

Biological and Environmental Research

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U.S. DEPARTMENT OF
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ENERGY
LEADING BASIC RESEARCH
FOR A SUSTAINABLE FUTURE

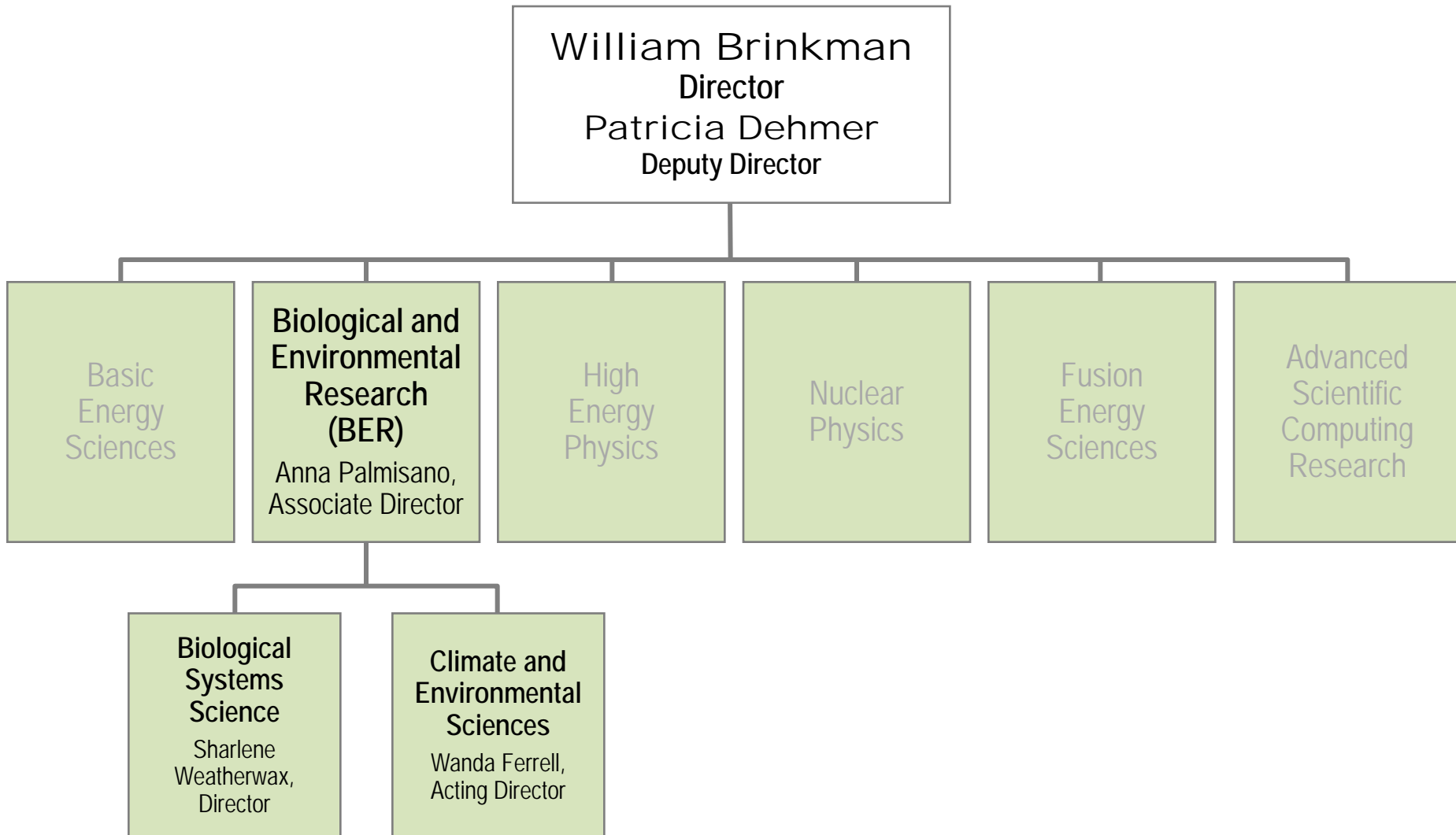
ENVIRONMENT
UNDERSTANDING CLIMATE CHANGE AND
IMPROVING THE ENVIRONMENT

INNOVATION
BUILDING RESEARCH INFRASTRUCTURE AND
PARTNERSHIPS THAT FOSTER INNOVATION

DISCOVERY
UNRAVELING NATURE'S
DEEPEST MYSTERIES

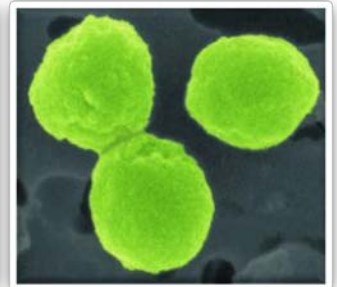
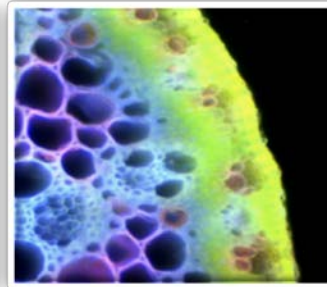
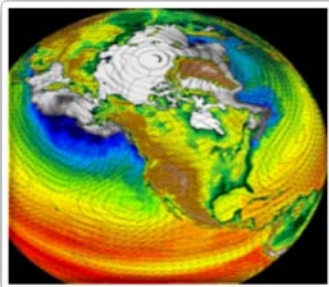
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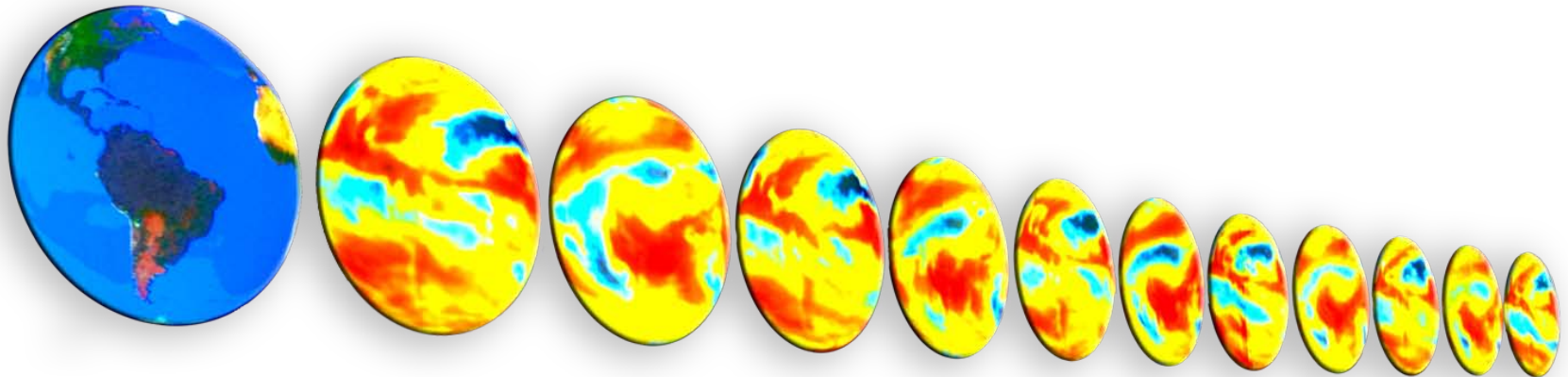
Biological and Environmental Research Mission

- To understand complex biological, climatic, and environmental systems across spatial and temporal scales.
- BER provides the foundational science to:
 - Support the development of biofuels as major, secure, and sustainable national energy resources
 - Understand the potential effects of greenhouse gas emissions on Earth's climate and biosphere and the implications of these emissions for our energy future
 - Predict the fate and transport of contaminants in the subsurface environment at DOE sites
 - Develop new tools to explore the interface of biological and physical sciences



Biological and Environmental Research Approach

- Understanding complex biological and environmental systems across many spatial and temporal scales:
