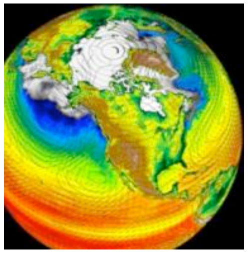
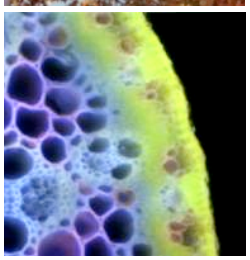
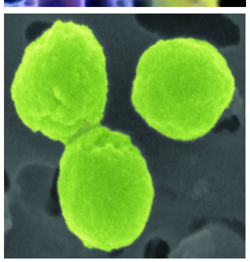


Accelerated Climate Model for Energy

AGU Town Hall

ACME
Accelerated Climate Modeling for Energy

Gary Geernaert
Climate and Environmental Sciences Division

Dorothy Koch
Earth System Modeling

Biological and Environmental Research

December 18, 2014

ACME Town Hall Agenda

DOE perspectives

- **Gary Geernaert, Climate and Environmental Sciences Division Director**
- **Dorothy Koch, Earth System Modeling Program Manager**
- **Randall Laviolette, Advanced Scientific Computing Research Program Manager**

Project presentations

- **Project structure and introductions**
- **William Collins: Climate Science Goals**
- **Rob Jacob: Computational Science Goals**

Early Project Highlights

- **Ocean-ice: Phil Jones**
- **Biogeochemistry: Peter Thornton, Bill Riley**
- **Workflow: Dean Williams**
- **Coupled model: Peter Caldwell**

Q&A

Accelerated Climate Modeling for Energy

Accelerated Climate Model for Energy Overview

- **Unique branch of the Community Earth System Model (CESM), i.e., within the family of models jointly supported by DOE and NSF**
- **ACME is supported by DOE to serve mission needs:**
  - **high resolution (15-25 km), with adaptable grids <10 km**
  - **Time horizon: 1970-2050**
  - **Analysis of energy-water-land-human system interdependencies**
- **Designed to effectively utilize next and successive generations DOE Leadership Class computers, through exascale**
- **ACME consists of a consolidation of existing DOE Laboratory model development projects, and is therefore a more efficient use of existing resources**
- **ACME officially launched in July 2014**

ACME
Accelerated Climate Modeling for Energy

ACME climate projections goals for energy

- Water availability for power production (e.g., coal-power, nuclear power, biofuels, hydro-electric)
- Sea level rise and changing frequency of occurrence of storm surges (coastal infrastructure, energy and land use planning)
- Abatement, i.e., estimating and projecting land uptake or release of carbon to/from the atmosphere
- Time horizon of next 50 years

Computing

- DOE ASCR acquires cutting edge, increasingly disruptive, computational facilities, which are exceedingly challenging for domain scientists to effectively use.
- DOE and ACME embrace this challenge, risk, and opportunity as ACME develop software and codes to efficiently exploit current and future computer architectures.

Project History

January 2013: workshop (and whitepaper) to consider how DOE could better contribute computational advances to CESM

March 2013: Formation of project leadership "Council" of 9 DOE Laboratory scientists to organize project

September 2013: Invitation to Dave Bader to submit proposal on behalf of the consortium of Laboratories

January 2014: Proposal submitted to BER (>100 pages of technical material)

March 2014: Proposal and project reviewed face-to-face by a panel of 18 scientists (panelists were 50-50 Model groups and University; 65-35 Climate and computation; 4 non-U.S.)

June 2014: Project launched.

