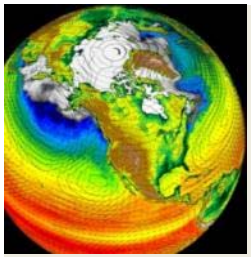
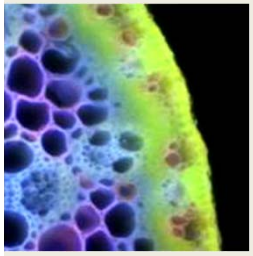
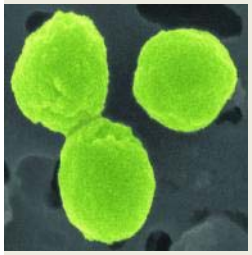


Climate and Environmental Sciences Division

BERAC update

June 27-28, 2013

G. Geernaert
BER/CESD

Outline

- Management updates
  - Solicitations, meetings, workshops, reviews
- Executing the strategic plan. Streamlining research and management with:
  - Context
  - The Enterprise Model
  - Data informatics
  - Staffing
- Research highlights
  - Facilities updates
  - Science Highlights

Climate and Environmental Sciences Division

(Gary Geernaert)

(K Carlson-Brown; L Runion; N Mekerdijian; TBD)

Data Informatics

Atmospheric Science

Atmospheric System Research (Ashley Williamson; Sally McFarlane)

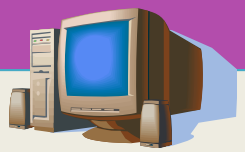
Atmospheric Radiation Measurement (ARM) Climate Research Facility (Wanda Ferrell; Rick Petty)

Climate and Earth System Modeling

Regional & Global Climate Modeling (Renu Joseph)

Earth System Modeling (Dorothy Koch)

Integrated Assessment (Bob Vallario)

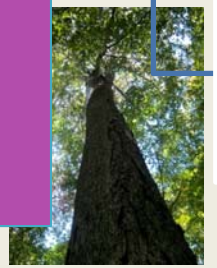


Environmental System Science

Terrestrial Ecosystem Science (Mike Kuperburg, Dan Stover)

Subsurface Biogeochemical Research (David Lesmes, Paul Bayer)

Environmental Molecular Sciences Laboratory (Paul Bayer)



Management Update: Recent and active FOA's

Funds	Program	Partic. programs	Issued	Preapps	Proposals	Selected
FY13	TES	RGCM, ESM	Aug 12	140/207	121	16
FY14	ASR		Mar 13	123/146	111	Panel July 15 wk
FY14	TES (via NASA ROSES)	NASA, NOAA, USDA, NSF	Feb 13	385	Due July 29	Panel Sept.
FY14	ASR (GOAMAZON)	FAPEAM, FAPESP	May 13		Due July 1	Panel Sept.

Management updates: SFA/CA - triennial reviews

Lab	Program	Type	Date	Outcome
LBNL	SBR	Renewal	April 2013	Pending
ANL	TES	New	April 2013	Approved w/minor
LBNL	**RGCM**	**Renewal**	**Mid-Sept. 2013**	
BNL	**ASR**	**Renewal**	**Mid-Sept. 2013**	
PNNL	**SBR**	**Renewal**	**May 2014**	
SLAC	**SBR**	**Renewal**	**May 2014**	

CESD meetings/workshops/actions

PI Meetings:

- ASR Science Team Meeting: March 18-22, 2013
- ESS PI meeting: May 14-15, 2013
- Modeling PI meeting: postponed until fall/winter 2013

Workshops

- New DOE earth system model: Dec 2012; April 2013; June 2013.
- EMSL Workshop on Aerosol Chemistry: Jan 30, 2013
- NACP: February 4-7, 2013
- Climate-Finance workshop: June 3-4, 2013
- Upcoming: EMSL science roadmap in response to BER needs