 - From the sub-micron to the global
 - From individual molecules to ecosystems
 - From nanoseconds to millennia
- Integrating science by tightly coupling theory, observations, experiments, models, and simulations
- Supporting interdisciplinary research to address critical national needs
- Engaging national laboratories, universities, and the private sector to generate the best possible science



Biological and Environmental Research

Budget

Appropriations		FY10	FY11
Research	Biological Systems	\$166M	\$169M
	Bioenergy Research Centers	\$75M	\$75M
	Climate Change Research	\$134M	\$150M
	Subsurface Biogeochemical Research	\$50M	\$50M
	Total	\$425M	\$444M
Facilities: Scientific User Facility Operations	Joint Genome Institute (JGI)	\$69M	\$69M
	ARM Climate Research Facility	\$42M	\$46M
	Environmental Molecular Sciences Laboratory (EMSL)	\$52M	\$51M
	Total	\$163M	\$166M
Other	(e.g., Small Business Innovation Research)	\$16M	\$17M
Total BER		\$604M	\$627M

Biological and Environmental Research Divisions

Biological Systems Science Division

- Genomic Science Program
- Bioenergy Research Centers
- DOE Joint Genome Institute
- Low Dose Radiation
- Radiochemistry, Imaging, and Instrumentation
- Structural Biology

Climate and Environmental Sciences Division

- Climate Change Research
- ARM Climate Research Facility
- Subsurface Biogeochemical Research
- Environmental Molecular Sciences Laboratory

