infrastructure

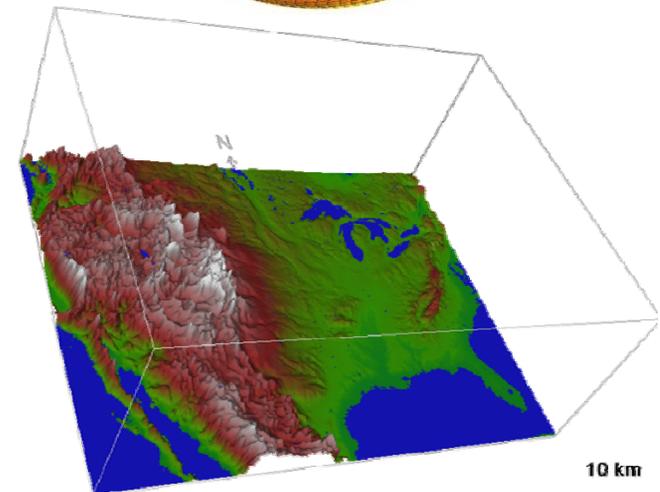
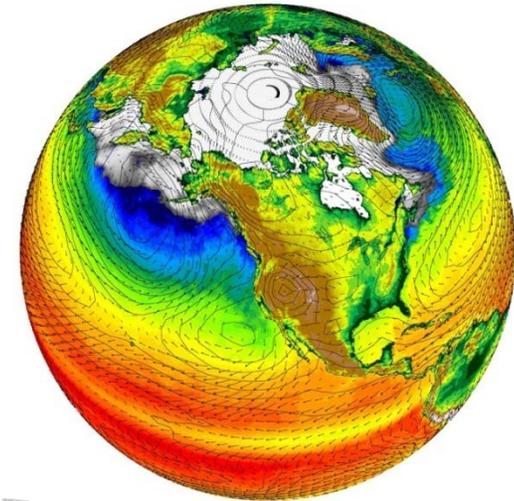
- Support of synchrotron and neutron beamlines for structural analysis of key biomolecules and complex cellular components



# Climate & Environmental Sciences

## Climate & Earth System Modeling

- Develop models with strong theoretical foundations
- Improve representations of key climate processes
- Develop diagnostic methods and tools to evaluate models
- Test and apply coupled climate and Earth system models that stay at leading edge of scientific knowledge
- Increase fidelity and throughput of climate change projections

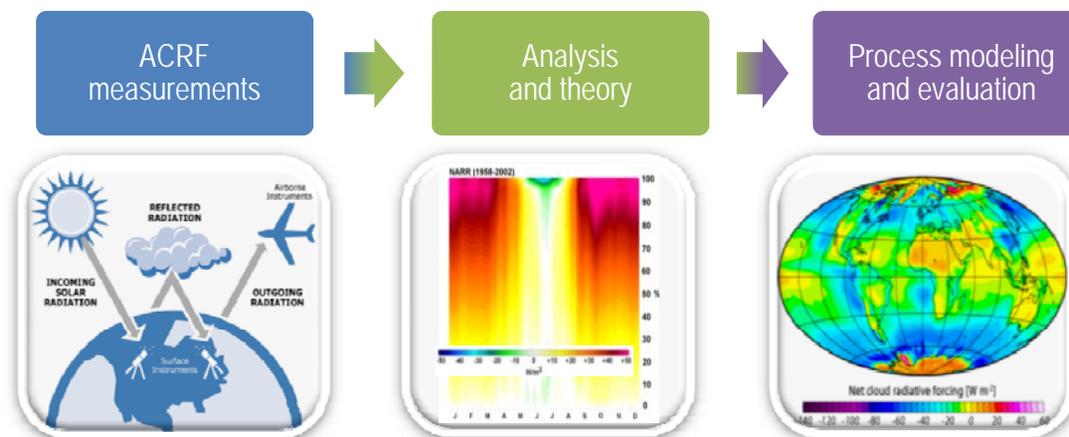


# Climate & Environmental Science



## Atmospheric Systems Research

- Use of Atmospheric Radiation Measurement (ARM) Climate Research Facility short- and long-term climate measurements
- Analysis, theory, process modeling, and retrospective climate simulations and evaluations
- Enhanced cloud and radiation formulations used to improve decadal climate predictions
- Improved scientific understanding of the atmospheric processes that drive aerosol radiative forcing of climate, including laboratory and field experiments, modeling, and instrumentation