Committee of Visitors

- Date: July 8-10, 2013

U.S. DEPARTMENT OF ENERGY

Office of Science

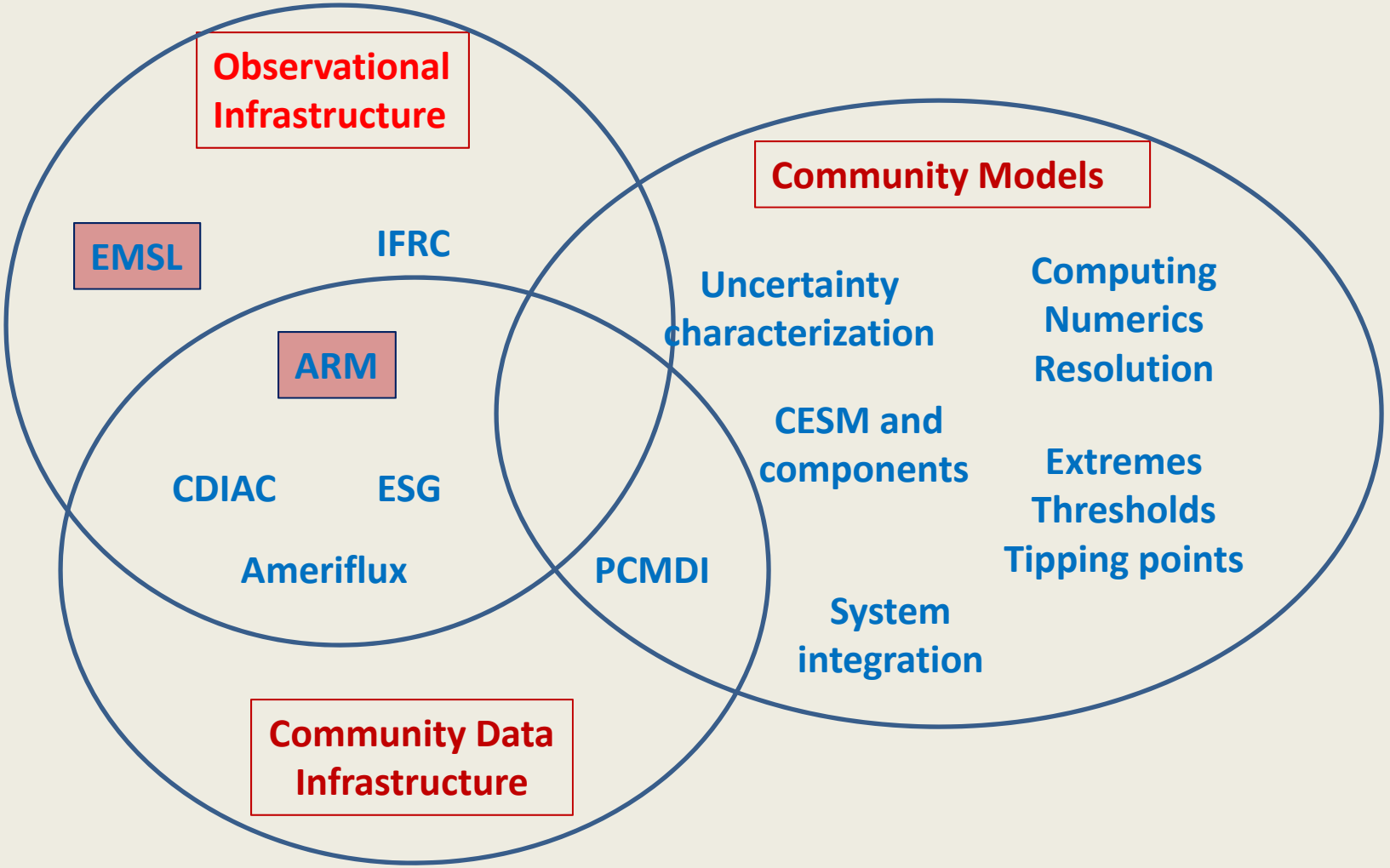
CESD strategic plan (eff 2012)

Mission: 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.

Goals

- **Process knowledge and innovative computational methods advancing next-generation, integrated models of the human-Earth system.**
- **Process-level understanding of atmospheric systems and terrestrial ecosystems, extending from bedrock to the top of the vegetative canopy.**
- **Coupled biogeochemical processes in complex subsurface environments to enable systems-level environmental prediction and decision support.**
- **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.**
- **Address science gaps that lead to solutions for DOE's most pressing energy and environmental challenges.**

Platforms for science integration



BER earth system model

- What is the new model?
  - Branch off CESM, initially limited to -40 to +40 year time horizon.
  - All CESD programs plug in.
  - Has coordinating partnership with ASCR.
  - Governance led by National Laboratories, linkages to CESM/NCAR.
  - End users: scientific research; data useful to DOE/fed stakeholders

- Why a new model
  - CESD strategy focusses on predictability, requiring integration of climate, environment, computation, and uncertainty quantification research.
  - DOE's investments require a modeling platform and governance structure that are compatible with DOE needs.