Programmatic rationale:
Before ACME DOE sponsored 7 model-development activities across 8 Labs

	CSSEF	Polar	COSIM	IMPACTS	UV-CDAT	Hi-Res	iESM
ANL							
LANL							
LBNL							
LLNL							
ORNL							
PNNL							
SNL							
BNL							

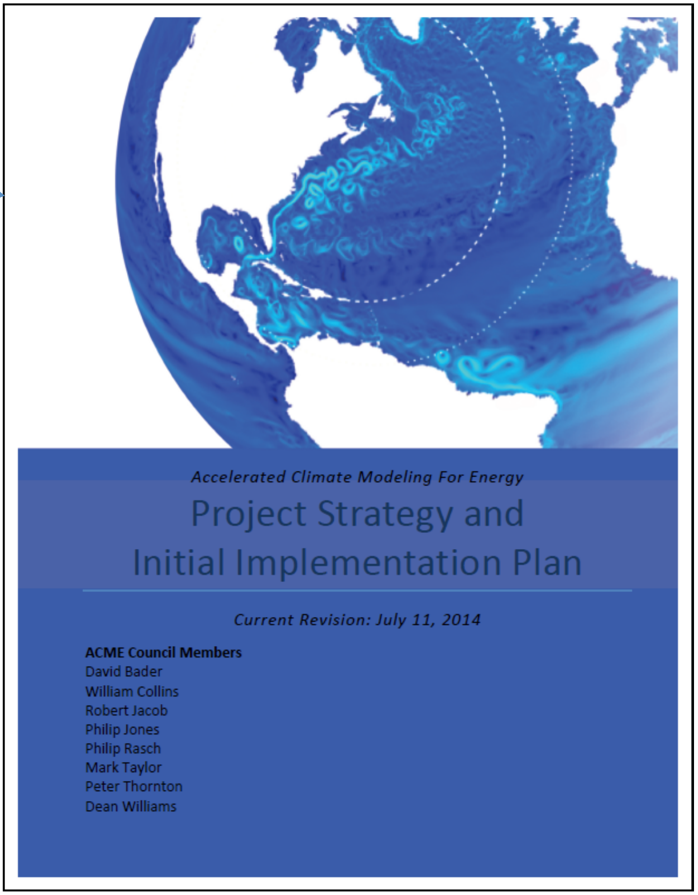
Team ACME:

	ACME	iESM
ANL		
LANL		
LBNL		
LLNL		
ORNL		
PNNL		
SNL		
BNL		
Other	NCAR, UC-Irvine, Scripps, NYU-Poly, U-MD, Kitware	

Reviewer recommendations

- **Concise and visionary document describing the project, which the team prepared. Available on-line**

http://climatemodeling.science.energy.gov/projects/accelerated-climate-modeling-energy



- **Extra careful consideration of the treatment of the energy/societal components. BER held a community workshop in October 2014 to consider how best to model "societal" elements together with Integrated Assessment and Impacts Adaptation Vulnerability approaches and communities**

ACME Science goals and energy mission

ACME design is mainly for high-resolution, coupled, short-term (1970-2050) climate hind-cast and projection

Water cycle

How do the hydrological cycle and water resources interact with the climate system on local to global scales?

Evolution of precipitation and river flow.

Biogeochemistry

How do biogeochemical cycles interact with global climate change?

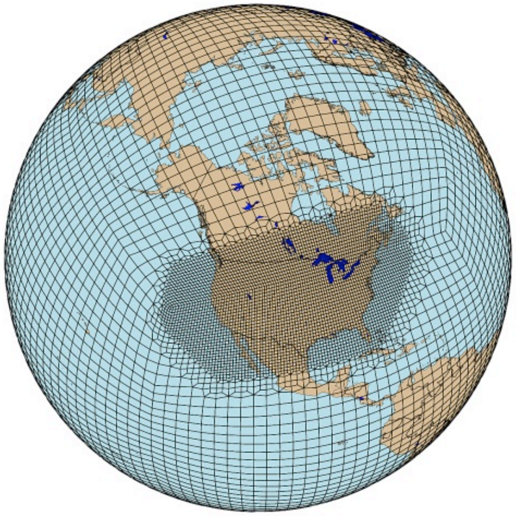
Evolution of natural versus managed systems fluxes of greenhouse gases.