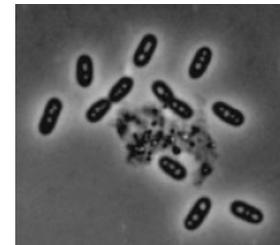
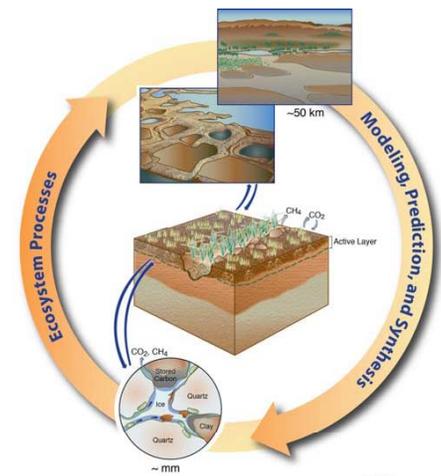


# Climate & Environmental Sciences

## Environmental Systems Science

Provides scientific understanding of:

- the effects of climate change on terrestrial ecosystems
- the role of terrestrial ecosystems in global carbon cycling
- the role of subsurface biogeochemical processes determining flow and transport in the subsurface and how the subsurface and above ground environments interact.
- Support for the Arctic Next Generation Ecosystem Experiment (NGEE) to improve the representation of the major carbon sinks associated with changes in Arctic permafrost ecosystems in Earth system and regional climate models.
- Initiate second NGEE focused on climatically-sensitive tropical region examining the role of rainfall stress on Amazonian ecosystems and the resulting shifts in released aerosols that serve as cloud condensation nuclei.



# BER Scientific User Facilities

## Joint Genome Institute

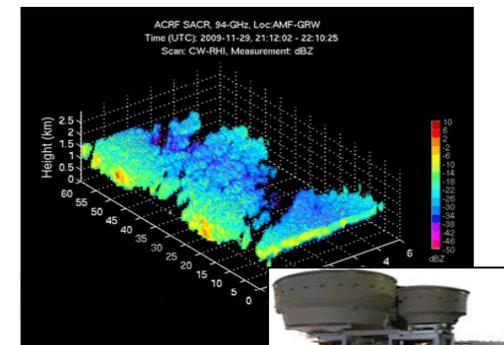
- Using high throughput tools, technologies and comparative analysis, the JGI serves as a discovery platform to understand the organization and function of complex genomes for bioenergy, carbon cycle, and bioremediation.

## ARM Climate Research Facility

- Provides the world's most comprehensive 24/7 observational capabilities for obtaining atmospheric data for climate change research.
- Data transformed understanding of aerosol-cloud interactions. Built most advanced parameterizations of atmospheric radiative transfer.

## Environmental Molecular Sciences Laboratory

- Integrated experimental and supercomputing capabilities enable users to study molecular-level processes underpinning energy, science, and environmental challenges



# Interagency Activities – many key partnerships

- **Planning**
- **Coordination**
- **Funding Opportunity Announcements**

## Biological Systems Science

- USDA for plant feedstock genomics research
- Biomass Research and Development Board (11 agencies)
- Radiobiology with NIH
- ...and more