BER Climate Change Research

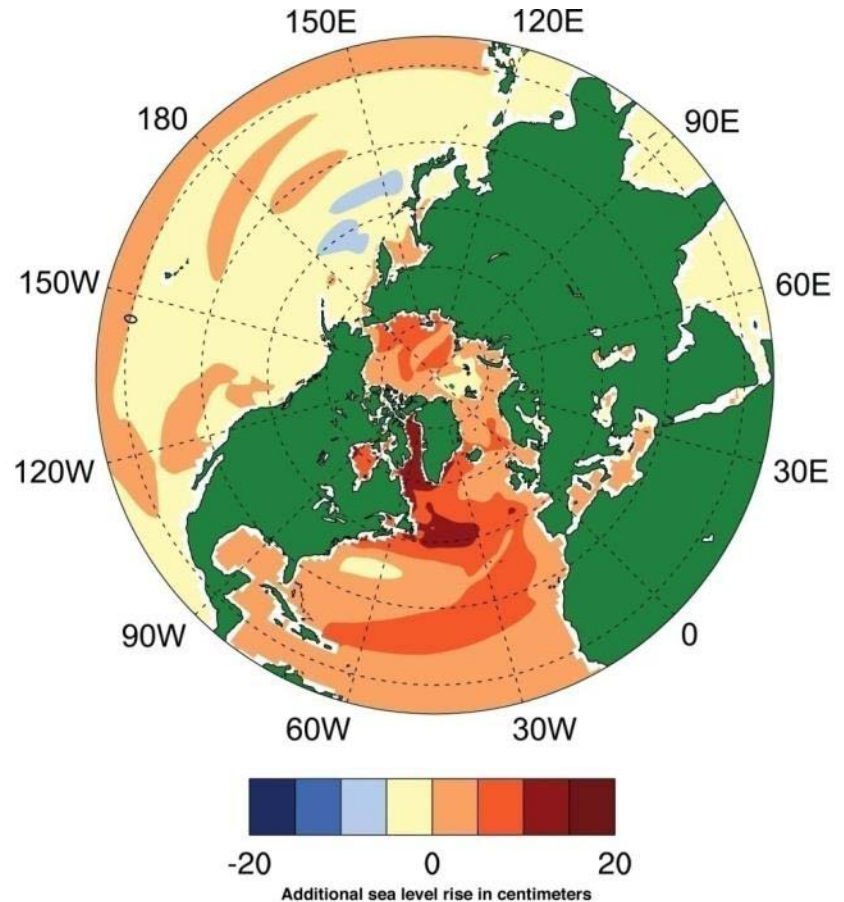
Strategic themes

1. Atmospheric System Research
2. Environmental System Science
3. Climate and Earth System Modeling
4. Facilities and Infrastructure



BER Climate Change Research: The energy-climate connection

“Advance climate change research to provide knowledge of effects of greenhouse gas emissions on Earth’s climate and biosphere—supporting effective energy and environmental decision making”



Modeling the impacts of climate change
Sea-level rise modeled with the
Community Climate System Model

Atmospheric Research – Facility/Research

- Objective: Improve scientific understanding of the radiation balance from the surface of the Earth to the top of the atmosphere and how this balance is affected by clouds, aerosols, and increases in the concentration of greenhouse gases in the atmosphere.
- Two components
 - ARM Climate Research Facility (ACRF)
 - Atmospheric System Research

