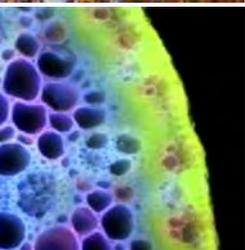


Terrestrial Ecosystem Science



TES/SBR Joint Investigators Meeting
Potomac, MD

April 28-29, 2015



Daniel B. Stover, Ph.D.

J. Michael Kuperberg, Ph.D.

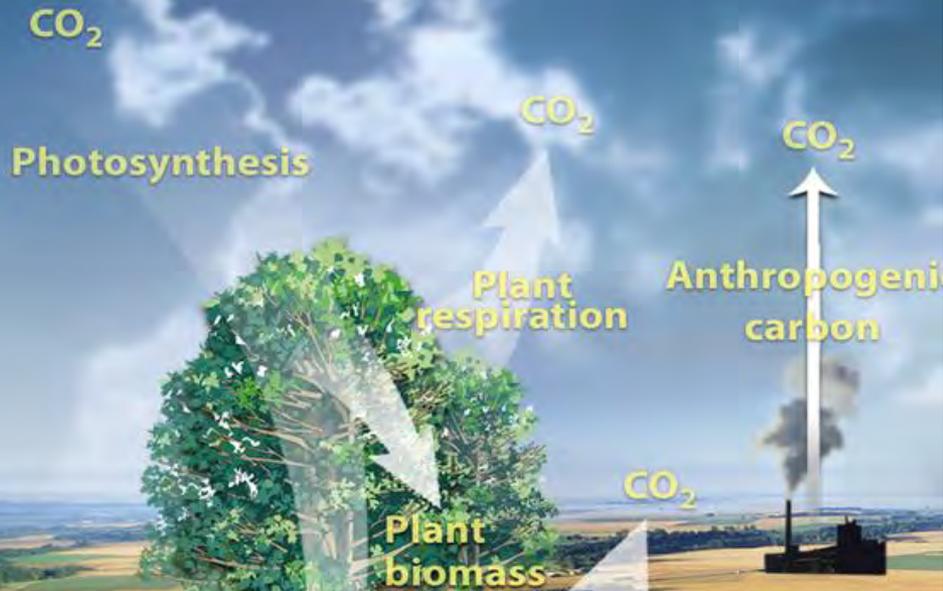


U.S. DEPARTMENT OF
ENERGY

Office
of Science

Office of Biological
and Environmental Research

Atmospheric System Science



Terrestrial Ecosystem Science



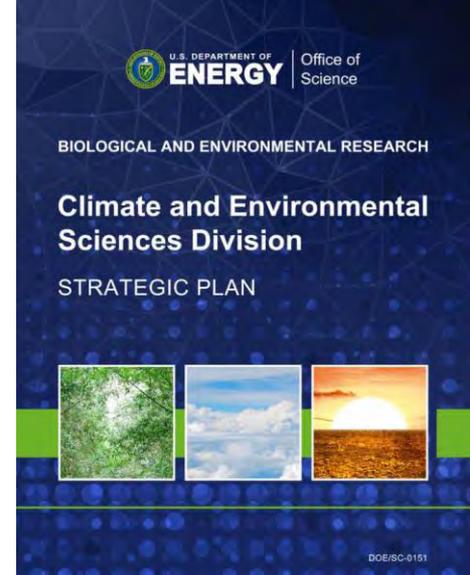
Subsurface Biogeochemical Research

The cover features the following text and graphics:

- U.S. DEPARTMENT OF ENERGY** logo and **Office of Science** text.
- BIOLOGICAL AND ENVIRONMENTAL RESEARCH**
- Climate and Environmental Sciences Division**
- STRATEGIC PLAN**
- Three small images: a green forest, a blue sky with clouds, and a sunset over a field.
- Reference code: **DOE/SC-0151**

CESD Strategic Plan

1. Synthesize new process knowledge and innovative computational methods advancing next generation, integrated models of the human-earth system.
2. Develop, test and simulate process-level understanding of atmospheric systems and of **terrestrial ecosystems** extending from bedrock to the top of the vegetative canopy.
3. Advance fundamental understanding of coupled biogeochemical processes in complex subsurface environments to enable systems-level prediction and control.
4. Enhance the unique capabilities and impacts of the ARM and EMSL scientific user facilities and other BER community resources to advance the frontiers of climate and environmental science.
5. Identify and address science gaps that limit translation of CESD fundamental science into solutions for DOE's most pressing energy and environmental challenges.



