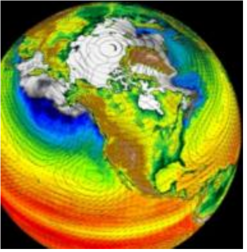
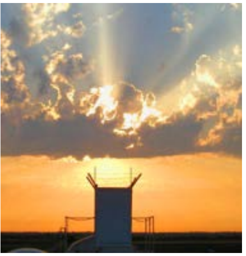
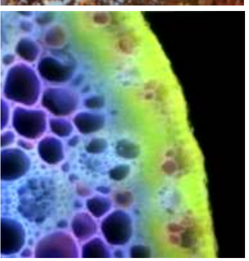






Climate and Environmental Sciences Division

G. L. Geernaert

Outline

- Management updates
- Science highlights
- Executing our strategic plan

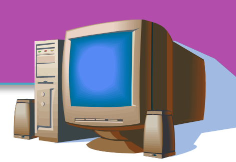
Climate and Environmental Sciences Division
(Gary Geernaert)
(Karen Carlson-Brown; Leslie Runion, Patrick Horan; Nver Mekerdijian)

Atmospheric Science

- Atmospheric System Research (Ashley Williamson)
- 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 (Todd Anderson, David Lesmes)
- Environmental Molecular Sciences Laboratory (Paul Bayer)

CESD management updates

FOA's	preapps	rec'd/encouraged	selected
ASR		107(93)	31(27)
TES/(ESM)	207	140	12-18?

PI Meetings:

- ASR: March 12-16, 2012
- TES: April 23-25, 2012
- Subsurface: April 30- May 3, 2012
- EASM PI meeting: July 9-11
- ARM science board meeting: Aug 22-23
- SCIDAC PI meeting: Sept 10-11

Workshops

- **NGEE tropics: June 4-6**
- **Integrated water cycle: September 24-26, 2012**
- **AMAP Methane workshop: September 27-28, 2012**

SFA/CA - triennial reviews

***SFA triennial reviews this FY*:**

• ORNL TES	April 2012	accepted
• SLAC SBR	April 2012	accepted
• ANL SBR	May 2012	accepted
• ORNL SBR	May 2012	accepted
• UCAR CA	June 2012	under review
• LLNL SBR	June 2012	accepted
• PNNL ASR/IA/ESM/RGCM	Aug 2012	under review
• LLNL RGCM/ESM/ASR	Sept 2012	under review

Upcoming – FY 2013 major meetings

PI meetings

• Modeling programs	February 2013 (tentative)
• ASR program	March 18-22, 2013 (approved)
• TES programs	March/April 2013 (tentative)

SFA's triennial reviews in the pipeline

• LBNL ESM/ASR	April 2013
• LBNL TES	April 2013
• BNL ASR	spring/summer 2013
• PNNL SBR	spring/summer 2013

