Terrestrial Ecosystem Sciences

TES/SBR Joint Investigators Meeting
Potomac, MD

May 6-7, 2014

Daniel B. Stover, Ph.D.
J. Michael Kuperberg, Ph.D.
Terrestrial Ecosystem Science

Foundational science to improve our predictive understanding of terrestrial ecosystems in the context of a changing climate.

–Observations

–Manipulations

–Large-scale, long-term field studies

–Process modeling with ties to Earth-system models

Funding to both universities and national laboratories.
Model-Experimental Coupling (MODEX)

- DOE’s goal is to: To advance a robust predictive understanding of Earth’s climate and environmental systems and to inform the development of sustainable solutions to the Nation’s energy and environmental challenges.

- “Predictive understanding” is code for MODEX.

- Our goal is to coordinate process and modeling science to maximize scientific outcomes.

- This is not a one-way street, it is an iterative dialog (a “new” way to do business).

- We recognize the importance of and role for “discovery science”. 
University programs

• Supported through grants in response to annual funding opportunity announcements

• Implement MODEX at the university scale as well, asking PI’s to pose their questions in the context of needs and structure of Earth system models

• Wide range of scientific projects, questions and systems in the university portfolio

• Some in collaboration with national lab projects, many as independent projects
Next Generation Ecosystem Experiments (NGEE)

• The 2008 Ecosystem Workshop
  – identified arctic and tropical ecosystems as important regions of climate prediction uncertainty that require DOE and community attention.
  – "NGEE concept" grew out of this workshop report, to advance experimental concepts that leverages other DOE strengths and mission needs.

NGEE focuses on systems that are:
  – Globally important;
  – Climatically sensitive;
  – Insufficiently understood or represented in coupled models; and
  – Feasible
NGEE – Arctic

**Goal:** Advance the predictive understanding of the structure and function of Arctic terrestrial ecosystems in response to climate change.

**Objectives:**
- Development of a process-rich ecosystem model, extending from bedrock to the top of the vegetative canopy, in which the evolution of *Arctic ecosystems* in a changing climate can be modeled at the scale of a high resolution Earth System Model (ESM) grid cell (i.e., approximately 30x30 km grid size).

**Approach:**
- Collaborative effort among DOE National Laboratories and universities, led by Oak Ridge National Laboratory.
- Interdisciplinary, multi-scale approach to advance predictive understanding through iterative experimentation and modeling.
- Opportunities for leveraging through external collaboration (DOE and other agencies).
Phase 1 (2012-2014) field and laboratory research and modeling will focus on characterizing ice-wedge polygons, thaw lakes, and drained thaw lake basins.

Barrow Environmental Observatory (BEO)
Barrow, Alaska
7,450 ha research preserve
Opportunities to Become Engaged with NGEE

- Leverage investments and facilitate continued scientific collaboration in Barrow, Alaska (Phase 1).
- Affiliate with other projects to understand Arctic ecosystems and feedbacks to climate (e.g., AON, NEON, ABoVE, and CARVE).
- Encourage single PI interactions with NGEE investigators; future TES solicitations.
- Synthesis activities; workshops; facilitate model inter-comparisons.
- Share resources; make datasets and samples available, permafrost samples, etc.
NGEE – Tropics

- A 2012 workshop identified a broad set of science needs in tropical ecosystems.

- **Goal:** Improve our understanding of the tropical water-nutrient-vegetation nexus in the context of a changing climate.
  - Understand responses of tropical forests to changes in precipitation (e.g., drought), temperature, nutrient cycling, and disturbance (e.g., land-use change and fire) to improving our predictive understanding of ecosystem-climate feedbacks to greenhouse gas fluxes and changes in surface energy balance.

- **Objectives:** Development of a representative, process-rich ecosystem model, extending from bedrock to the top of the vegetative canopy, in which the evolution and feedbacks of tropical ecosystems in a changing climate can be modeled at the scale/resolution of a high resolution next generation Earth System Model (ESM) grid cell.
NGEE – Tropics

• “NGEE – Tropics” will:
  – be a model informed field study that results in iterative refinement of high resolution predictive models.
  – be based on field studies in the most climate sensitive tropical geographies that provides a high scientific return on investment.
  – utilize a distributed network of focused research sites

• NGEE activities will be highly multidisciplinary.
• NGEE will provide a framework for collaboration.
• LBNL has been asked to develop a whitepaper and Phase 1 proposal in FY-14.
Green Ocean Amazon

• In 2014-2015, BER is conducting an integrated experiment, GreenOceanAmazon, to observe, analyze, and model the coupled biosphere-atmosphere system.

