

# DOE perspectives on CESM

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Climate and Environmental Sciences Division (CESD)

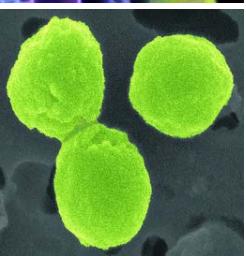
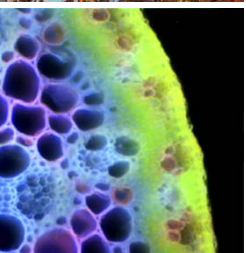
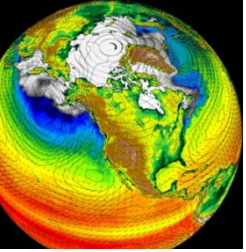
Office of Biological and Environmental Research (BER)



U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

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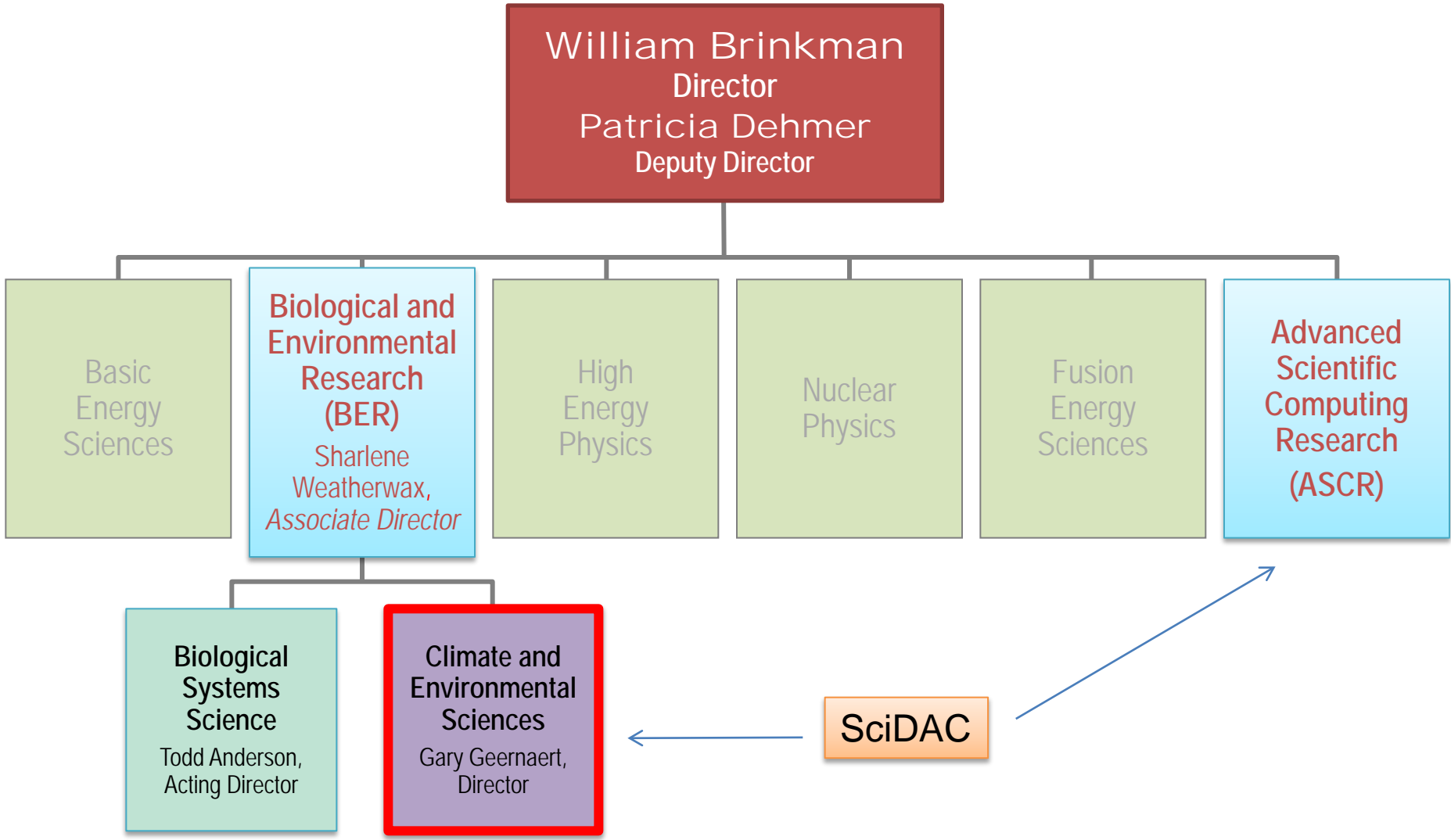