Major workshops

• North American Carbon	November 2012
• ARM US/EU	November 13-16

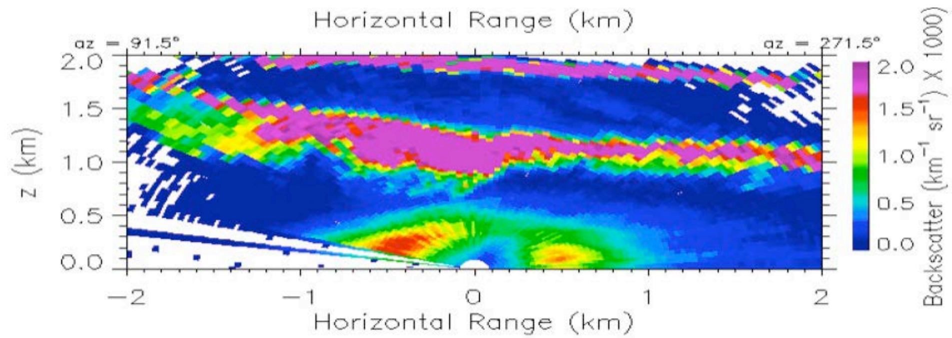
Committee of Visitors — July 2013

Science Highlights

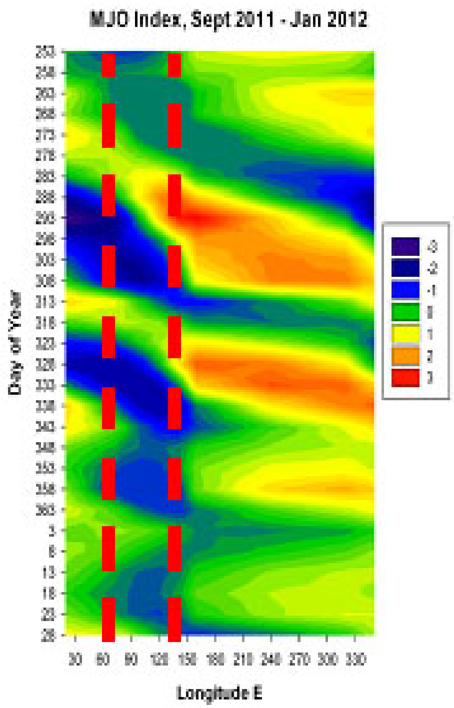
- **ARM, aerosols**
  - **Sea salt: ARM, EMSL, ASR**
- **Uncertainty and sensitivity of predictions**
  - **Hydrology: ESM**
  - **boreal shrubs: TES, modeling**
- **Storms in future climate states**
- **Biogeochemistry / genomics**
- **NGEE Arctic**

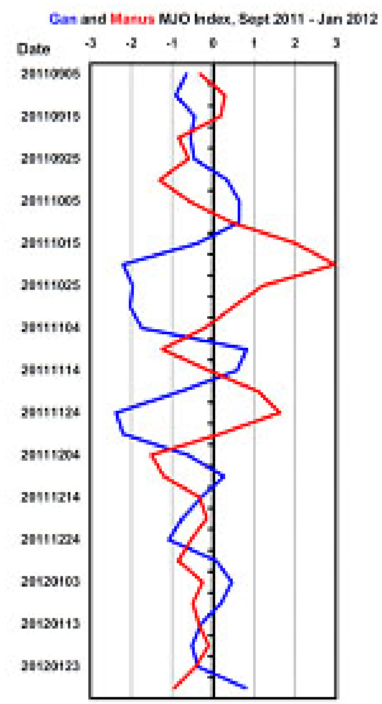
ARM campaigns

- Permanent
  - Azores install
- Mobile
  - 3: Oliktok FY12-15+
  - 1: TCAP FY12
  - 2: MAGIC FY13
  - 1: GOAMAZON FY14



Aerosol layer over India





ARM Climate Research Facility (AMF2) – MAGIC Begins

- **MAGIC - Marine ARM GPCI Investigation of Clouds:**

  Oct 1 2012 - Sept 2013
- **Ship: *Horizon Spirit***
- **R/T Transects: LA – Honolulu**
- **Two week intervals**
- **Goal: data collection in stratus-stratocumulus-cumulus transition zones, as a function of season.**

Sea Salt Particles Found to Evolve in the Atmosphere

Challenge – How and to what extent do sea salt aerosols evolve in the atmosphere?

Results – Sea salt samples obtained during G-1 aircraft flights as part of the 2010 CARES campaign were analyzed using capabilities at EMSL and ALS.

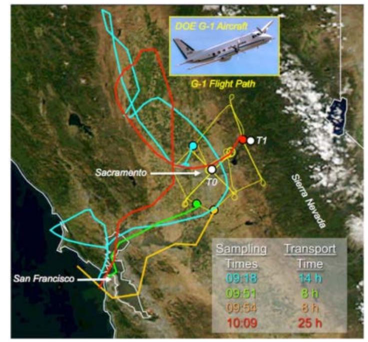
During the aging/drying of sea salt aerosols, their inorganic chloride is replaced by weak organic acid salts from secondary organic compounds formed by atmospheric reactions.