Cryosphere

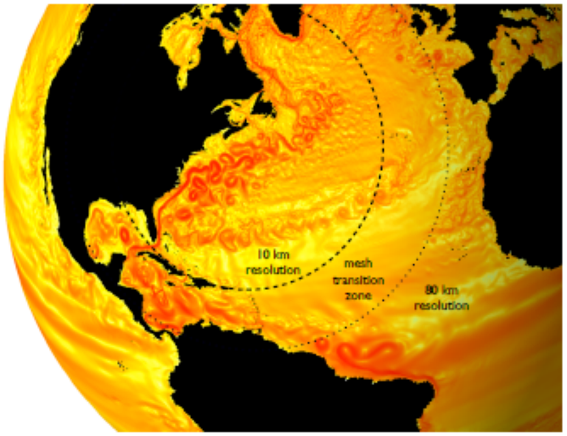
How do rapid changes in cryospheric systems interact with the climate system?

Long term committed Antarctic ice sheet contribution to SLR from changes in 2010-2050.

ACME computation

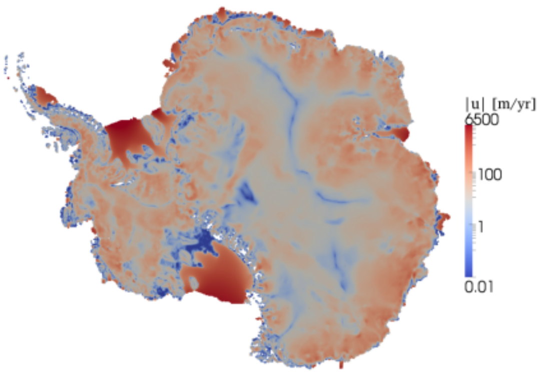


Performance
Design of codes to run on DOE's Leadership Class computers, both existing and next-generation.



Software design
Software development for portability, and rapid testing are priorities; modularity

Workflow
Design of end-to-end model configuring, testing and provenance



Algorithm
Use of new climate systems that allow adaptive mesh refinement in regions of interest or requirement. These are challenging for representing seamless physics across scales.

ACME community engagement

DOE
ACME is used by other programs (parameterization development and analysis)
Computing office (ASCR) supports with the SciDAC program and facilities.

CESM
ACME is within the CESM family of models and has ongoing coordination
Direct engagement (and future partnerships) with NCAR and other community collaborators
Codes to be made available to CESM

Climate modeling and High Performance Computing
Regular release of codes
Develop methods to deploy climate codes on Leadership-class architectures, maximize portability;
Tools to process and analyze large datasets

Energy-mission
Direct engagement with other model groups/types (IA, IAV) and stakeholders

Two Architecture Paths for Today and Future Leadership Systems

Power concerns for large supercomputers are driving the largest systems to either Hybrid or Many-core architectures

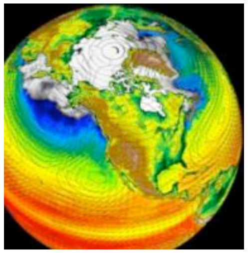
Hybrid Multi-Core (like Titan)

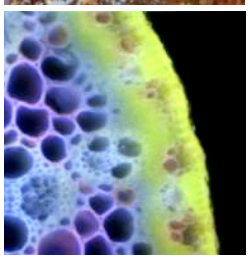
- CPU / GPU hybrid systems
- Likely to have multiple CPUs and GPUs per node
- Small number of very powerful nodes
- Expect data movement issues to be much easier than previous systems – coherent shared memory within a node
- Multiple levels of memory – on package, DDR, and non-volatile

Many Core (like Sequoia/Mira)

- 10’s of thousands of nodes with millions of cores
- Homogeneous cores
- Multiple levels of memory – on package, DDR, and non-volatile
- Unlike prior generations, future products are likely to be self hosted

http://science.energy.gov/~/media/ascr/ascac/pdf/meetings/20141121/Bland_CORAL.pdf




Thank you!

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