- Why now?
  - Major international competition has integrated science and computation, and CESM may lose its "research edge" if action is not taken to advance computational efficiencies.
  - We are beginning a new planning cycle: for next IPCC and CMIP6.

BER Earth System Model

- Science framework and objectives
  - Climate and the water cycle
  - Biogeochemistry
  - Cryosphere
  - Natural and anthropogenic drivers
  - Extreme events

- Computational framework (collaboration with ASCR)
  - Upgrade codes to efficiently adapt to future “extreme scale” architectures, i.e., utilize current/future LCFs
  - Exploit software engineering advances

- BER Programmatic home based on BER-wide input
  - ESM leads “model development” investments involving SFA instrument
    - Proposal and roadmap to be drafted before FY14

- Data informatics: greater efficiencies for validation and development
  - ESGF, ARM, CDIAC, AMERIFLUX
  - Other agency leveraging opps: NASA, NOAA, USGS, DHS, NGA, USDA
  - Microbial community inventories…

Staffing: recruitment

- Science Assistant
  - Focus: support to the Division's administration
  - Interviews underway
- Physical scientist (data, informatics)
  - Focus: data, informatics, visualization
  - New position – interviews underway

Research Highlights

- ARM facility update
- EMSL update
- Ocean warming and phytoplankton
- Soil warming, microbial efficiency, and GHG
- SOA formation
- Uranium bioremediation
- Omics – frontier for ESS component of earth system modeling and simulation…
- Another Maunder Minimum?
- Role of biofuel crops in climate change

ARM Climate Research Facility – New Sites

- First set of instruments to Oliktok and the Azores sites.
- Instruments will be operational at both sites, in September.
- Delivery of cloud radars in October

EMSL Planning and Calls for Proposals

2013 EMSL Planning Workshops

- Atmospheric Aerosol Chemistry – January 30, 2013
- Belowground Carbon Cycling – February 20-21, 2013
- Molecules for Biofuels and Renewable Chemicals - May 6-7, 2013

2013 Science Theme Call

- 192 proposals submitted (vs. 185 in FY12)

2013 EMSL-JGI Call

- 27 full proposals submitted
- joint EMSL/JGI peer review at JGI on June 28th

Winners and Losers: Changes in a Warming Ocean

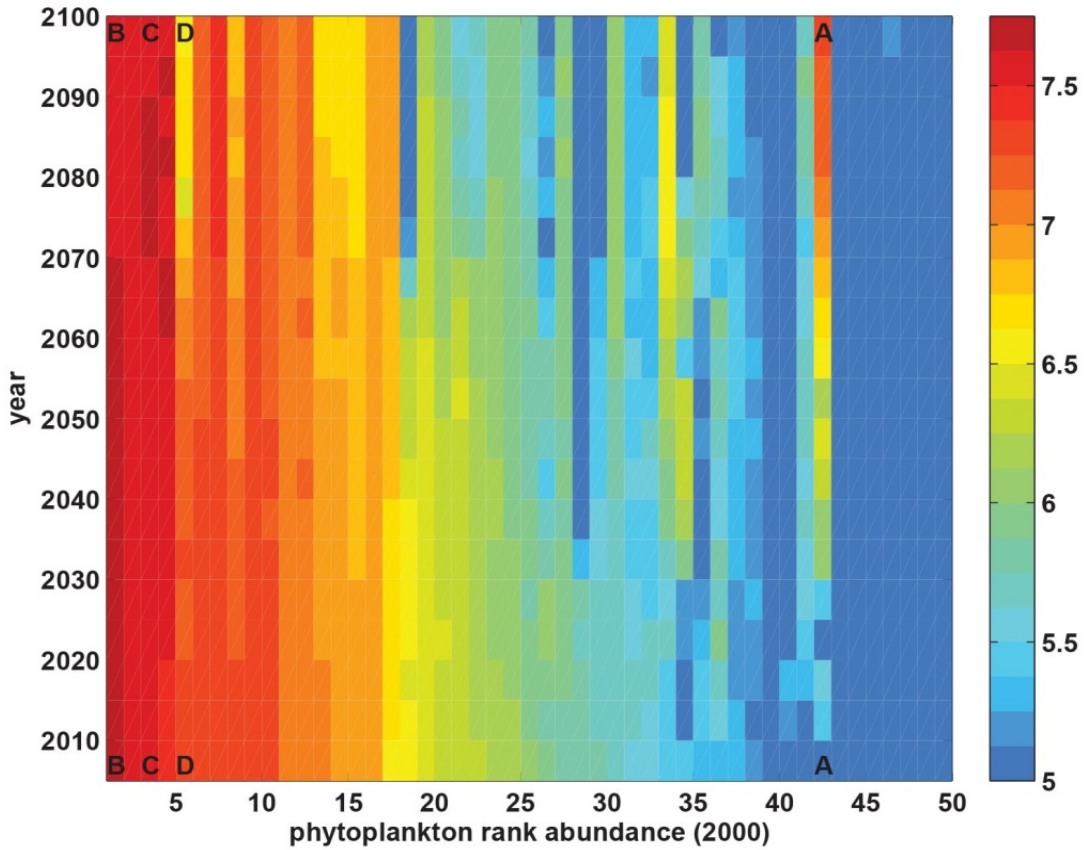
Objective: Understand how phytoplankton communities respond to climate change, and how the response affects carbon cycling to the deep ocean.