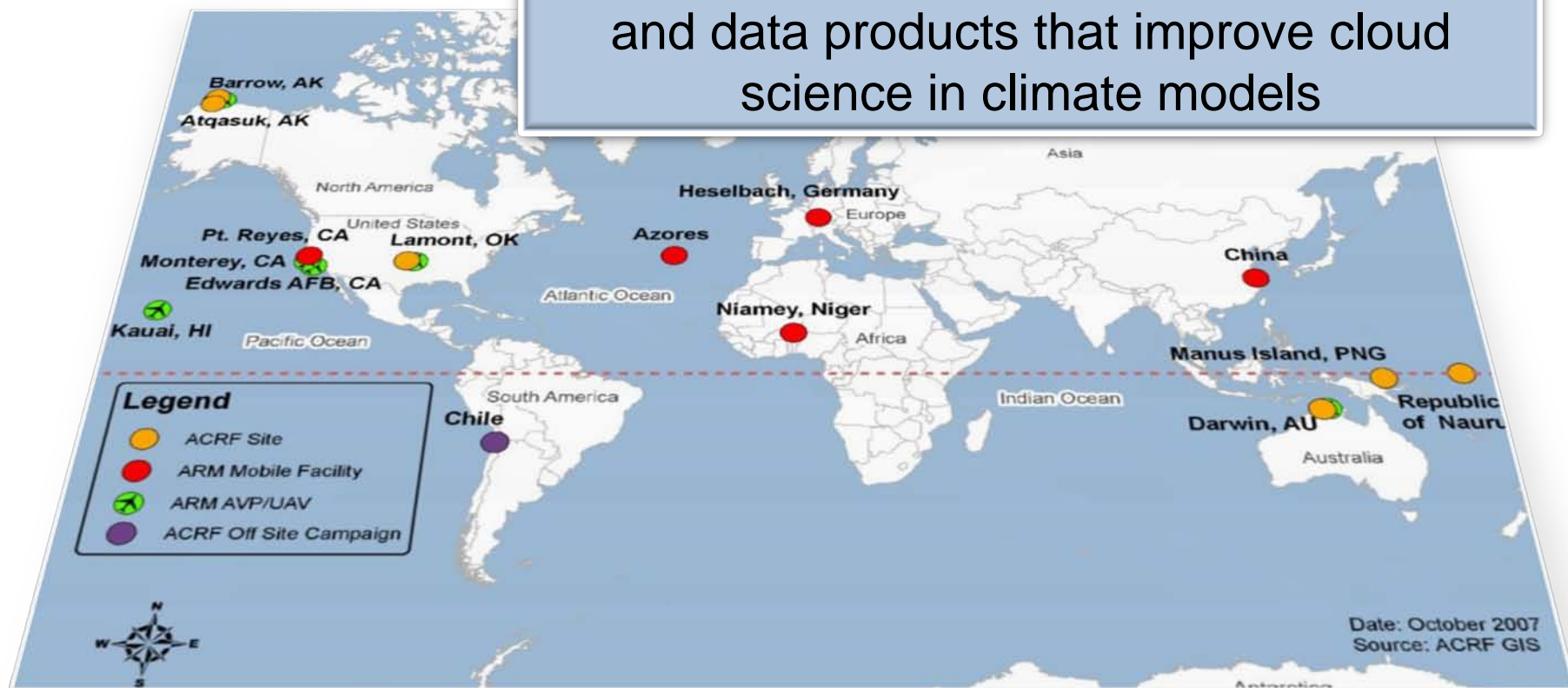
Radar Wind Profiler and radio acoustic sounding system (RASS), Barrow, Alaska



DOE Scientific User Facility ARM Climate Research Facility



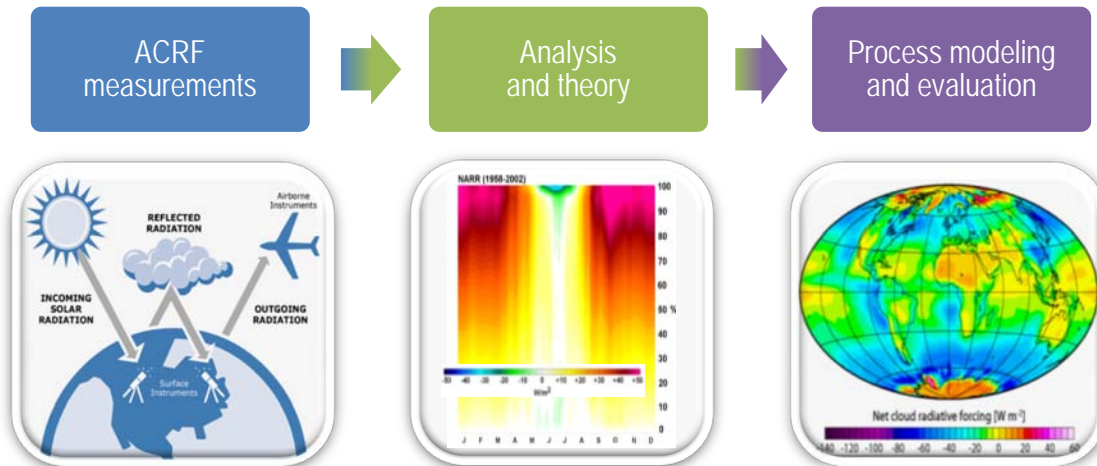
Provides continuous field measurements and data products that improve cloud science in climate models