## Climate and Environmental Sciences

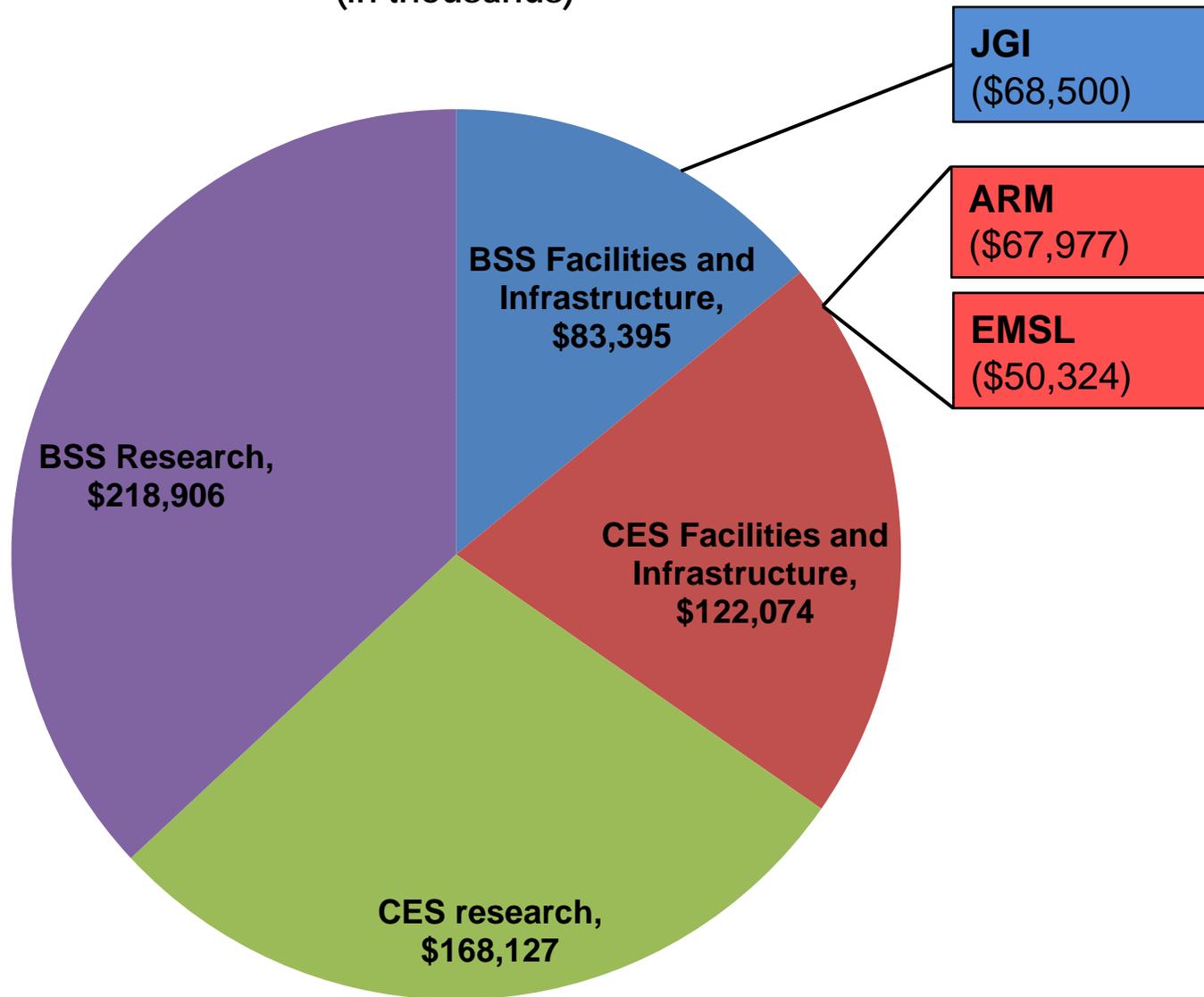
- With the 13 agency US Global Change Research Program
- Strategic Environmental Research and Development Program - DOD, EPA
- Joint climate modeling solicitation – NSF, USDA
- DOE – Energy Efficiency & Renewable Energy, Fossil Energy, Policy
- Department of Defense – Navy, Veterans Affairs
- ...and more