• The goal is to improve understanding of cloud-aerosol-precipitation interactions including the role of biological material directly released from rainforest biota.

• TES interests focus on factors regulating BVOC production in tropical forest canopies.

• ASR, ARM, EMSL, RGCM and Brazilian collaborators are cooperating to expand the integrative scope of the campaign.
AmeriFlux

- AmeriFlux is a coordinated research network of long-term flux sites in the Americas for quantifying and understanding the role of the terrestrial biosphere as a component of the Earth System
- DOE BER supports AmeriFlux network infrastructure
- DOE provides ongoing support to the network and maintenance of the long-term data records represented by many AmeriFlux sites

- In 2012, DOE awarded management and operational support to LBNL
  - LBNL provides technical support, management, and operational coordination to the AmeriFlux network and subcontracts measurement operations of a subset (10-15 sites) of existing, long-term sites
New Phytologist Virtual Special Issue from Scaling Root Processes: Global Impacts workshop

The 2012 workshop was organized in response to the growing recognition of the importance of terrestrial ecosystems in the global carbon cycle and the need to improve model representation of carbon flow within ecosystems by bringing root functions into models.

• The VSI’s 25 articles focused on:
  – root structure and function
  – interactions with the soil and microbial environments
  – processes and mechanisms that should be incorporated into ESMs

• These articles challenge some common assumptions used to represent root physiological functions, identify root–microbial–soil environment processes that could be incorporated into models, and demonstrate how new methods and modeling approaches can improve the representation of physiological function of roots in models.

TES Program Update

- FY-12 annual university solicitation – $3M/year
  - 200 pre-apps, 140 full applications, 11 awards
  - Highlighted: natural disturbances, belowground processes, coupled biogeochemical cycles and Arctic and tropical ecosystems

- FY-13 annual university solicitation – $3M/year
  - 207 pre-apps, 121 full applications, 15 awards
  - Jointly supported with the DOE climate Modeling programs

- FY-14 GOAmazon university solicitation - $2.3M/year ($700k/year)
  - 33 LOI, 32 full applications, 6 awards
  - Jointly supported with ASR, RGCM, FAPEAM and FAPESP

- FY-14 NASA ROSES joint solicitation - $5M
  - 10 awards
  - Jointly supported with NASA, USDA, and NOAA

- DOE Early Career solicitation
  - FY-10 (Nate McDowell, LANL)
  - FY-12 (Dan Hayes, ORNL)
  - FY-13 (Rebecca Newman, Univ of Washington)
TES Program Update

• Annual Solicitation for FY-15
  – Anticipated late spring/summer release

• SBIR/STTR

• Programs at National Labs – ANL, LBNL, ORNL, PNNL, LANL
  – Arctic soil carbon, SOM dynamics, SPRUCE, biogeochemistry, Southwestern drought

• Town Hall Meetings at AGU (12/14), and ESA (8/14)
Looking Ahead and Strategic Plans

• Strategic Research Interests in:
  – Role of belowground processes in the carbon cycle
  – Support large-scale coupled modeling and process research projects as well as large-scale, long-term ecosystem studies
  – Arctic and tropical ecosystems and their feedbacks in a changing climate
  – Analyze long-term ecosystem observational records to inform and evaluate models
  – Encourage exploratory research (high risk-high payoff)

• Future directions
  – Terrestrial-aquatic interfaces
  – Natural-urban interfaces

• Connect projects closely to other research activities within CESD, within BER, and among the other Federal agencies.

• Forge strong programmatic coordination with the BER Scientific User Facilities (ARM, EMSL and JGI)
  – EMSL Post-doc (Malak Tfaily)
Interagency and International Coordination

- Represented on USGCRP interagency working groups:
  - Carbon Cycle IWG
  - Ecology IWG
  - Biogeochemistry IWG

- Interagency Arctic Research Policy Council

- Arctic Council/Arctic Monitoring and Assessment Program

- DoD’s Strategic Environmental R&D Program (SERDP)
  - Environmental Restoration and Sustainable Infrastructure focus areas
  - Natural Resources and Climate Change focus areas
Last words

• High quality science
• Understanding terrestrial ecosystems, their role in a changing climate, and their representation in models
• Close ties to coupled Earth system models
• Annual call to the university community
• NGEE-Tropics launched in 2014
• Encourage leveraging of existing investments

• Be sure to notify us of new publications and awards!!!
Questions?

Daniel.Stover@science.doe.gov
Michael.Kuperberg@science.doe.gov
tes.science.energy.gov