Atmospheric System Research



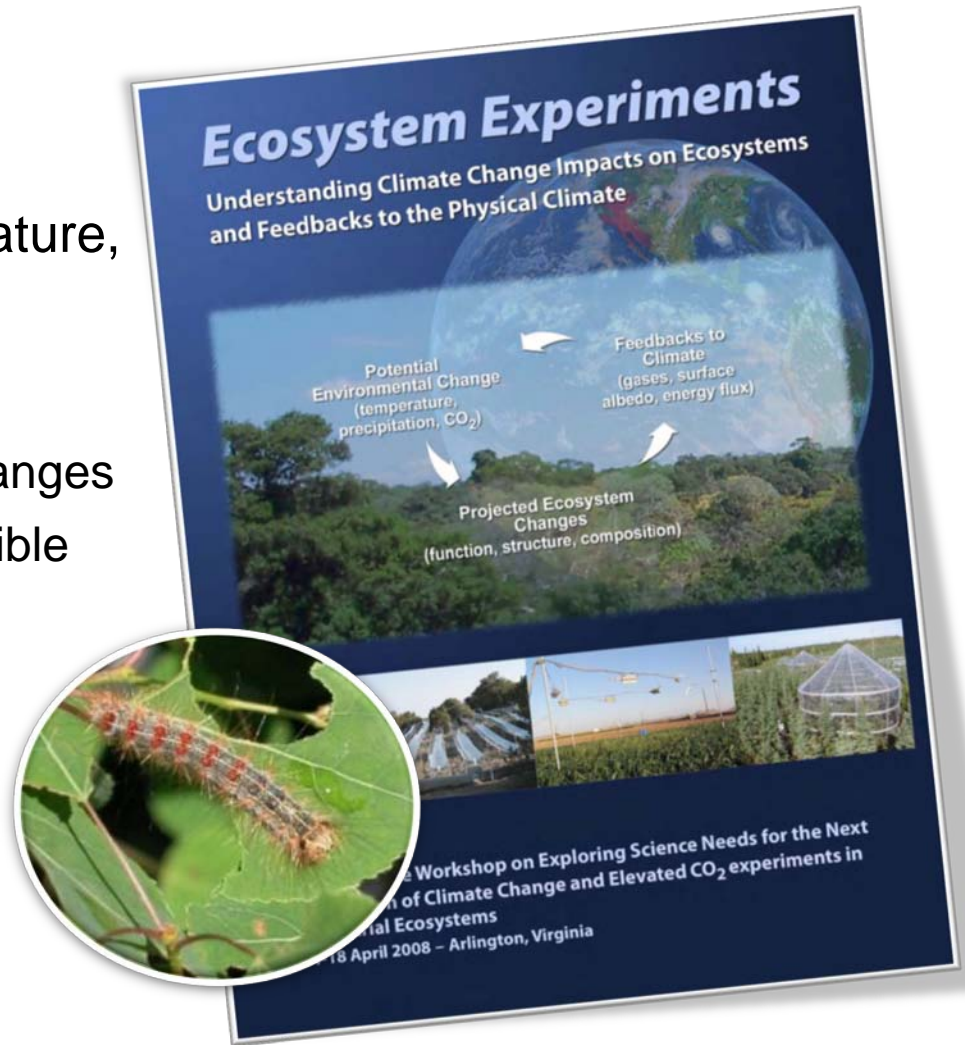
- Use of ACRF short- and long-term climate measurements
- Analysis, theory, process modeling, and retrospective climate simulations and evaluations
- Enhanced cloud and radiation formulations used to improve decadal climate predictions
- Improved scientific understanding of the atmospheric processes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



Environmental System Science

Terrestrial Ecosystem Science – Impacts

- Develop and sustain unique, long-term, and ecosystem-scale experiments manipulating temperature, precipitation, and CO₂ levels
 - Quantify effects of warming on abundance of plant and animal species across their geographic ranges
 - Understand mechanisms responsible for plant mortality and altered plant-insect interactions induced by climate change
 - Quantify effects of warming on northward migration of plant species critical to ecosystem health



Terrestrial Ecosystem Science – CO₂ Fluxes

- Experimental and field-oriented program to:
 - Understand processes and mechanisms controlling the exchange of CO₂ between the atmosphere and terrestrial ecosystems
 - Develop process-based models
 - Improve reliability of global carbon models



