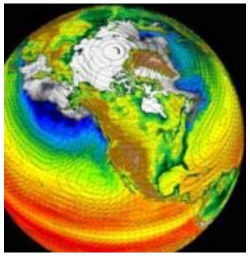
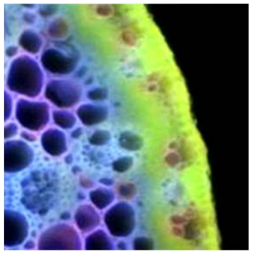
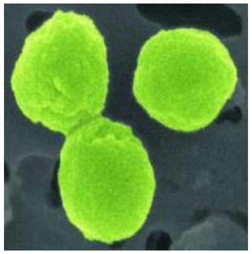


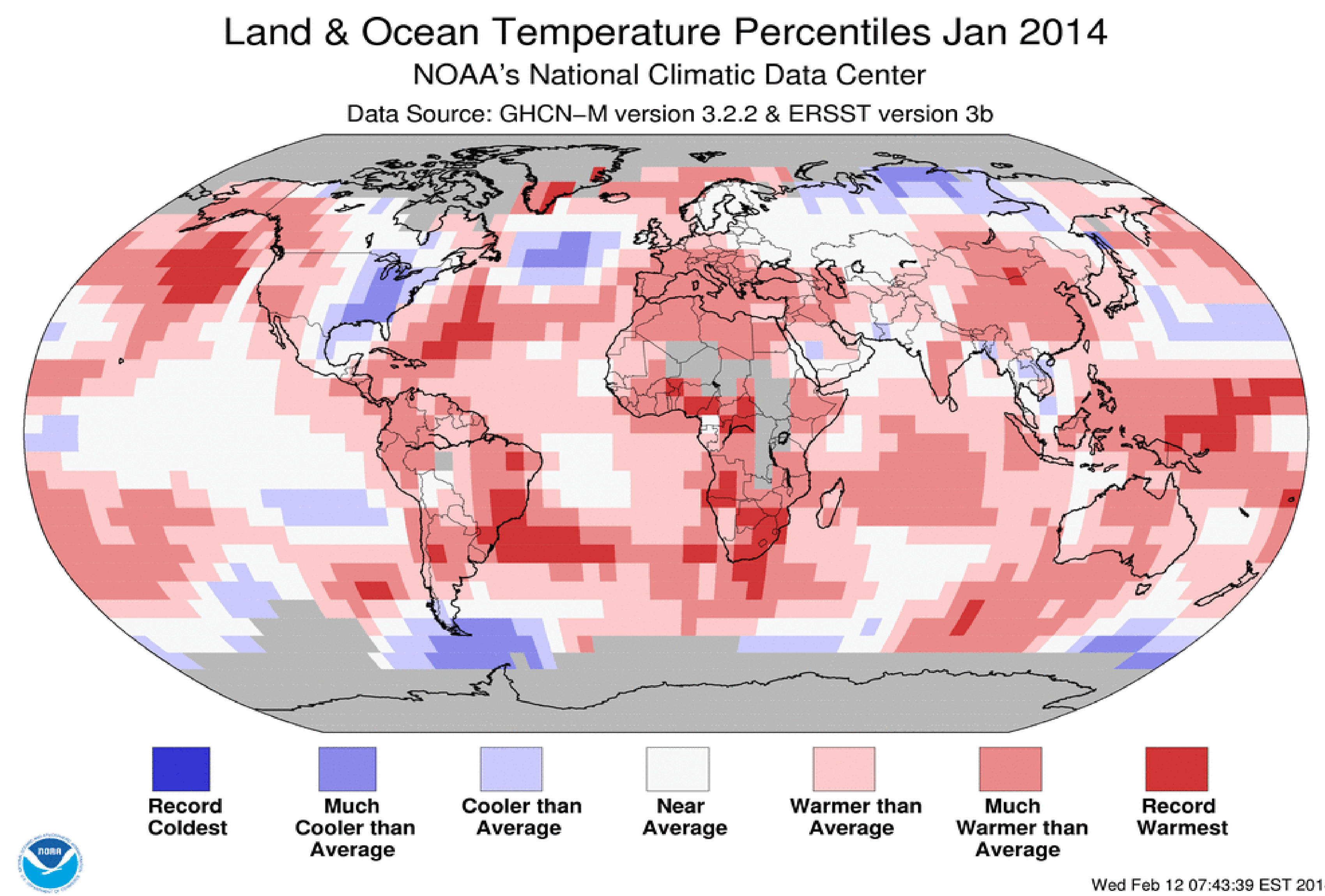




Climate and Environmental Sciences Division

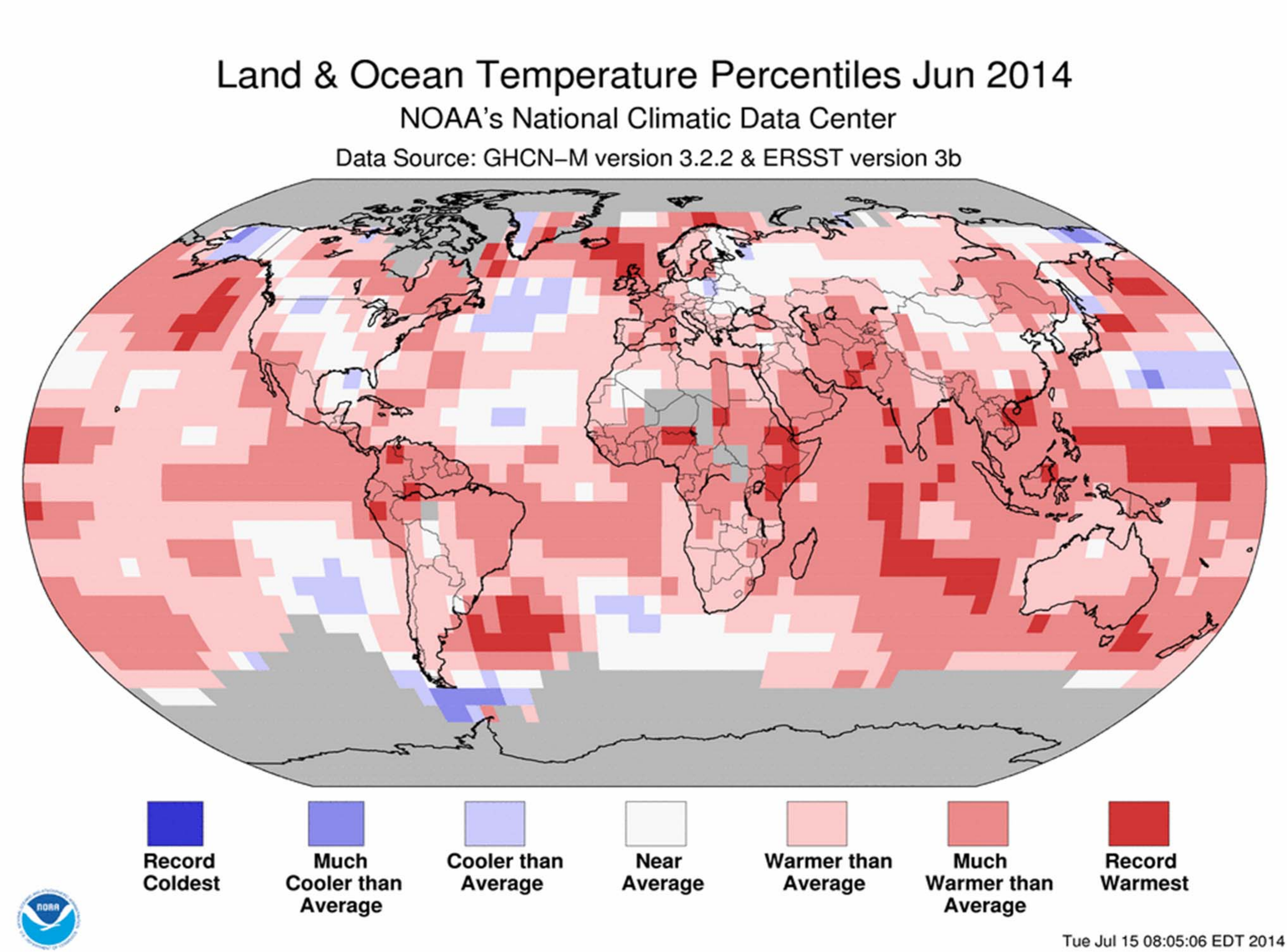
BERAC update

October 1-2, 2014

G. Geernaert
BER/CESD



- Warmest southern hemisphere on record
- 4th warmest January northern hemisphere


Land & Ocean Temperature Percentiles Jun 2014
NOAA's National Climatic Data Center
Data Source: GHCN–M version 3.2.2 & ERSST version 3b
Record Coldest
Much Cooler than Average
Cooler than Average
Near Average
Warmer than Average
Much Warmer than Average
Record Warmest
Tue Jul 15 08:05:06 EDT 2014

Management Update: Recent and projected FOA's