Approach:

- Couple the DOE-supported Integrated Global Systems Model (IGSM) to a marine ecosystem model
- Simulation of phytoplankton species distribution over the next 100 years.
- Analyze the two main drivers of change in these species: higher metabolic rates and changes in food and light sources.

Results:

- **Total global** amount of phytoplankton nearl constant
- Distribution and diversity is significantly altered, as nutrient and light input changes.
- Many species tend to be less efficient at exporting carbon to the deep ocean.



Total effects of climate change on populations of different phytoplankton species through 2100. Chart shows the 50 most abundant phytoplankton types arranged in order of their current abundance (in gigatons of carbon, using a logarithmic scale). Red represents more abundant species, while blue represents less abundant species. Some species increase (e.g., A), and some decrease (e.g., B).

Dutkiewicz, Stephanie, Jeffery R. Scott and Mick J. Follows, Winners and Losers: Ecological and Biogeochemical Changes in a Warming Ocean, Global Biogeochemical Cycles, IN PRESS.

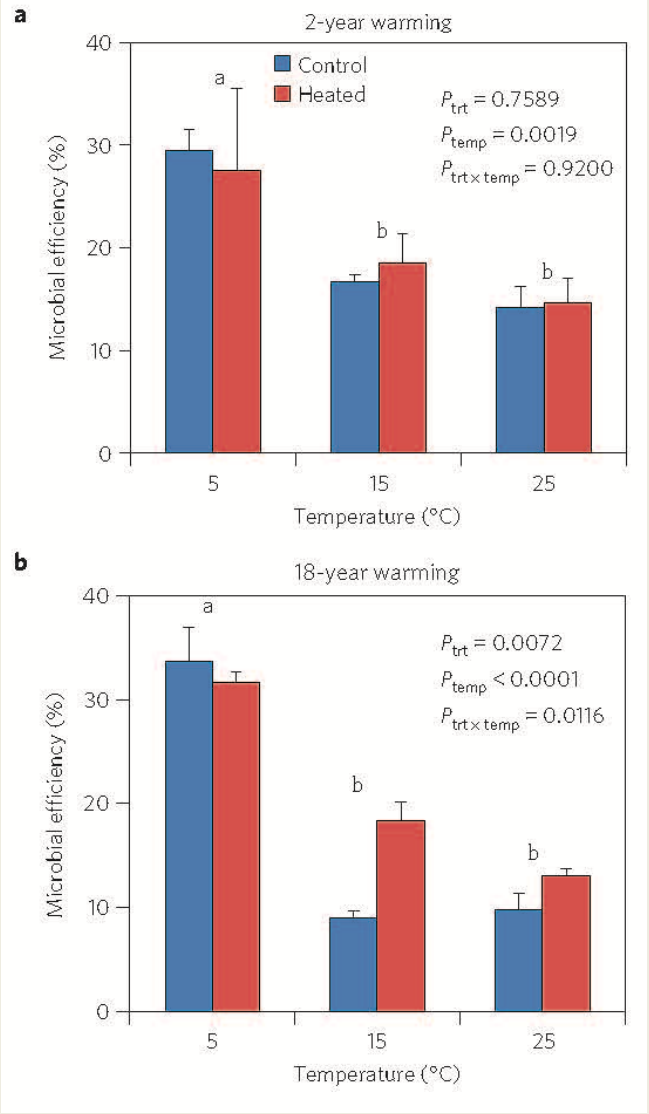
Climate Change and Soil Feedbacks to the Climate System

Will warming lead to increased soil organic matter decay and an accelerated release of soil carbon as CO2?