Significance and Impact – Current climate models do not consider these reactions, which may alter the optical properties and reactivity of aerosols in coastal areas where sea salt and reactive organic emissions may be found together.

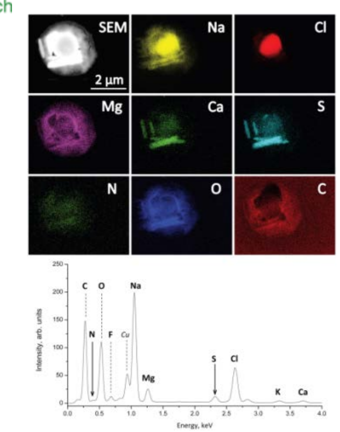
ARM CLIMATE RESEARCH FACILITY

ASR Atmospheric System Research

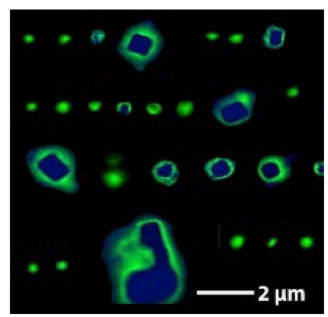
EMSL



G-1 Flight Paths in CA

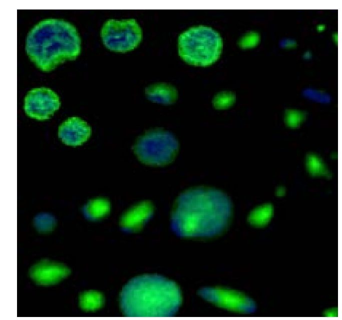


SEM Images and EDX elemental maps



8h old sea salt particles

Atmospheric aging



14-25h old sea salt particles

As sea salt particles age, organic carbon is replaced by inorganic constituents.

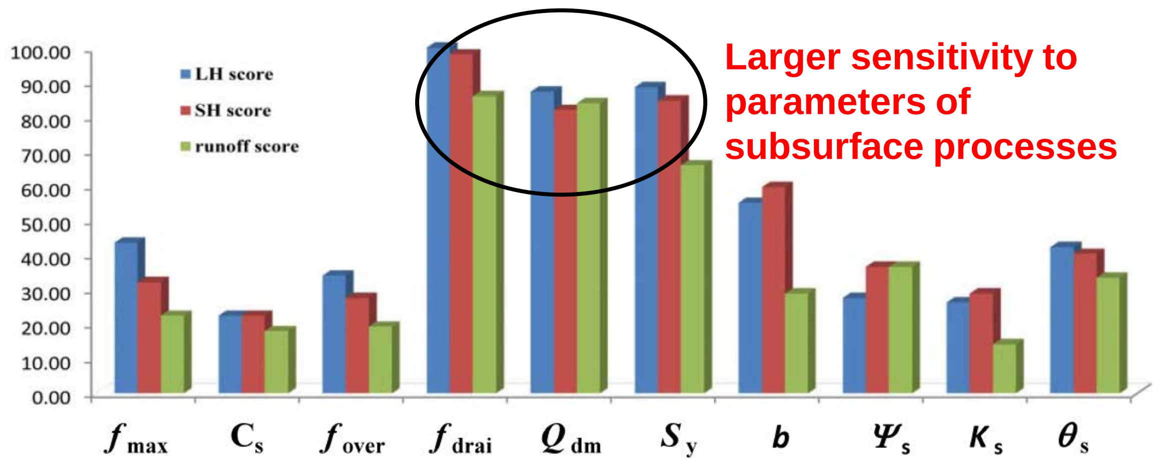
Laskin, A, RC Moffet, MK Gilles, JD Fast, RA Zaveri, B Wang, P Nigge and J Shutthanandan. 2012. *J Geophys Res-Atmospheres* 117:D15302.