CO₂ flux towers
and instrumentation

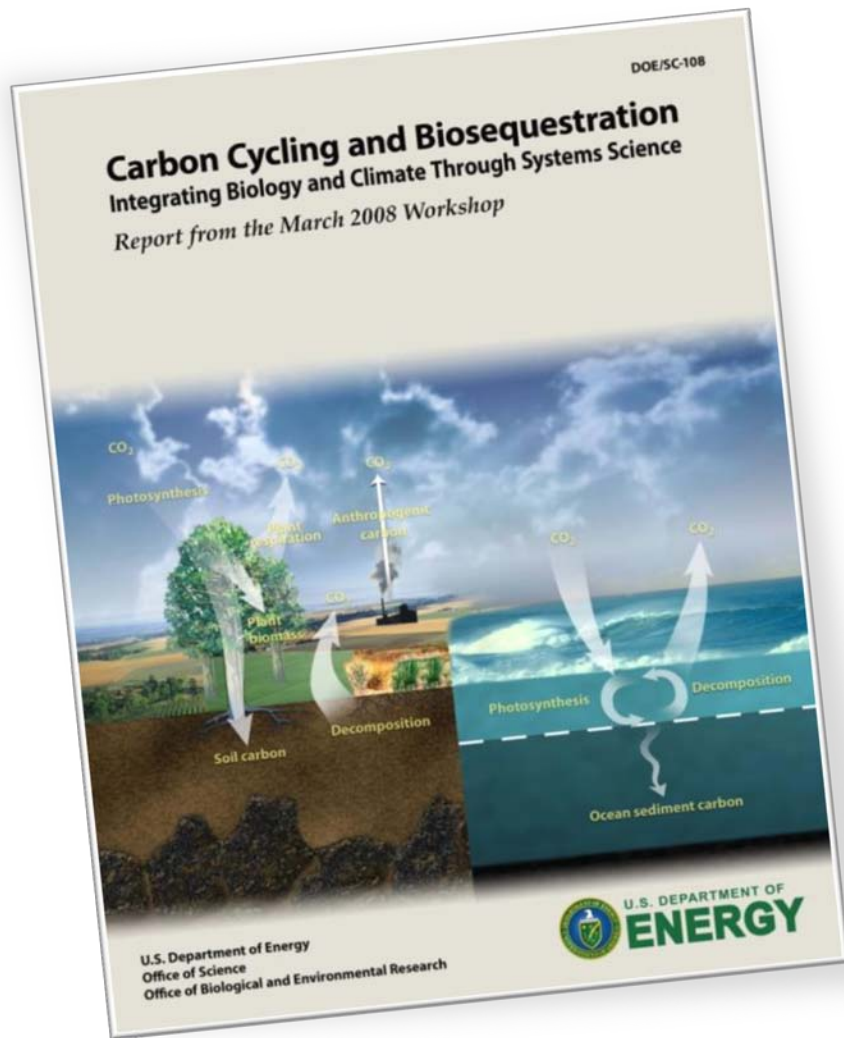
Terrestrial Carbon Biosequestration Research

- Supports basic research to understand how natural processes that control carbon biosequestration in terrestrial vegetation and soils can be modified to enhance sequestration
- DOE is the lead agency in the U.S. Climate Change Technology R&D Program



Workshop jointly held by two BER programs

Diverse scientific community provided input

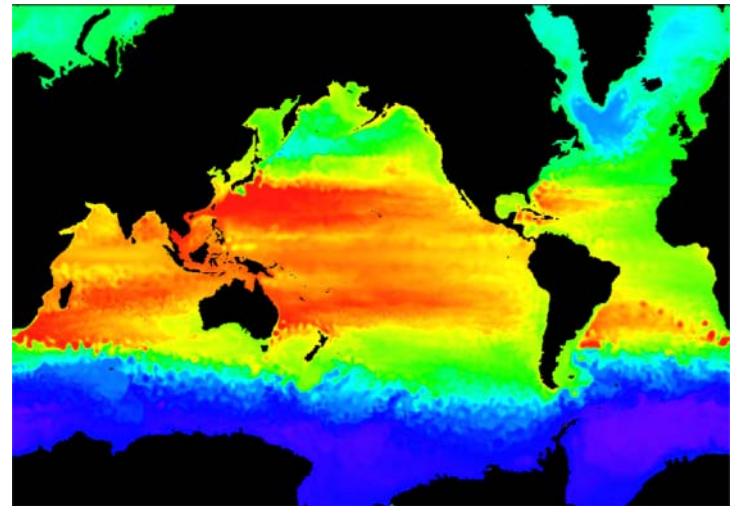
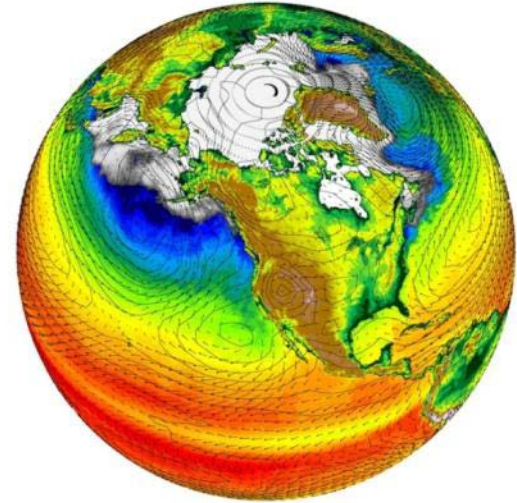


Understanding natural carbon cycle and biosequestration processes requires an integration of biology and climate through systems science