# International partnerships

- MOU between the Indian Institute of Science and the Aryabhata Research Institute of Observational Sciences and the Department of Energy for cooperation in ARM
- MOU in development with Brazil for GOAmazon.
- Cooperates on Climate Science under the *PROTOCOL FOR THE COOPERATION IN THE FIELD OF FOSSIL ENERGY TECHNOLOGY DEVELOPMENT AND UTILIZATION* with the Chinese Academy of Sciences and the China Meteorological Administration.
- US – EC Biotechnology Task Force

# FY 2012 BER Appropriation

(in thousands)



# Biological and Environmental Research

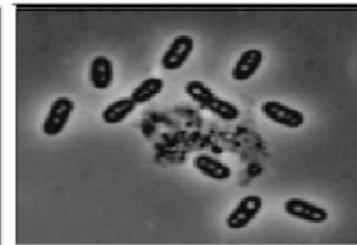
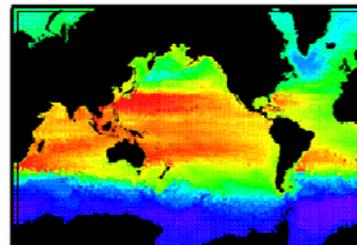
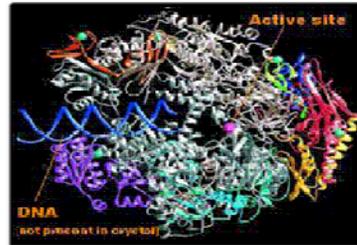
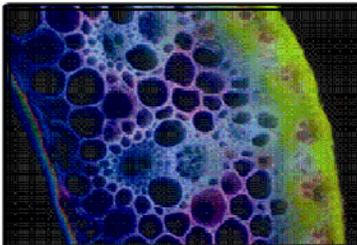
Understanding complex biological, climatic, and environmental systems across vast spatial and temporal scales

## The Scientific Challenges:

- Understand how genomic information is translated to functional capabilities, enabling more confident redesign of microbes and plants for sustainable biofuel production, improved carbon storage, or contaminant remediation.
- Understand the roles of Earth's biogeochemical systems (atmosphere, land, oceans, sea ice, subsurface) in determining climate so we can predict climate decades or centuries into the future, information needed to plan for future energy and resource needs.