<http://science.energy.gov/~media/ber/pdf/CESD-StratPlan-2012.pdf>

Climate & Environmental Sciences Division

(FY 2015 funding levels)

- Research Programs

- Climate and Earth System Modeling (ESM, RGCM, IA) (\$62.8M)
- Atmospheric Systems Research (\$24.1M)
- Environmental Systems Science
 - Terrestrial Ecosystem Science (\$42.2M)
 - Subsurface Biogeochemical Research (\$22.3M)
- Climate Data Informatics/Management (\$2.5M)

- Facilities

- Atmospheric Radiation Monitoring (ARM) Climate Research Facility (\$67.2M)
- Environmental Molecular Sciences Laboratory (\$44.4M)

Terrestrial Ecosystem Science (TES) Program

Goal: The TES program seeks to improve the representation of terrestrial ecosystem processes in Earth system models, thereby improving the quality of climate model projections and providing the scientific foundation of solutions for DOE's most pressing energy and environmental challenges.



Approach: A model-inspired fundamental research approach focusing on ecosystems and processes that are:

- Globally/regionally significant;
- Climatically sensitive;
- Insufficiently understood or inadequately represented in predictive models

Collaborative interactions as an Environmental Systems Science group with the Subsurface Biogeochemistry Research (SBR) Program.

Terrestrial Ecosystem Science

TES approach advances basic understanding of terrestrial ecosystems through a combination of projects from single PI's to large consortia including:

- Observations (e.g., AmeriFlux network)
- Large-scale, long-term field studies and manipulations (e.g., SPRUCE, NGEE, prior FACE studies)
- Synthesis (e.g., NACP and FACE)
- Research questions in the context of needs, process and structure of Earth system models

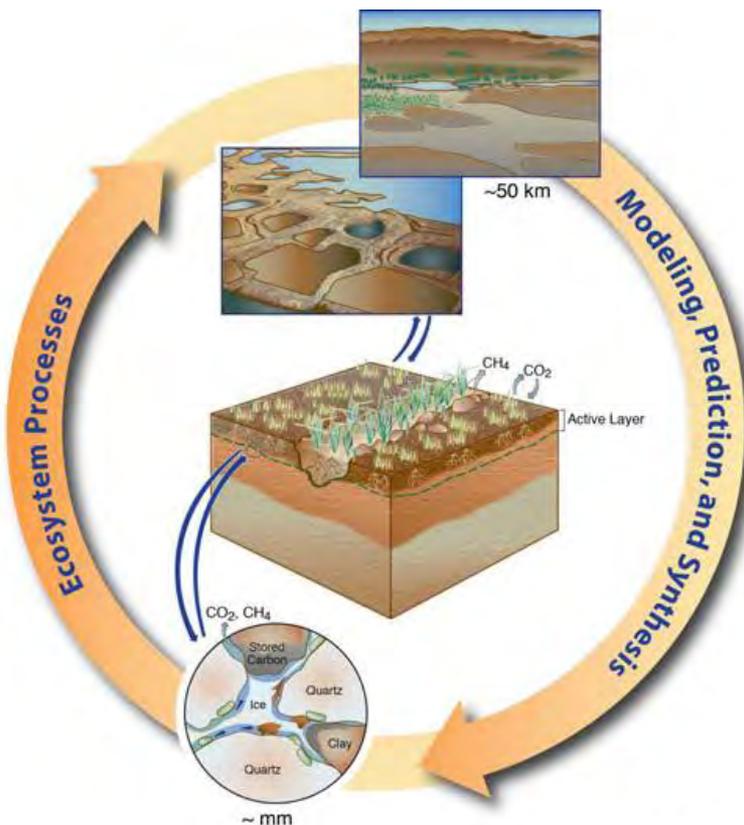
Funding to both universities and DOE National Laboratories