A 22 year in situ soil warming study at Harvard Forest was used to determine rates of root and microbial respiration.

Results:

- Warmed plots had higher respiration, but declined after about a decade. However, during the last seven years, soil respiration increased in the heated plots – a long-term response to soil warming never before documented.
- Data suggests a shift in microbial community structure in the heated plots that indicates an increase in taxa or pathways adapted to recalcitrant carbon decomposition.
- This long-term study suggests that the soil microbial community will adapt to long-term warming in a way that will lead to a depletion of the recalcitrant soil carbon stocks and a self-reinforcing feedback to the climate system.



Frey, S.D., J. Lee, J.M. Melillo, J. Six. 2013. Soil Carbon Cycling: The temperature response of microbial efficiency and its feedback to climate. *Nature Climate Change.* 3, 395–398 doi:10.1038/nclimate1796.

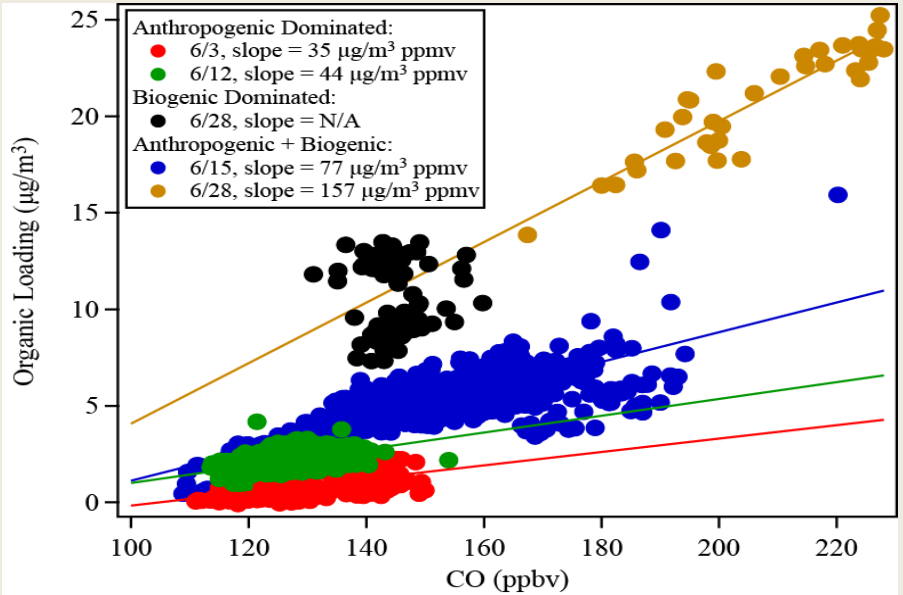
Enhanced SOA formation from mixed anthropogenic and biogenic emissions during the CARES campaign

Objective

- Investigate the hypothesis that organic aerosol formation is enhanced when biogenic (tree) and anthropogenic emissions interact in the ambient atmosphere.

Approach

- Collected data during the CARES campaign near Sacramento onboard the G-1.
- Examine the organic aerosol formation efficiency from flight patterns where the Sacramento pollution plume did and did not pass over forested areas
- Use aerosol mass spectrometry and trace gas data to understand the chemical mechanism(s) responsible for the enhancements.



Organic aerosol formation is enhanced when emissions from natural and man-made sources interact.

Results

- Demonstrated that secondary organic aerosol (SOA) formation is enhanced by a factor of 2-4 when biogenic and anthropogenic emissions mix near Sacramento.
- Determined that NOx concentrations play a role in enhancing SOA formation in these conditions.
- To accurately represent organic aerosol impacts on climates; models will need to include these mechanisms

Reference: Shilling JE, RA Zaveri, JD Fast, L Kleinman, ML Alexander, MR Canagaratna, E Fortner, JM Hubbe, JT Jayne, A Sedlacek, A Setyan, S Springston, DR Worsnop, and Q Zhang. 2013. "Enhanced SOA formation from mixed anthropogenic and biogenic emissions during the CARES campaign." *Atmospheric Chemistry and Physics* 13, 2091-2113. DOI:10.5194/acp-13-2091-2013.

