

## **Science, Scenarios & Co-development**

# **Accelerated Climate Model for Energy (ACME) & GCAM (& IAV?)**

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U.S. DEPARTMENT OF  
**ENERGY**

Office  
of Science

Office of Biological  
and Environmental Research

# ACME-GCAM meeting: May 20, 2016, JGCRI

## Scenarios and Science

Given potentials of ACME and GCAM, how might these communities work together to address science questions relevant to DOE mission?

Are there particular scenarios or experimental designs to support these questions? Scenarios needed, or just sensitivity studies?

What developments and co-developments would be required for the full system (GCAM and ACME)?

Four potential topics under development (Calvin, Jones)  
Relevance to DOE, scope of effort required

# Accelerated Climate Model for Energy (ACME) Overview

ACME is a global coupled climate model development project started in 2014 to develop a high-resolution version of the Community Earth System Model (CESM) that will:

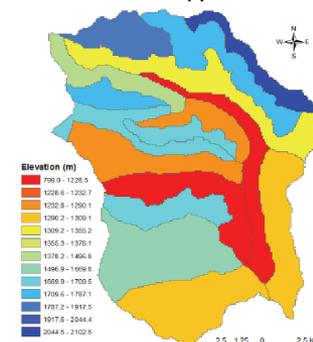
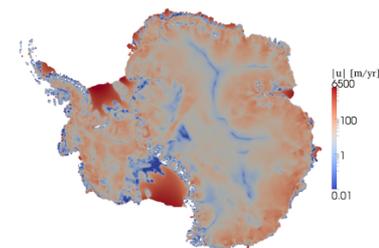
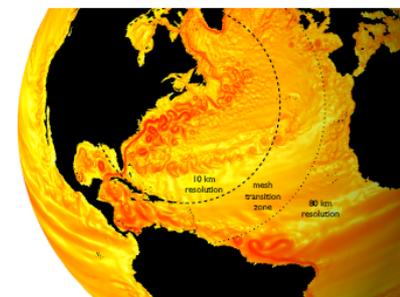
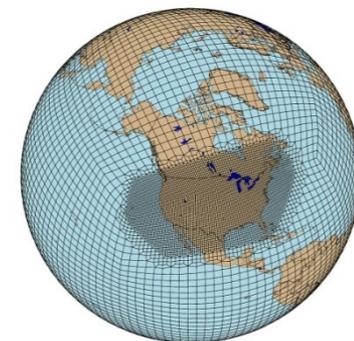
- effectively use advanced DOE computational facilities, with high-resolution (1/4 degree) short time-scale emphasis (1970-2050)
- address Energy-mission-relevant science challenges

**ACME Version 1 to be released in 2017:**

**Ocean-ice:** New ocean with high-variable-resolution, coupled to dynamic land ice (good for SLR)

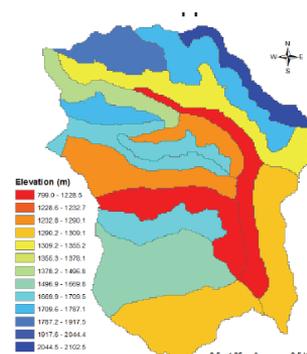
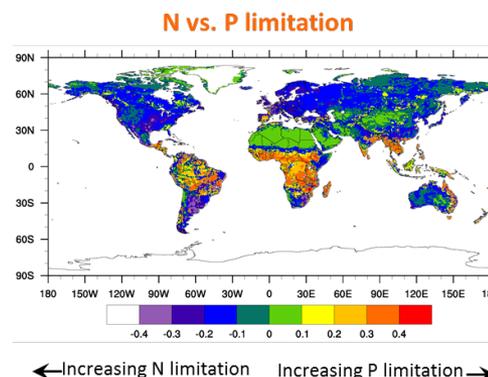
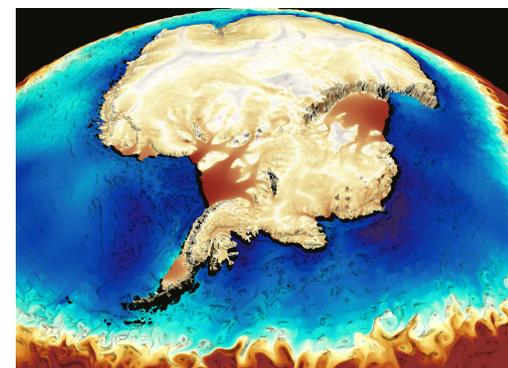
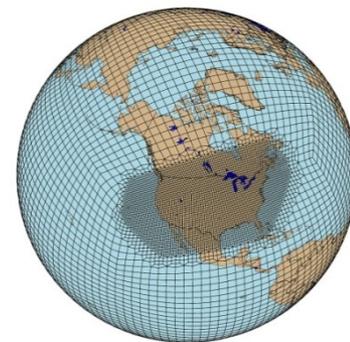
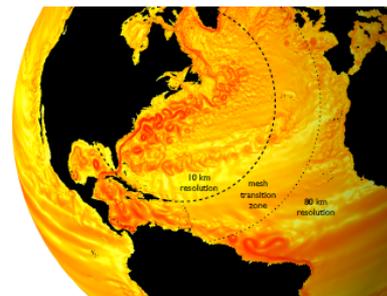
**Land:** River-component, new hydrology developments, P/N/C, new crops

**Atmosphere:** Aerosol and cloud microphysics, high-resolution in horizontal and vertical



# ACME “features”

- Basin-sub-basin hydrology, some water management
- River features: BGC, sediment, temperature, dams
- Crops: some management, irrigation (could add more)
- Aerosol chemistry, including (soon) organic species (that evolve and feed-back with terrestrial systems), nitrate
- Aerosols, aerosol-cloud interactions
- Methane – natural-land-emissions “best in class”, wetlands, permafrost
- High-resolution and Variable Resolution for all components – can zoom into regions of interest
- High-quality ocean, sea-ice and land-ice systems, good SLR capability



# ACME Climate Science Drivers and Questions

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

**What are the processes and factors governing precipitation and the water cycle today and how will precipitation evolve over the next 40 years?**

*Water management and availability*

*Biogeochemistry:* How do biogeochemical cycles interact with global climate change?