Annual university Funding Opportunity Announcement (FOA)



Coupled Model-Experimental Linkages (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 also recognize the importance of and role for “discovery science”.

ESD11-008

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
 - 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 Neumann, Univ of Washington)



TES Program Update

- Annual Solicitation
 - FY-15 (DE-FOA-0001172) currently under review
- SBIR/STTR
 - Trace gas measurements and hyperspectral (other new ideas?)
- Early Career
 - Land-atmosphere interactions
- Programs at National Labs – ANL, LANL, LBNL, ORNL, PNNL
 - Arctic soil carbon, SOM dynamics, SPRUCE, biogeochemistry, Southwestern drought
- Town Hall Meetings at AGU (12/14 and 12/15), and ESA (8/15)



University Programs

- Supported through grants in response to annual funding opportunity announcements
- Implement MODEX approaches at the university scale, asking PI's to pose 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
- University investigators are encouraged to familiarize themselves with existing BER/CESD/TES & SBR investments and leverage where appropriate

DOE National Laboratory Programs

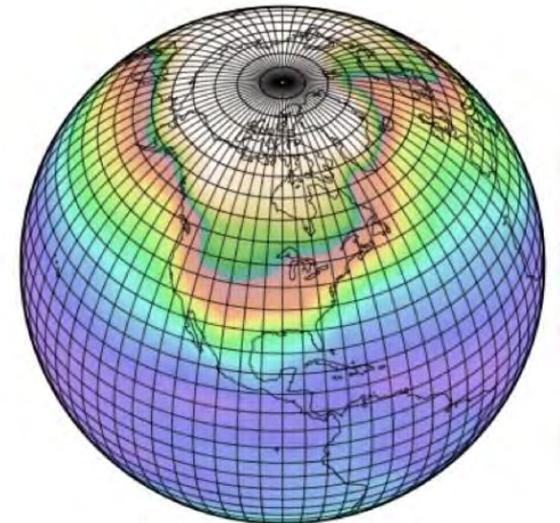
- Supported through Science Focus Area (SFA) awards which represent long-term strategic research focus based on program mission (triennial reviews)
- Implement MODEX, asking SFA teams to pose their questions in the context of needs and structure of Earth system models
- Wide range of scientific projects on:
 - Arctic Soil Carbon, SOM Dynamics, Biogeochemistry, Forest Mortality/Drought
 - SPRUCE
 - NGEE – Arctic
 - NGEE – Tropics
- Many in collaboration with university supported projects

Next Generation Ecosystem Experiments (NGEE)

- The 2008 Ecosystem Workshop
 - identified several critical 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

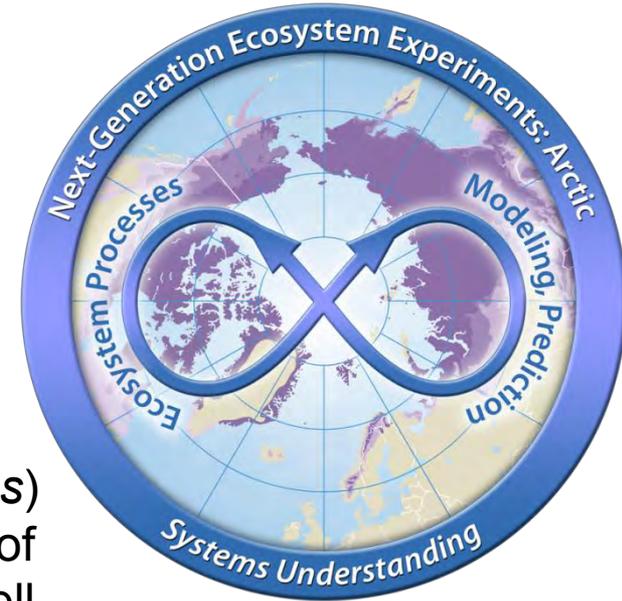


NGEE – Arctic

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).