A New Model for Uranium Bioremediation

Objective

- Understanding U, Fe, and S redox transition pathways *in aquifers* at molecular to pore scales

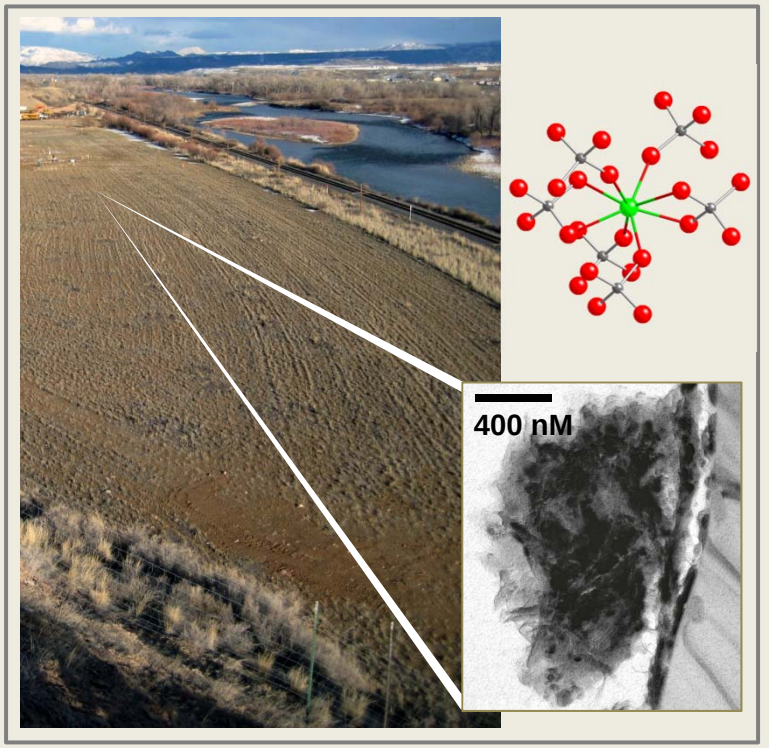
Approach

- A novel *in-situ* method was developed to study uranium bioremediation in the field
- Sediments characterized using synchrotron x-ray spectroscopy/microscopy and genome, electron microscopy, and chemical extraction methods

Results

•Bioreduced U(IV) is complexed by biopolymers that are much more reactive than crystalline UO_2, the form posited in reactive transport models. Model revision is required.

•A newly discovered biotic-abiotic reaction pathway helps explain uranium behavior under widely varying conditions in biostimulated aquifers and ore deposits.



Mobile uranium(VI) in the contaminated DOE-Rifle, CO aquifer (above) is reduced to relatively immobile U(IV) by nano-phase iron sulfides precipitated on bacterial biomass (lower right). Upper right: A structural analog for U(IV) complexed to biopolymers.

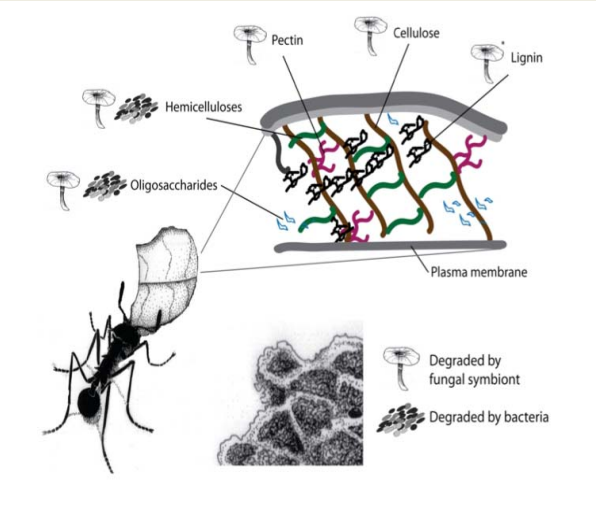
J.R. Bargar, K.H. Williams, K.M. Campbell, P.E. Long, J.E. Stubbs, E.I. Suvorova, J.S. Lezama-Pacheco, D.S. Alessi, M. Stylo, S.M. Webb, J.A. Davis, D.E. Giammar, L.Y. Blue, and R. Bernier-Latmani, *PNAS*. **110**, 4506 (2013).
This project was supported by DOE-BER and DOE-BES

Integrating Omics to Study Lignocellulose Degradation

Objective Determine the relationship between bacteria, fungi and leaf-cutter ants in lignocellulose degradation.