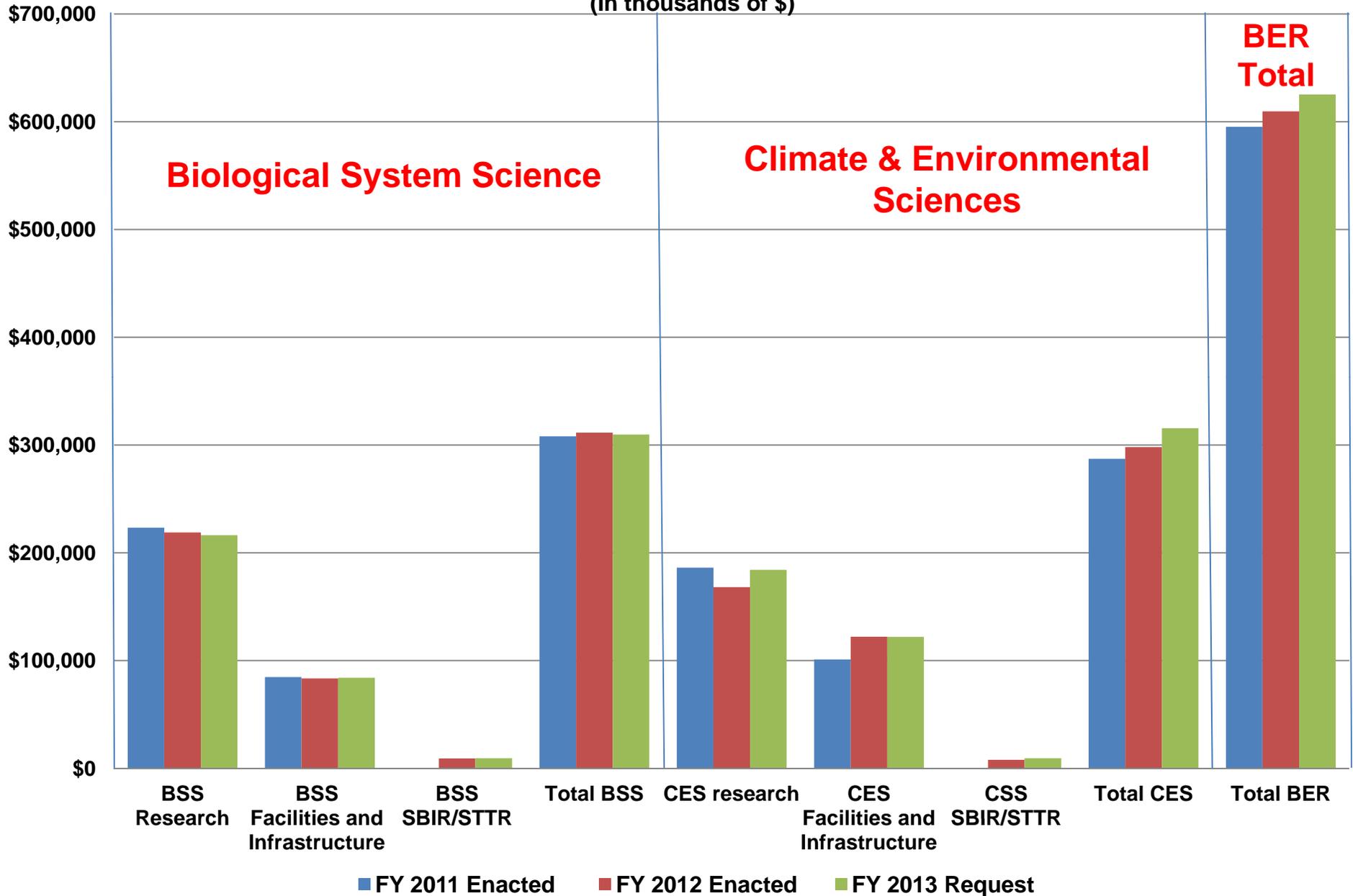
## FY 2013 Highlights:

- Clean energy biodesign on plant and microbial systems through development of new molecular toolkits for systems and synthetic biology research.
- Research and new capabilities to develop comprehensive environmental system models in the Arctic and tropics, regions especially vulnerable to rapid climate change.
- Continue support for the three DOE Bioenergy Research Centers, and operations of the Joint Genome Institute, the Environmental Molecular Sciences Laboratory, and the Atmospheric Radiation Measurement Climate Research Facility.



# BER Funding Profile

(In thousands of \$)



# Bioenergy Research Centers



- Two phase onsite reviews recently completed. (1) Year 4 progress review. (2) Renewal proposal for years 6-10. 7-9 reviewers on each of three different panels (one reviewer in common).
- BRCs have each made substantial and impressive progress during first 4 years, enabled by the unique, integrative nature of each Center.
- Results from each are distinct yet complementary, reflecting specific research emphases of each Center and different approaches toward enabling efficient, sustainable bioenergy production
- BRCs have reached out to bioenergy industry creating links for future commercialization.
- BRCs are encouraged to forge a strong linkage to the DOE Systems Biology Knowledgebase.
- BRCs are encouraged to develop & maintain interactive websites to communicate scientific accomplishments & societal impacts to the public.
- BRCs are encouraged to maintain their core research focus and to continue coordination with the other BRCs.
- BER recommends execution of the BRCs research plans for Years 5-10 following established guidelines.