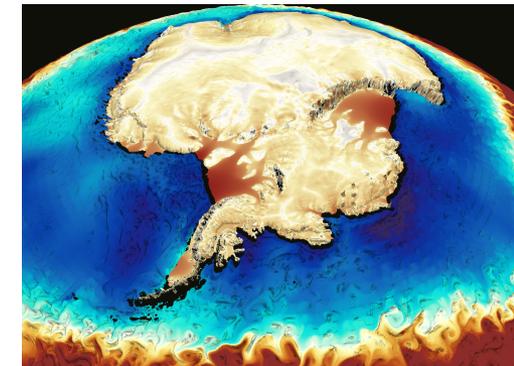
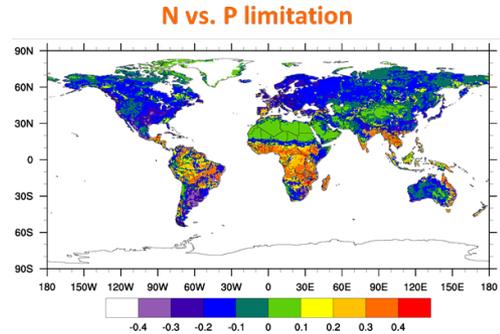
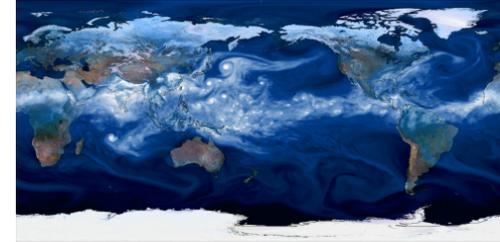
**What are the contributions and feedbacks from natural and managed systems to current greenhouse gas fluxes, and how will those factors and associated fluxes evolve in the future?**

*Carbon cycle – carbon exchange between land and atmosphere, effect of nutrients (C-N-P), hydrology, climate*

*Cryosphere-Ocean:* How do rapid changes in cryospheric systems interact with the climate system?

**What is the long-term, committed Antarctic Ice Sheet contribution to sea level rise (SLR) from climate change during 1970–2050?**

*Sea level rise, coastal impacts*



# Topic 1: Land-use and carbon



Consider alternative trajectories of land-use in combination with contrasting energy-pathways, and how these affect carbon uptake by land

DOE: complements terrestrial programs, ACME terrestrial and LULCC activities

Challenges to models:

Continue with carbon-coupling in iESM project?

Consistent scenarios from single IAM

## Topic 2: water-energy



Consider climate effects (including extremes) on energy costs and options, comparing energy-pathways that are more and less water-dependent, and scenarios with more or less warming.

DOE:

Topic is very central to mission; water-management capability is under development, basin and river-treatment focused development, flooding and other hydrology

Challenges to models:

Requires hard or iterative coupling?

How to feed extremes from ESM to IAM? How to feed decisions (e.g. for water consumption options) from IAM to ESM for seasonal issues

IAM: design or selection of scenario with contrasting water-dependent pathways, and with contrasting carbon pathways



# Topic 3

## Low vs High Fossil



Consider climate-energy interactions for low-fossil-fuel and high-fossil-fuel pathways

Low-FF: shifting opportunities for solar, nuclear, biofuel, wind, hydro as climate changes and these energy-options are expanded (with any feedbacks)

High-FF: Include impact-effects from climate change (e.g. damage from extremes)

DOE: Central to energy mission

Challenges to models:

Feedbacks needed from climate to IAM

How to incorporate “damage” impacts?

# Topic 4: Settlement pathways Coastal regions



Consider effects and feedbacks between regional development options and climate, for example – urban/suburban designs, transportation, energy-siting, water usage, parks, population distribution, AQ – temperature; Include coastal element and SLR effects?

DOE: Energy infrastructure, but other important stakeholders – regional?

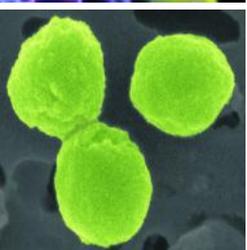
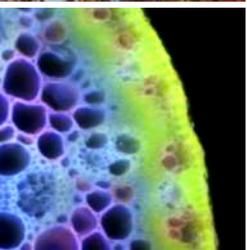
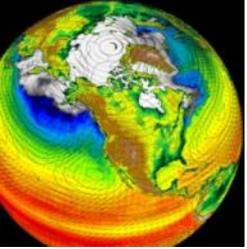
Challenges to models:

Settlements: require substantial development in both IA and ESM models, opportunity for co-development for “settlements”.

Coastal: Include impacts for SLR and coastal impacts (some of this is priority for ACME)

Question:

How important are feedbacks to climate for urbanization – sensitivity work needed; regional vs global simulations?



# Thank you!

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