Funds	Program lead	Participating programs	Issued	Preapps	Proposals	Selected
FY14	ESM	ESM, RGCM	Nov 20, 2013	293	138	10 (panel 4/21)
FY15	SBR	ASCR	May 22, 2014	2	2	1 (Panel July 21)
FY15	ASR	ASR (ENA; NSA)	May 27, 2014	5	5	1 tbd (Nov 7)
FY15	TES	ESS (TES, SBR)	July 31, 2014	183		
FY15	ASR	ASR (open)	Aug 5, 2014	148		
FY15	SBR	SBR	Fall			

Management updates: 2014 SFA and Facility reviews

Lab	Program	Type	Notification	Review date	Outcome
LLNL, multi-lab	ACME SFA	New	Aug 1, 2013	March 4-6	A – Jun 27
LBNL	ASR SFA	Renewal	Oct 2, 2013	April 8-9	Conversion to project - May 2
LBNL	TES SFA	Renewal	Jan 18, 2013	April 8-9	A – April 17; vision
PNNL, multi-lab	ARM facility	Review	Oct 30, 2013	April 14-17	A - April 28; vision
SLAC	SBR SFA	Renewal	Oct 3, 2013	May 5	A - June 26
PNNL	SBR SFA	Renewal	Oct 3, 2013	May 8	A – July 2
ORNL, multi-lab	RGCM SFA	New	Oct 11, 2013	May 16	A – July 8
PNNL	EMSL facility	Review	Feb 11, 2014	Sept 23-24	
LANL	RGCM SFA	Renewal	Oct 11, 2013	Nov 13-14	

Management updates: 2015 SFA and Facility reviews

Lab	Program	Type	Notification	Review date	Outcome
NGEE (LBNL+)	ESS	Project new	Sept 2, 2014	Spring	
CDIAC (ORNL)	Data, ESS	Project renewal	Aug 18, 2014	Spring	
ORNL	TES	SFA	Jan 16, 2014	July	
ORNL	SBR	SFA	Sept 16, 2014	April	
ANL	SBR	SFA	Sept 15, 2014	April	
LLNL	SBR	SFA	Sept 15, 2014	April	
LLNL	RGCM, ASR	SFA	Sept 4, 2014	July-Aug	
PNNL	RGCM, ASR	SFA	Aug 20, 2014	Spring-Summer	
PNNL	IA	SFA		Spring-Summer	