Climate and Earth System Modeling

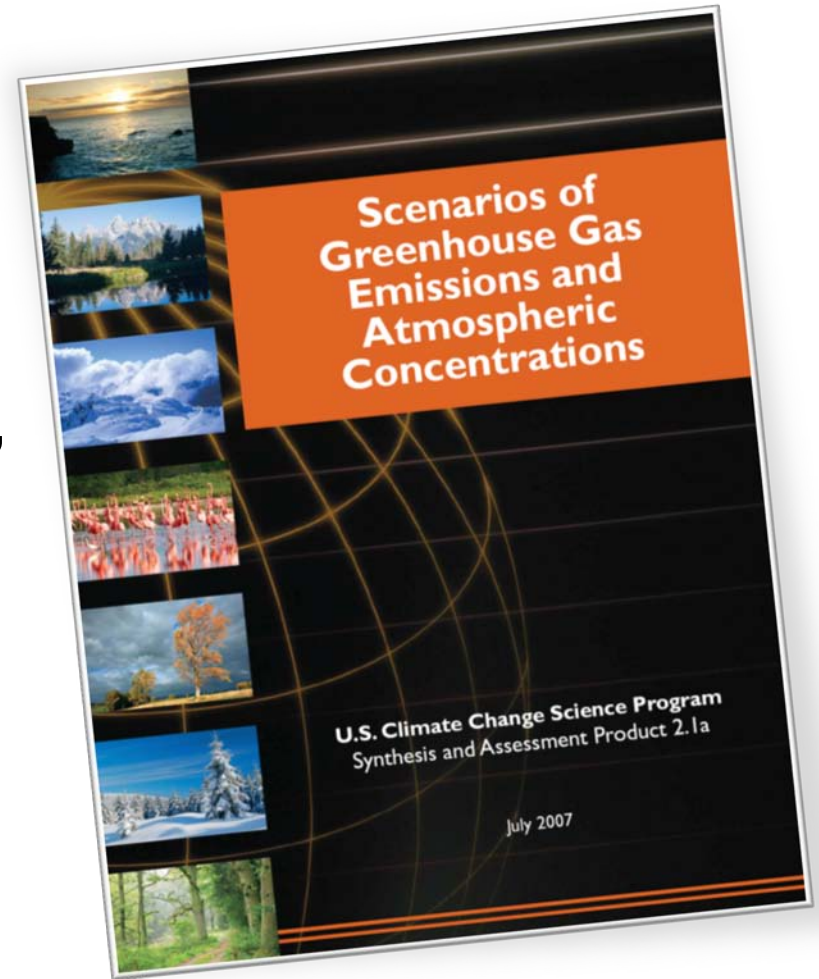
Regional, Global, and Earth System Modeling

- Develop models based on definitive theoretical foundations
- Develop better 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 the leading edge of scientific knowledge
- Increase fidelity and throughput of climate change projections
- Examine issues related to climate change detection and attribution



Integrated Assessment Research

- Understand and model the complex interactions of human and natural systems
- Explore developmental pathways, emissions, the role of energy innovations, and mitigation strategies
- Provide insights into climate change impacts, adaptations, and the effects of combined, multiple stressors
- Develop global, national, and regional perspectives within economic and other policy-relevant frameworks



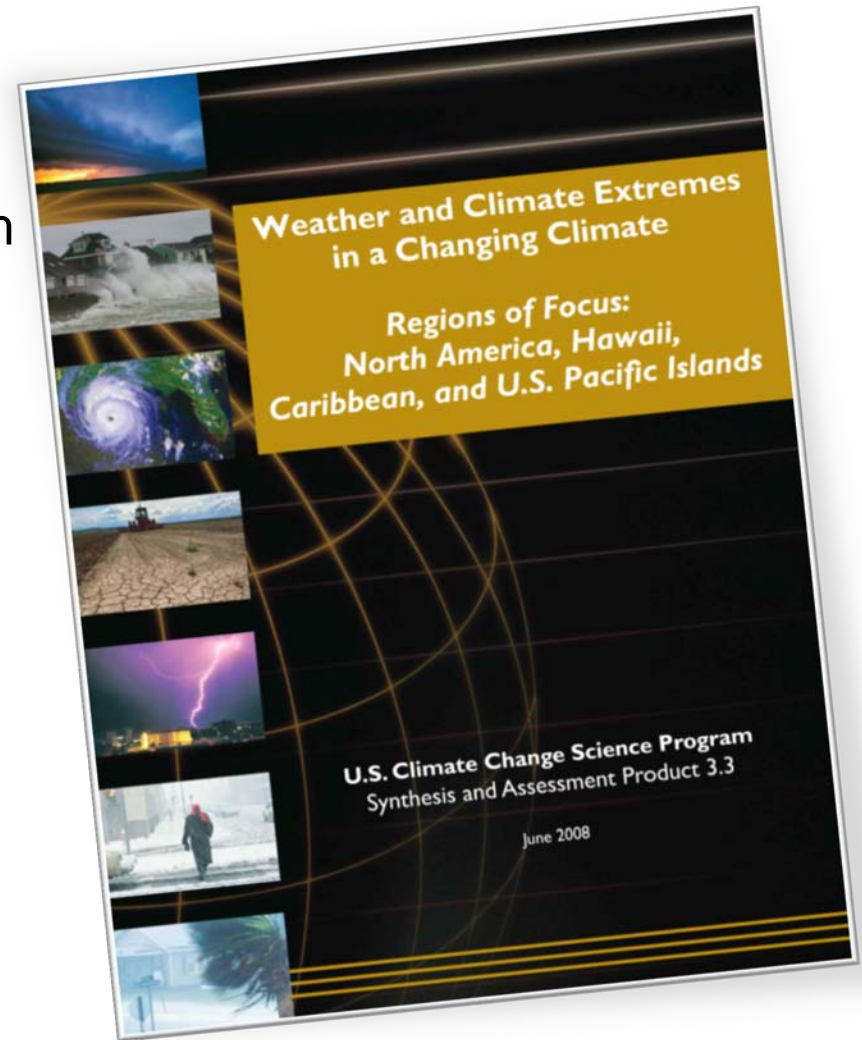
Global Change Education Program (GCEP)