New Uncertainty Quantification Framework for Community Land Model 4 Reveals the Sensitivity of Surface Flux Simulations to Hydrologic Parameters

Objective

- Reduce uncertainties in the connections between simulated water and energy fluxes to hydrologic parameters
- Use this Uncertainty Quantification (UQ) framework to constrain model parameters

Input parameter significance ranking over 13 *Ameriflux* sites



Approach

- The UQ framework is applied to 13 *Ameriflux* sites spanning a wide range of climate and site conditions to select most impactful parameters
- The sensitivity of simulated surface fluxes to the UQ-selected hydrologic parameters in the Community Land Model (CLM4) is analyzed through forward modeling

Impact

- CLM4 surface fluxes show the largest sensitivity to <u>subsurface runoff generation parameters</u>. Sites with finer soil texture and shallower rooting systems have larger sensitivity.
- Study provides guidance on reduction of parameter set dimensionality and parameter inversion framework design for CLM4 under different hydrologic and climatic regimes.

Hou Z, M Huang, LR Leung, G Lin, and DM Ricciuto. 2012. "Sensitivity of surface flux simulations to hydrologic parameters based on an uncertainty quantification framework applied to the community land model,: *J. Geophys. Res.*, DOI:10.1029/2012JD017521.

Growth and expansion of boreal shrubs enhances warming

Objective

How does shrub height & expansion affect boreal climate and permafrost?

Approach

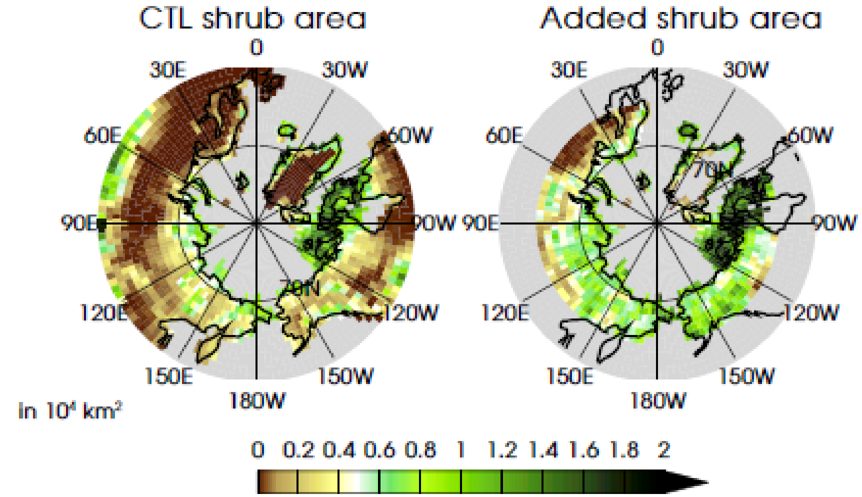
9 experiments performed with CCSM4:

- Expanding shrubs, taller shrubs
- Coupling to climate
- Increasing CO_2

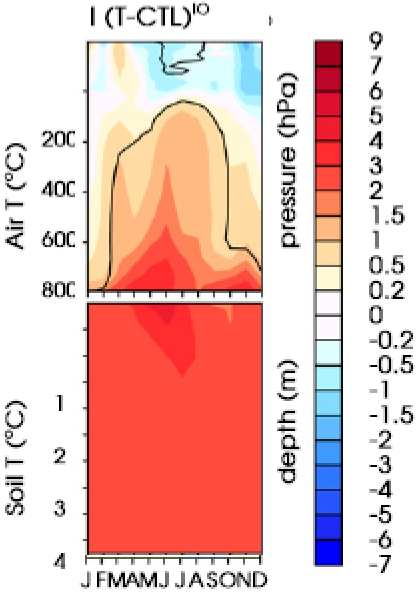
Results

- Shrub expansion leads to atmospheric heating through two feedbacks (albedo and evapo-transpiration)
- The strength and timing of these feedbacks are sensitive to shrub height
- Tall shrubs destabilize the permafrost more substantially than short shrubs