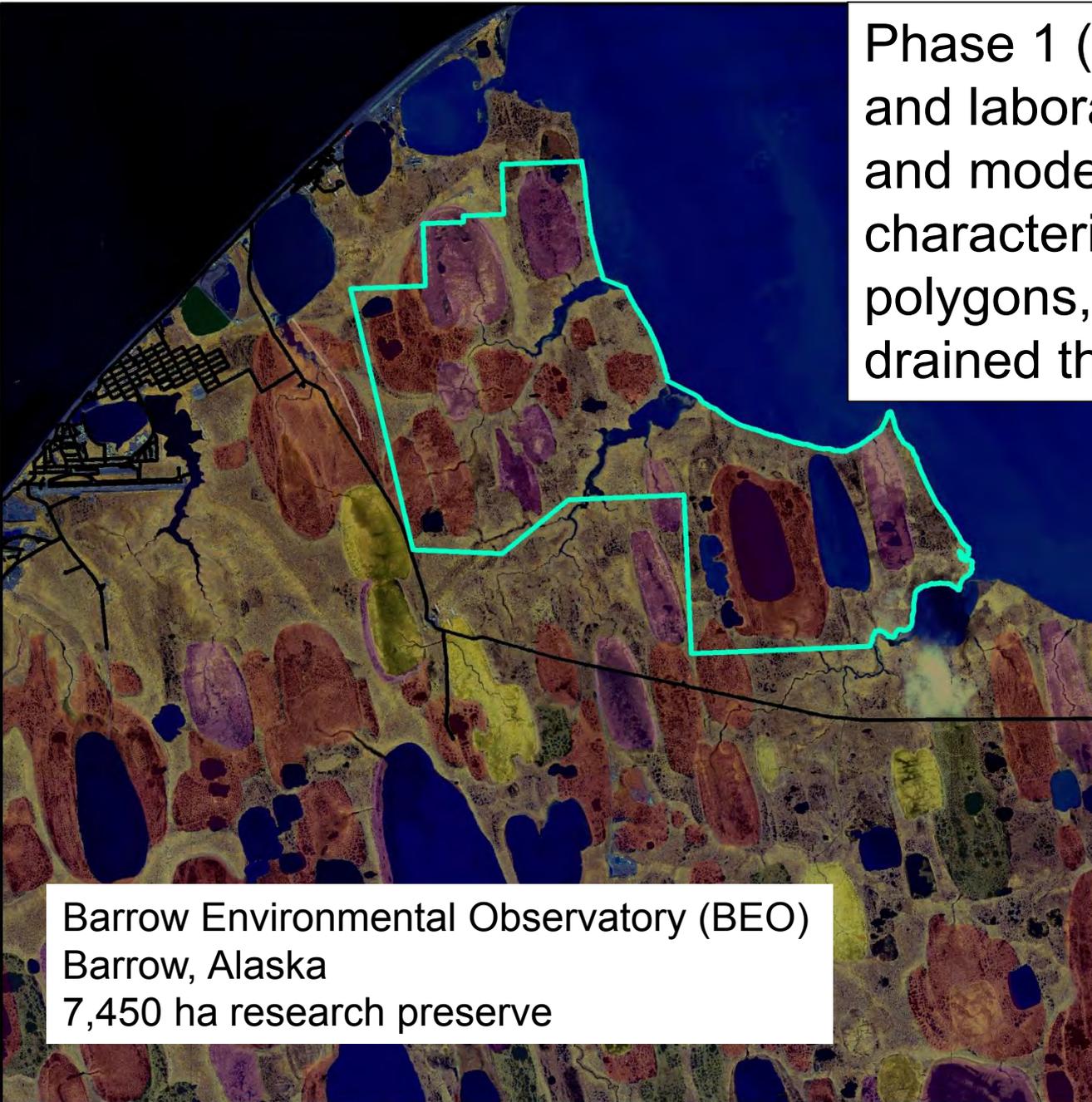


Approach:

- 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 (2012-2015) field and laboratory research and modeling focuses on characterizing ice-wedge polygons, thaw lakes, and drained thaw lake basins.

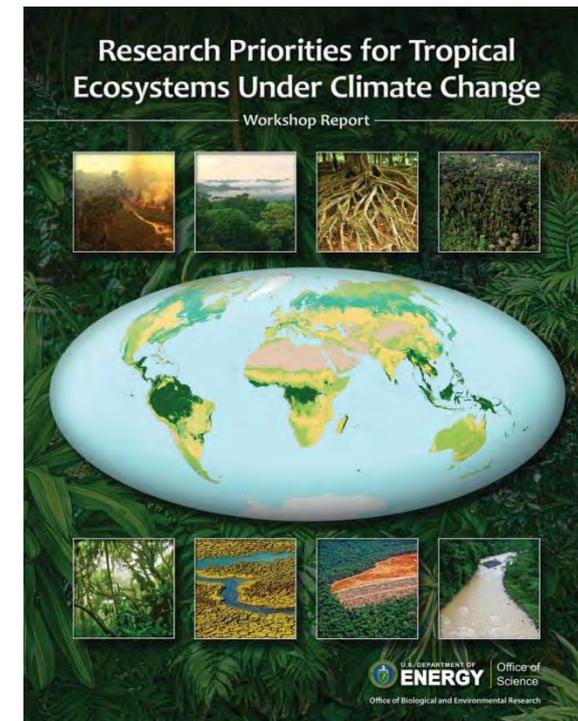


Barrow Environmental Observatory (BEO)
Barrow, Alaska
7,450 ha research preserve



NGEE – Tropics

- A 2012 workshop identified a broad set of science needs in tropical ecosystems.
- **Goal:** Improve our understanding of ecosystem-climate feedbacks due to changes in precipitation, temperature, nutrient cycling and disturbance in tropical forests.
- **Objectives:** Development of a representative, process-rich ecosystem model, extending from bedrock to the top of the vegetative canopy-atmospheric interface, 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.



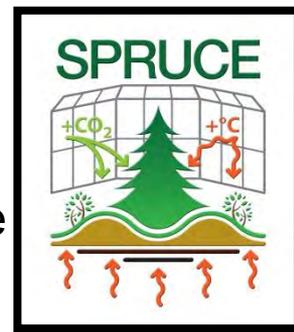
NGEE – Tropics

- “**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
 - employ a unique trait-based modeling approach
- NGEE activities will be highly multidisciplinary.
- NGEE will provide a framework for collaboration.
- Collaborative effort among DOE National Laboratories and universities, led by Lawrence Berkeley National Laboratory.