- Summer Undergraduate Research Experience (SURE)
- Graduate Research Environmental Fellowships (GREF)



Coordinating U.S. Climate Change Research

- All BER climate change research is coordinated with the interagency U.S. Global Change Research Program (USGCRP)
- USGCRP integrates federal research on climate and global change among 13 federal agencies
- DOE is represented
 - On the USGCRP Principals Group
 - On most USGCRP working groups



Atmospheric System Research

- Climate research portfolio restructured in FY 2010 to more effectively address major climate science questions by better integration of the division's programs
- Atmospheric System Research created by merging the Atmospheric Science Program (ASP) and Atmospheric Radiation Measurement (ARM) Science Program.
- ASR integrates research on the two largest uncertainties in climate models – the role of clouds and aerosols
- ASR goals and plans articulated in the recent Atmospheric System Research Science Plan, to be summarized later this morning.
- ASR is a team effort with the ARM Climate Research Facility
 - Atmospheric team members: ASR Program Managers, Alapaty & Williamson, and ARM program managers, Ferrell & Petty

Partnerships are key!

Within ASR:

- Opportunity for ASR to make some breakthroughs in Aerosol and Cloud sciences. Your new working group structure should encourage interactions between these science areas.

Within DOE :

- ASR is a client to Climate Modeling Programs: Improved or new process science can be evaluated in seasonal and decadal modes modeling programs.
 - Joint projects: Cloud Associated Parameterizations Testbed (CAPT) Project is jointly funded with RGM.
 - ASR program managers have been designated for some crosscutting ESM projects: BNL Fast Physics, LANL Cloud/Cryosphere projects

With other Agencies:

- ASR participates with the U.S. GCRP Water Cycle and Atmospheric Composition Interagency Working Groups)
- Joint postdoctoral partnerships (NOAA GFDL, ECMWF)

Goal of Atmospheric System Research

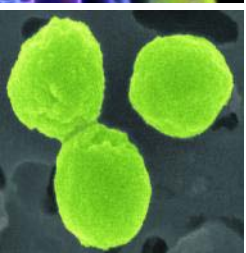
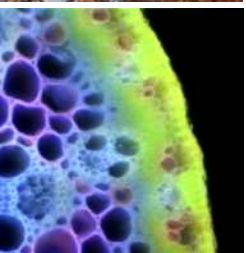
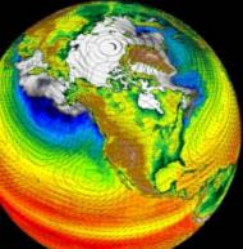
(from ASR Science Plan, 2009)

The goal of ASR, in partnership with the enhanced ARM Facility, is to quantify the interactions among aerosols, clouds, precipitation, radiation, dynamics, and thermodynamics to improve fundamental process-level understanding, with the ultimate goal to reduce the uncertainty in global and regional climate simulations and projections.

Building on Success

Past Accomplishments of ASR science efforts

- Major improvements in atmospheric physics in latest DOE/NCAR climate model version derived from ASR research:
 - Community Atmospheric Model (CAM) package heavily influenced by ASR cloud and aerosol research products
- The Rapid Radiation Transfer Model (RRTM) has become a “gold standard” radiation package for global models
- Several ASR investigators have made significant advances in characterizing the dynamics and climate impacts of Secondary Organic Aerosols.



Thank you!

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