Bare ground north of 60°N converted into shrubs



Seasonal air and soil warmer from expanded and taller shrubs



Bonfils, C., TJ Phillips, DM Lawrence, P Cameron-Smith, WJ Riley, ZM Subin, 2011: On the influence of shrub height and expansion on northern high latitude climate. *Environmental Research Letters*, **7**, 015503, 2012. **Dr. Bonfils is the 2012 Early Career recipient

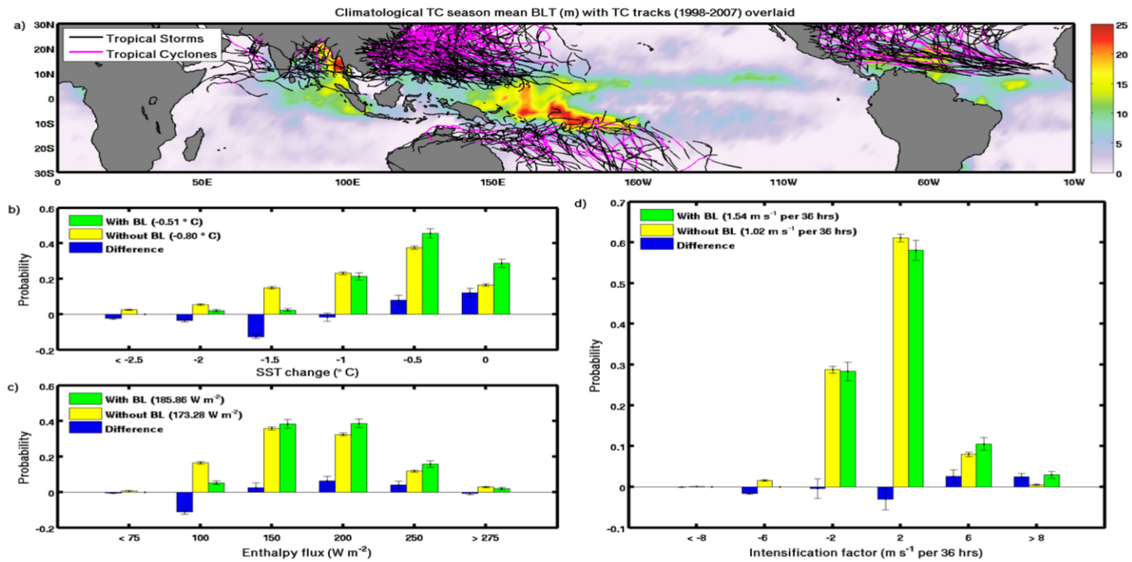
Impact of Ocean Barrier Layers on Tropical Cyclone Intensification

Objective

- Investigate the role of salinity-induced 'Barrier Layers' (BLs) in Tropical Cyclone (TC) intensification

Approach

- Perform a Lagrangian computation of Sea Surface Temperature (SST) change, enthalpy flux exchange at the air-sea interface and TC intensification factor along the tracks of various TCs for the decade 1998-2007, using a host of *in situ* and reanalysis data sets
- Comparative analysis between situations when TCs pass and do not pass over a BL
- Complement observational analysis with numerical modeling using a high resolution Coupled Regional Climate Model



Top: An illustration of the TC tracks (1998-2007) used for the observational analysis, overlaid on TC season averaged BL thickness. Below: Probability Distribution Functions of SST change, enthalpy flux exchange and TC intensification factor for TCs with and without BLs.

Impact

- BLs enhance TC intensification by nearly 50% on average
- Important to monitor the upper-ocean salinity structure, along with the thermal structure, in deep tropical BL regions to improve TC intensity forecast
- BL changes must be considered in projecting future TC activity, as the hydrological cycle responds to global warming

Funded jointly by RGCM and IARP

Balaguru K, P Chang, R Saravanan, LR Leung, Z Xu, M Li and JS Hsieh. 2012. "Ocean Barrier Layers' Effect on Tropical Cyclone Intensification," *Proceedings of the National Academy of Sciences*, U.S.A., Early Edition, online the week of August 13, 2012. DOI:10.1073/pnas.1201364109. (*In press*).