# Discovery of a New Type of Lignin

## Objective:

Investigate plasticity of lignin biosynthesis to enable engineering of increased biomass digestibility.

## Approach:

- Discovered novel lignin polymer constructed almost entirely from catechyl (C) units (C-lignin).
- C-lignin is a major component of *V. planifolia* seed coat, while other tissues have typical angiosperm G/S lignins.
- Detection of C-lignin in both monocots and dicots suggests a simple mechanism for derailment of monolignol pathway towards caffeyl alcohol production.



**Results:** These results will enable greater understanding of the lignin biosynthetic pathway as well as new approaches for engineering biomass that can be more easily and efficiently digested for conversion into biofuels.

F Chen, Y Tobimatsu, D Havkin-Frenkeld, RA Dixon, J Ralph. (2012) *Proc Natl Acad Sci USA* doi/10.1073/pnas.1120992109.

# Identifying Human Influence on Extreme Precipitation

## Objective

To search for anthropogenic influence on the observed changes in extreme precipitations that can have devastating impact on human society and the environment

## Research

- We compared observations and multiple climate model simulations forced with observed green-house gas increase using an optimal fingerprinting technique
- We find consistent increasing trends between observed and model simulated extreme precipitations over the large part of Northern Hemisphere lands during 1951-1999

Min, S.-K., X. Zhang, F. W. Zwiers, and G. C. Hegerl, 2011: Human contribution to more-intense precipitation extremes. *Nature*, **470**, 378-381, doi:10.1038/nature09763

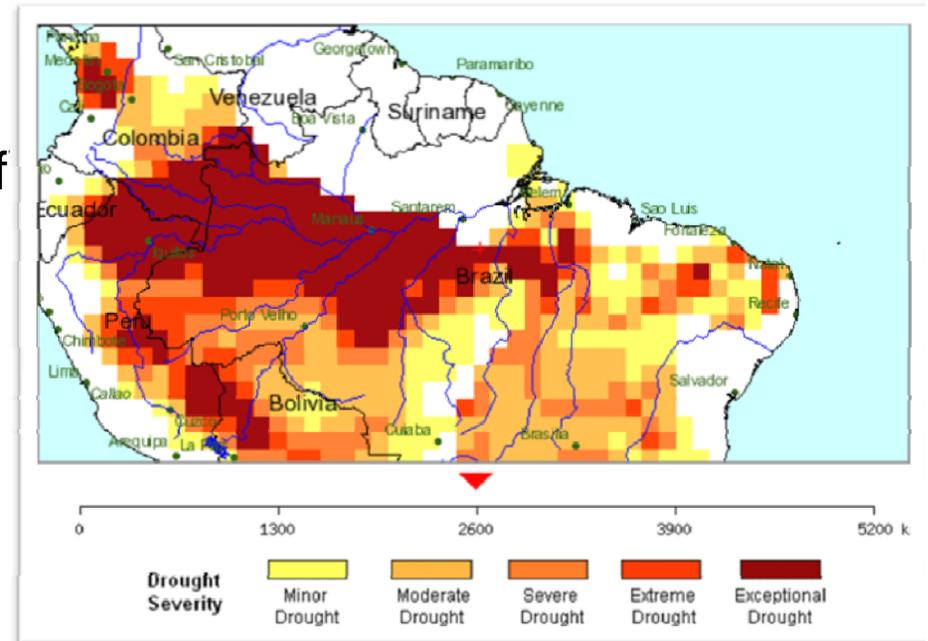


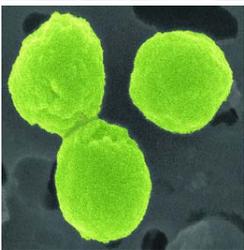
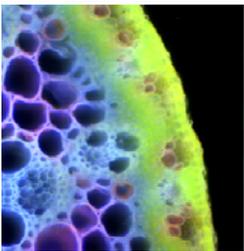
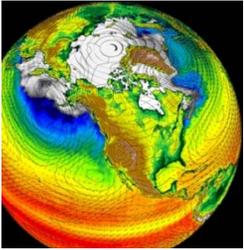
## Impact