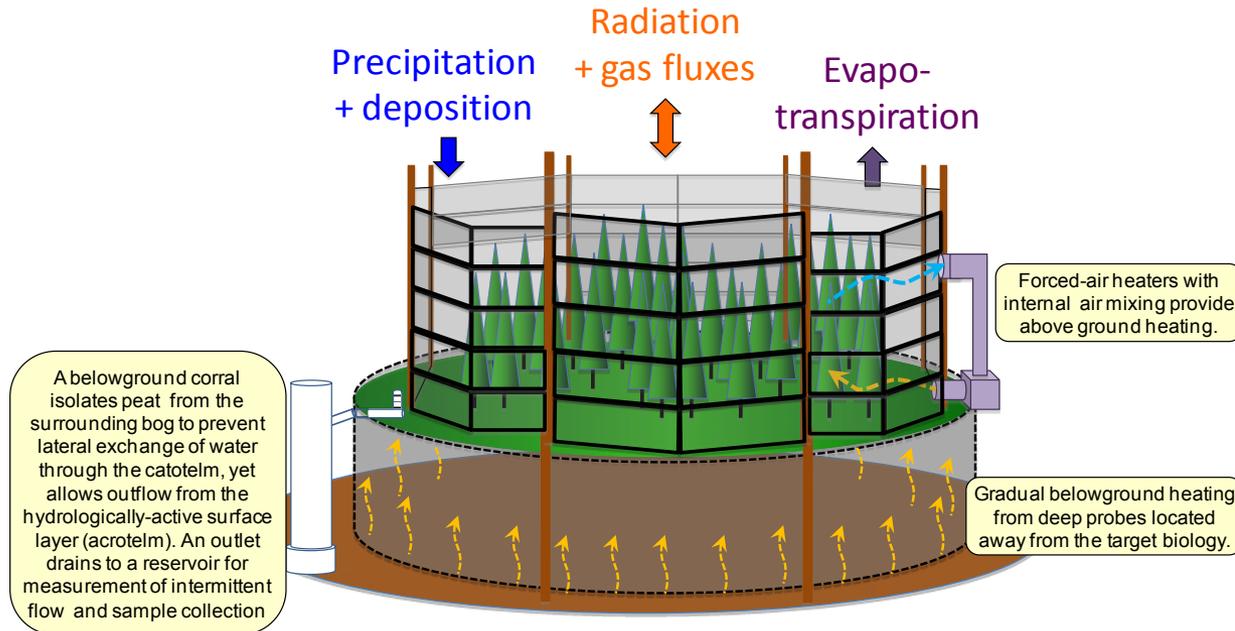
SPRUCE

- Spruce-Peatland Responses Under Climatic and Environmental Change - An experiment to test responses of high-carbon, high-latitude ecosystems to various levels of warming (as much as +9°C) with or without elevated CO₂.



Key Science Questions:

- Will deep belowground warming in the future release 10,000 years of accumulated carbon from peatlands that store 1/3 of the earth's terrestrial carbon? At what rate?
- Will releases of C be in the form of CO₂ or CH₄ with 30 times the warming potential?
- Are peatland ecosystems and organisms vulnerable to atmospheric and climatic change? What changes are likely?
- Will ecosystem services (e.g., regional water balance) be compromised or enhanced by atmospheric and climatic change?



SPRUCE





The AmeriFlux Network

214 Sites in the AmeriFlux Network

- 75 sites have submitted data since 2010
- More than 36 sites have joined or re-joined since 2012 (U.S., Canada, Panama, Mexico)