# Outline

1. Global climate modeling at DOE
2. DOE CESM investments
3. Climate modeling in 2011
4. Priorities, Needs



# Department of Energy Office of Science



# Climate and Environmental Sciences Division

## Atmospheric

Atmospheric System Research

Atmospheric Radiation Measurement Climate Research Facility

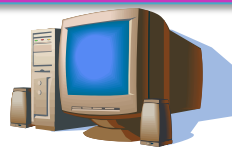


## Climate Modeling

Regional & Global Climate Modeling  
PCMDI, regional  
(Renu Joseph)

Earth System Modeling  
SciDAC  
(Dorothy Koch)

Integrated Assessment  
(Bob Vallario)



## Environmental Systems

Terrestrial Ecosystem Science

Terrestrial Carbon Sequestration Research

Subsurface Biogeochemical Research

Environmental Molecular Sciences Laboratory



## **Department of Energy Mission Relevance**

**- Impacts of fossil fuel emissions on climate system**

**- Climate change affects energy needs, potentials (e.g. effect of temperature extremes on power grid; future potentials for solar, wind, bio-energy, hydro-electric)**

# Further Modeling Program Principles

Support of Community models: primarily the Community Earth System Model, in collaboration with NSF

Balance support for DOE Laboratories and Universities



Partnership with DOE Advanced Scientific Computing Research to advance computation



CESD research priorities: Cloud/aerosol and Terrestrial Ecosystem science



# DOE Climate modeling investments

**FY11 67M, ~ 50/50 DOE Laboratory/University**

**UCAR ~ 3M (+new awards, > 4M)  
(Implement more formal review process?)**

**MOST DOE climate modeling research is around  
CESM development and analysis**

**MOST DOE laboratory climate modeling funds  
are for CESM development**

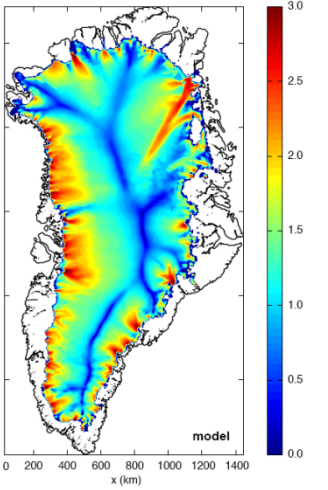
**Multi-Lab  
Model  
Development  
Projects:  
NCAR often  
serves as  
“integrator”**

	BNL	ORNL	LANL	LBNL	PNNL	LLNL	ANL	SNL
High Res		X	X	X		X		
IMPACTS		X	X	X	X	X	X	
SciDAC		X	X	X	X	X	X	X
Polar			X	X	X	X		
Regional		X	X	X	X			
CSSEF	X	X	X	X	X	X	X	X

- **“High Resolution”** Challenges and benefits of running model at very high resolution (0.25 x 0.1 atmosphere x ocean), hydrologic extremes, eddies
- **“IMPACTS”**: Abrupt climate change: 1. Stability of WAIS (sheet-ocean interface), 2. Drought potential over US (Land hydrology, dust), 3. Arctic methane clathrate and permafrost release (land, ocean, atmosphere biogeochemistry)
- **“SciDAC”**: Computationally intensive development of CESM dynamical cores, chemistry and biogeochemistry for atmosphere and ocean