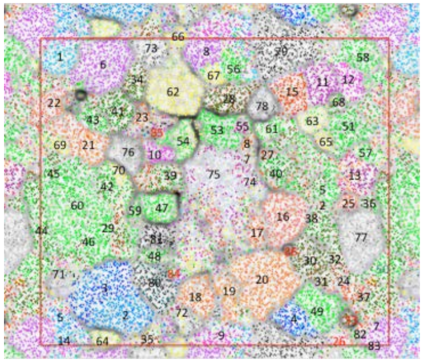
New Era of Metagenomic Analyses: Capturing microbial community structure and revealing biogeochemical function

Objective

- Develop and test novel environmental metagenomic techniques to more completely capture the microbial community structure and reveal the in-situ biogeochemical function of community members

Approach

- High throughput sequencing of groundwater samples taken from the Old Rifle IFRC site
- Cultivation-independent recovery of genomes
- Nearly all of the sequenced genes (150k) were assigned to one of 87 different organisms



Emergent Self-Organizing Map Analysis

Impact

•Produced 46 near complete microbial genomes
•Discovered 4 genomically unrecognized phyla and revealed their roles in hydrogen production, sulfur cycling, and fermentation of refractory sedimentary carbon
•Important implications for carbon cycling, biofuel production, and contaminant mobility

Wrighton, Banfield, et. al. (2012) Fermentation, Hydrogen and Sulfur Metabolism in Multiple Uncultivated Bacterial Phyla **Science.** 337(28): 1661-1665. *This project is supported by CESD-SBR, BSSD-Kbase, JGI-CSP, and EMSL*

High-Resolution Datasets Quantify Land Surface-Subsurface Properties in Permafrost Ecosystems (NGEE Arctic)

Objective:

Quantify variation in landscape geomorphology for Arctic ecosystems using remote sensing and geophysical datasets.