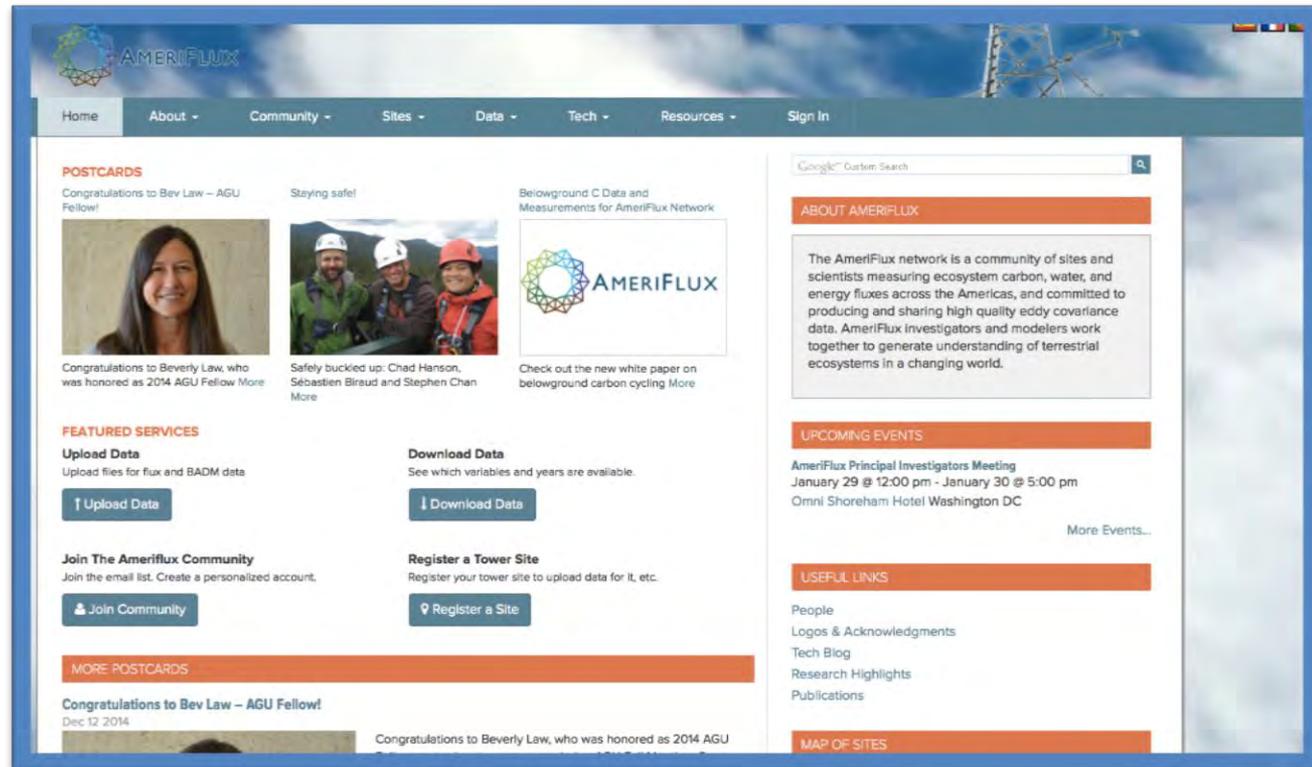
AmeriFlux Management Program Support:

- Contracts for operations
- Data managers' trainings*
- QA/QC intercomparisons, calibrations, loaners*
- Safety Training*
- Assistance with data and metadata processing

* Offered to whole network!

Exciting Growth Within the AmeriFlux Community

- 36 new sites joined the network in 2014
- New website launched (<http://ameriflux.lbl.gov/>)
- Launched the Rapid Response Tower system
- Data products



Exciting Growth Within the AmeriFlux Community

- New committees developing future visions for the community
 - “Belowground C Data and Measurements for AmeriFlux Network” whitepaper
- Safety education/ exchange of best practices
- Exceptional presence at AGU and ESA meetings
- AmeriFlux members being internationally recognized
 - Bev Law and Ralph Keeling new AGU fellows
- **Preparing for the 20th Anniversary of the network!!!**



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

Additional Opportunities

– BER'S DOE User Facilities



**Environmental Molecular Sciences
Laboratory** <http://www.emsl.pnl.gov/>

** TES sponsored post-doc to interface with this
community*



**Atmospheric Radiation Measurement
Climate Research Facility**

<http://www.arm.gov/>



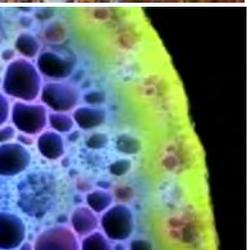
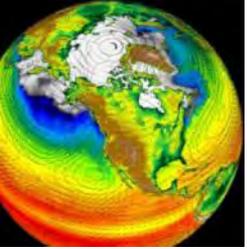
Joint Genome Institute

<http://jgi.doe.gov/>

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 2015
- Encourage leveraging of existing investments
- Final stages of recruiting an IPA

- Be sure to notify us of new publications and awards!!!



Terrestrial Ecosystem
SCIENCE

Questions?

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