This provides the first scientific evidence that human-induced increase in greenhouse gases have contributed to the observed intensification of heavy precipitation events. **Featured as the main story and cover picture in the Feb. 17, 2011 issue of Nature**

# NGEE-Tropics

- Tropical ecosystems comprise 40% of the Earth's land surface area and are responsible for numerous biases in current ESM's
- Tropical forests store significant amounts of C (~3 Gt/yr) which are vulnerable to predicted changes in land-use, temperature, drought, nutrient limitations and fire
- Current models suggest increased drought in the Amazon and increase precipitation in Southeast Asia
- Spatial and temporal variability necessitate a decadal effort to understand these processes and improvements to model representations of tropical processes
- Improved representation of tropical systems will help global climate predictions and thereby inform energy and carbon mitigation and adaptation strategies for the US





# Award



U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

Office of Biological  
and Environmental Research

# E.O. Lawrence Award

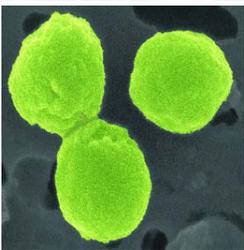
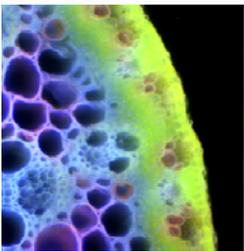
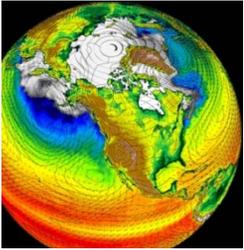


In Biological and Environmental Sciences:

For ground-breaking radiocarbon measurements of corals, advancements in understanding the paleo-history of ocean currents and ocean processes revealing past climate variability, and the elucidation of how physical and biogeochemical oceanic processes affect the global carbon cycle.

## **Tom Guilderson**

Lawrence Livermore  
National Laboratory



# Personnel Updates



U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

Office of Biological  
and Environmental Research

# BERAC Membership



**Bob Dickinson**  
2006-2011



**Stephen Padgette**  
2007-2011



**Joanna Fowler**  
2004-2011



**Peg Riley**  
2006-2011



**Paul Gilna**  
2009-2011



**Mavrik Zavarin**  
2006-2011

**Thank You to Outgoing Members!**



**Gaius (Gus) Shaver** – (Marine Biological Laboratory, Woods Hole, MA)  
**New member not able to attend**

# BER Personnel updates

- **BSSD Director**
  - Selection process is ongoing for a permanent Director
  - Acting directors—Thank You!



Susan Gregurick  
10/2011 – 1/2012



Joe Graber  
2/2012 – ~5/2012

- **BSSD Science Assistant--Shireen Yousef left 1/2012**



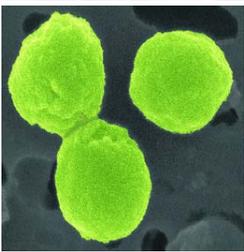
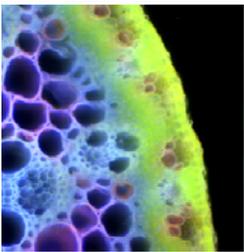
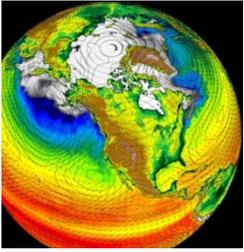
- **New Family Members!**



Colin & Patrick Horan



Lucas— Mike Riches' grandson



# Biological and Environmental Research:

- Trans-disciplinary science
- Systems-based, data intensive and diverse research
- World class, high impact user facilities
- Scientific partnering to meet DOE mission needs



U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

Office of Biological  
and Environmental Research