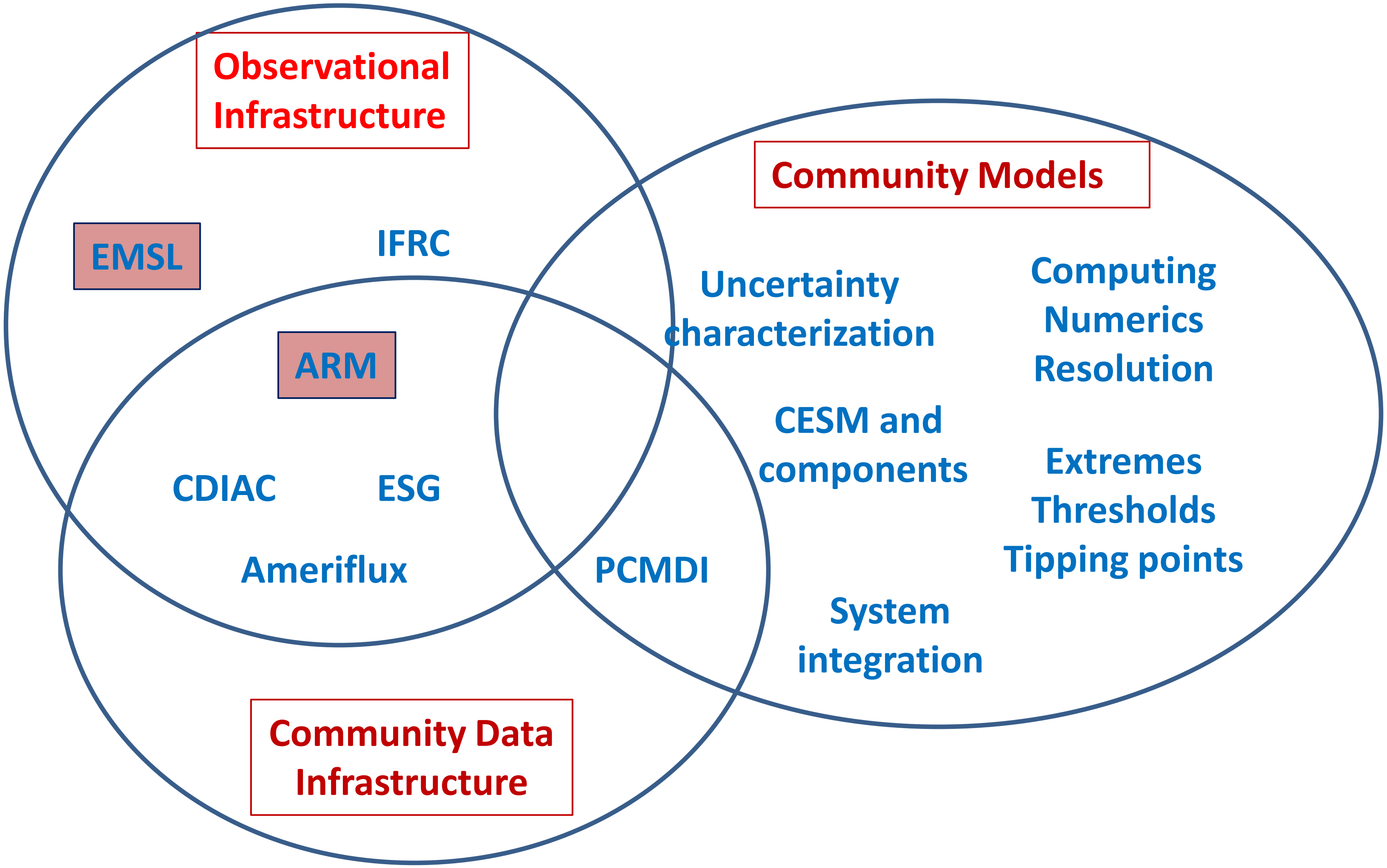
Approach:

Surface geophysical data were used with LiDAR and point measurements to characterize active layer depth, and soil water and ice content.