Approach

- Scientists from the Great Lakes BRC, JGI, EMSL and others used metagenomic and metaproteomic approaches to study the bacteria and fungus involved in breaking down cellulose in leaves found in leaf-cutter ant colonies.
- The genomics effort resulted in the first draft genome for the fungus.
- The proteomics effort revealed that the fungus produces a diverse set of lignocelluloses and appears to be the primary driver of leaf degradation.
- Bacteria further transform the partially digested sugars into a variety of nutrients.



The fungus plays a dominant role in breaking down cellulose, lignin, and pectin.
The bacterial community and the fungus break down simple oligosaccharides and hemicelluloses.
Graphic by FO Aylward.

Significance and Impact Although the fungus is the primary driver of leaf degradation, complete digestion requires the associated bacteria. These results provide insights toward the development of large-scale plant biomass conversion processes.

Aylward, FO *et al.* 2013. Leucoagaricus gongylophorus Produces Diverse Enzymes for the Degradation of Recalcitrant Plant Polymers in Leaf-Cutter Ant Fungus Gardens. *AEM* 79(12):3770.

Could a future "Grand Solar Minimum" like the Maunder Minimum stop global warming?

Objective

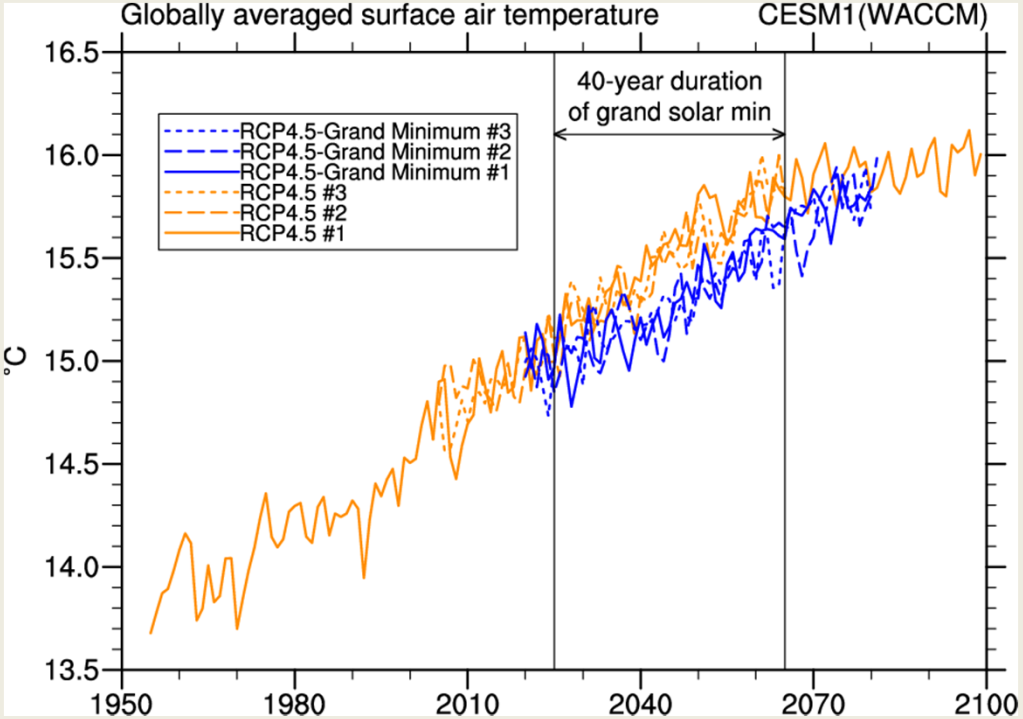
Determine if a future decrease in total solar irradiance as occurred during the Maunder Minimum could stop global warming in the 21st century.

Approach using CESM / WACCM

- solar irradiance is reduced by 0.25% during a 50 years: 2020-2070
- Apply emsision scenario (RCP4.5), that includes ozone chemistry and resolved stratospheric dynamics.

Impact

A future grand solar minimum could slow down but not stop global warming.