# Multi-Lab Model Development Projects



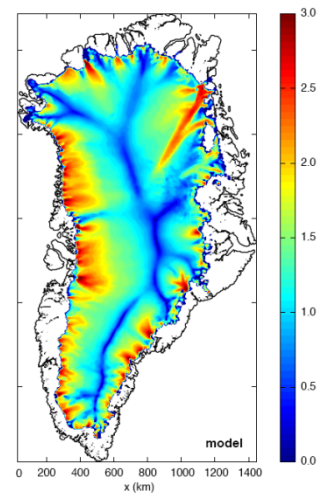
Project	BNL	ORNL	LANL	LBNL	PNNL	LLNL	ANL	SNL
High Res		X	X	X		X		
IMPACTS		X	X	X	X	X	X	
SciDAC		X	X	X	X	X	X	X
Polar			X	X	X	X		
Regional		X	X	X	X			
CSSEF	X	X	X	X	X	X	X	X



- **“Polar”**: Pollution transport to Arctic, Arctic cloud, and cryosphere development and coupling
- **“Regional”**: How does model hydrology simulation change with model resolution?
- **“CSSEF”**: Initial focus on test-bed development, Land model development, Uncertainty Quantification

# Other large DOE Lab activities

- **PCMDI:** Model evaluation, diagnostics
- **COSIM:** LANL development of CESM ocean, sea-ice, land-ice
- **Integrated Earth System Model:** Tight coupling between CESM (CLM) and human activities, IA
- **FAST physics cloud model testbed:** BNL: test and develop cloud parameterizations using ARM measurements
- **Carbon Feedbacks:** Improve terrestrial carbon simulation and coupling in CLM for low-middle-high latitudes
- **Earth System Grid Federation:** Cyber portal providing distribution of model/observational data
- **“Visualization”** development of tools for analysis and visualization of large and diverse (spatio-temporal) datasets (on ESG)



# Current trends and influences on DOE climate modeling research

- 1. Congress:** Eliminate duplicative climate research, DOE support should be for mission-relevant science
- 2. USGCRP:** Enlarge climate research scope to include e.g. ongoing climate assessment, improved provision of climate information to stake-holders and decision makers
- 3. DOE Office of Science:** supports basic science research

# Guiding principles

**1. Planet in peril** (e.g. sea-level rise)

**2. Basic research is still needed and will help.**

We have made great advances, however we have limited ability to provide climate information on scales needed by stakeholders. Significant advances are still possible.

**3. U.S. needs more than 1 climate model.**

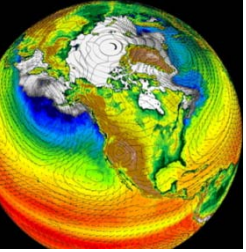
(If you were terminally ill would you want only 1 doctor to consult?)

**4. CESM: Benefits of “Community” model** (used and developed by 1000’s worldwide)

**5. DOE model development investments are critical for the CESM** complements not duplicates NSF

**6. DOE mission relevance:**

Basic research in support of: Determining impacts of fossil fuel on climate, climate change impacts on energy potentials



# DOE Modeling Research Priorities

CESD priorities: cloud/aerosol and terrestrial carbon cycle

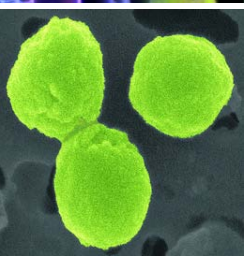
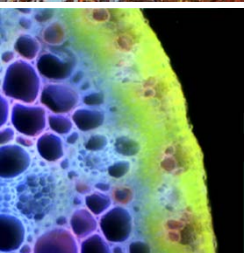
Testbeds: Model evaluation, validation and verification. Build Earth System Grid and connected tools.

High-resolution capability developments, crucial for connection with stakeholder needs (wind, precipitation, solar, biofuels). Focus on extremes.

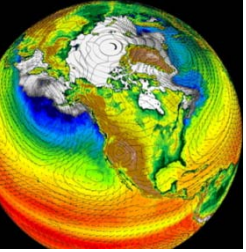
Model component development, physics: e.g. ground hydrology, land ice, clouds

Uncertainty characterization frameworks to guide research priorities and inform climate model interpretation

Integrated human-physical elements within climate modeling







# Further DOE needs from CESM

**Integrator: NCAR is integrator of DOE (Laboratory) research. Flexible coupling needed...**

**Credit...**

**Performance Metrics: Reports on achievements (particularly if supported by DOE).**