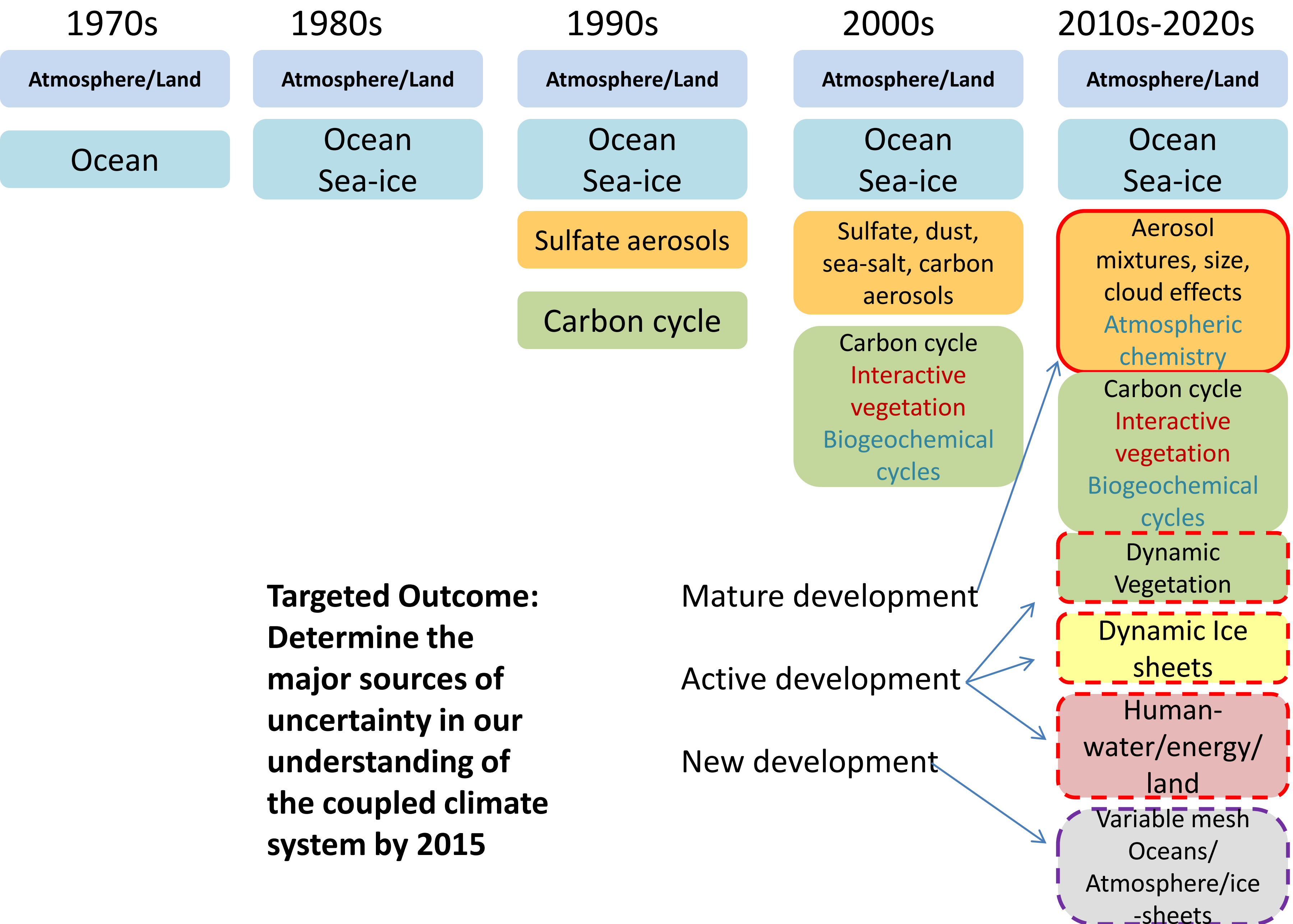
Results/Impacts:

- Cluster analysis revealed regions along transect with unique surface and subsurface properties.
- Small-scale information on these properties and their zonation can be upscaled to larger spatial scales and used to initialize and validate ecosystem models.
- Characterizing relationships between properties and scales of observations are important for a predictive understanding of ecosystem feedbacks to climate.

DOE roadmap to advance predictability



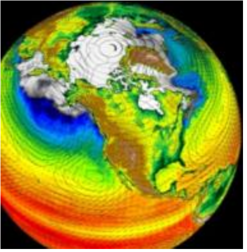
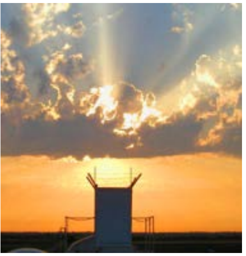
Evolution of Earth system prediction

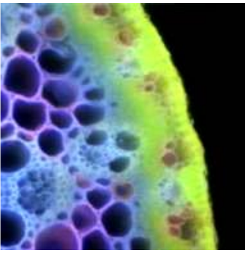
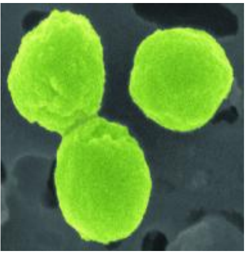


Targeted Outcome: Determine the major sources of uncertainty in our understanding of the coupled climate system by 2015

Executing our strategic plan

- More inputs
  - CESD strategic plan
  - USGCRP strategic plan
  - NRC report on the future of climate modeling
  - BERAC report
- What's important to focus on in FY13-14
  - Advancing CESM architecture into next generation
  - Enhancing "big data" infrastructure for AR6
  - Roadmap for the NGEE and ARM link to ESM's
  - Interagency partnerships

Thank you!

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