Time series of globally averaged surface air temperature anomalies (°C) relative to the 1986-2005 reference period for the CESM1(WACCM) standard RCP4.5 simulations (orange lines) and the grand solar minimum experiment (blue lines). The duration of the grand solar minimum experiment is indicated from 2025-2065.

Meehl, G.A., J.M. Arblaster, and D.R. Marsh, 2013: Could a future "Grand Solar Minimum" like the Maunder Minimum stop global warming? Geophys. Res. Lett., in press.

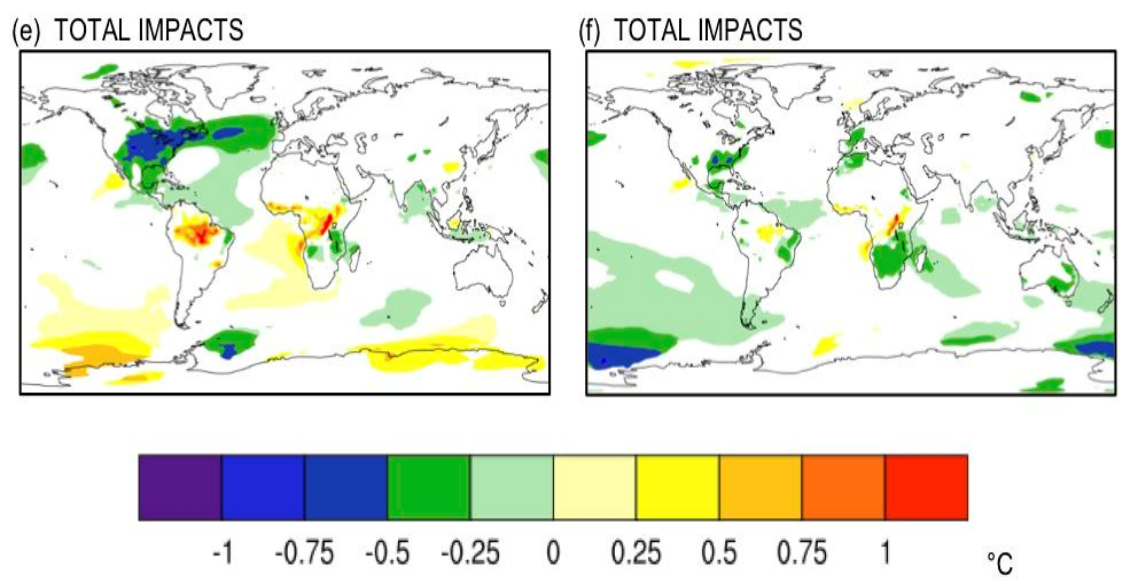
Climate Impacts of Large-Scale Biofuels Expansion

Objective: Investigate how land-use policies and economic factors influence where and how biofuel crops are planted, the ramifications for land-use change and greenhouse gas emissions, and how these influence climate.

Approach: This study uses the DOE-supported Integrated Global Systems Model (IGSM) to model the climate effects of two global biofuels programs—one that allows conversion of natural areas to meet the increased demand for land, and a second that encourages more intense use of existing managed land, and restricts deforestation.

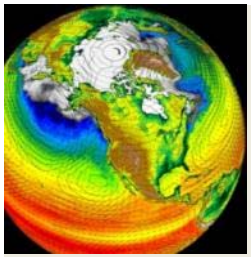
Results:

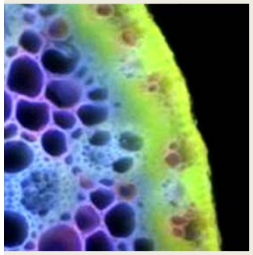
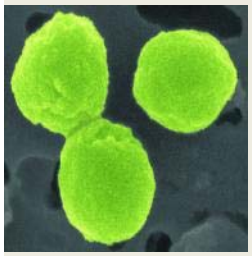
- Increased biofuel crop cultivation has negligible effect on global temperature.
- Siginificant regional warming will occur, up to 1.5 °C in the Amazon and Central Africa.
- Warming driven by forest clearing for cropland, strongly limited by degree of deforestation.



Total temperature change in (e) the first case examined, and (f) the second case examined.

Hallgren, Willow, C. Adam Schlosser, Erwan Monier, David Kicklighter, Andrei Sokolov and Jerry Melillo, Climate Impacts of Large-Scale Biofuels Expansion, Geophysical Research Letters, PENDING



Thank you!

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http://science.energy.gov/ber/research/cesd/