Management updates: 2014 - PI meetings, workshops

Title	Program(s)	Location	Date in 2014
ASR PI meeting	ASR	Bolger	March 10-12
Mechanistic modeling of Terrestrial environments	SBR, TES, ESM	DOE/GTN	March 26-27
Ameriflux PI meeting	TES	Bolger	May 4-5
ESS PI meeting	TES, SBR	Bolger	May 6-7
Modeling PI meeting	ESM, RGCM, IA	Bolger	May 12-15
ARM LES workshop	ARM, ASR	Rockville	May 19-20
Molecular Sciences Workshop	BER-wide	DOE/GTN	May 27-29
Population dynamics workshop	IA / USGCRP	Rockville	June 23-24
Land Use Land Cover Workshop	IA / USGCRP	Rockville	June 25-27
ARM North Slope Alaska Workshop	ARM, ASR	Gaithersb.	Sept 10-11
Climate-energy model interdependencies Workshop– Part 1	ESM, IA	Rockville	Oct 28-30
ASR Fall PI meeting	ASR	Bethesda	Nov 17-20

Management updates: 2015 - PI meetings, workshops

Title	Program(s)	Location	Date in 2015
NACP workshop and Ameriflux PI meeting	TES	Wash DC	Jan 26-30
Climate-energy model interdependencies Workshop– Part 2	ESM, IA		Spring
Climate-energy model interdependencies Workshop– Part 3	ESM, IA		Spring
ARM AAF strategy workshop	ARM, (ASR, ESS)		Spring
ESS PI meeting	TES, SBR	Bolger	April 28-29
ARM/ASR Facility PI meeting	ARM, ASR	Tysons	March 16-20

CESD Retreat – July 8, 2014

Goals:

* Division-wide team building
* Multi-program CESD future priorities

CESD retreat

Initial conditions

- CESD strategic plan: observations / data analytics / process models / system predictability
- DOE uniqueness: HPC; big data; infrastructure; mission
- Mapping to USGCRP priorities: Modeling, Arctic, Drought, ..
- Recognize ongoing multi-disciplinary and/or multi-program success stories, e.g.,
  - NGEE; GOAMAZON; joint facility FOA (EMSL; JGI)
- Collaborations with other agencies

- <u>Retreat outcomes: Priorities require multiple program commitments</u>

CESD retreat outcomes

Topics to pursue

- *Urban processes and regional climate*
- *Land-atmosphere interaction*
- *Polar environments*
- *Terrestrial-aquatic interfaces*

Assets and issues

- Facilities and instrumentation
- Scale-aware processes, interdependencies
- Multi-scale, high-res process modeling, data assimilation
- Data: mining, storage, analytics, visualization, automation

Setting CESD priorities and investment agenda

- Existing model sensitivity and uncertainty quantification
- Discovery: missing or inadequate in prediction systems
- DOE uniqueness, agency partnerships

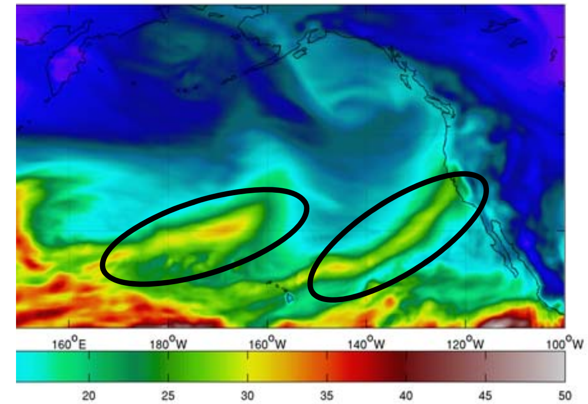
Intermediate frequency atmospheric disturbances: A dynamical bridge connecting western U.S. extreme precipitation with East Asian cold surges

T. Jiang, K.J. Evans, Y. Deng, X, Dong

Objectives

- Evaluate the representation of atmospheric rivers (AR) within a high resolution Community Atmosphere Model (CAM4) with spectral dycore (T341 1/3 degree)
- Determine the link between AR and large scale East Asian cold surges
- Determine how well the high-resolution model captures the scale interaction of dynamical anomalies

Impact



analyze AR in future scenarios

Accomplishments

- Finer scale moisture anomalies responsible for extreme precipitation over the West Coast US can be resolved well with 1/3 degree atmosphere models
- A higher resolution global atmosphere model can capture remotely connected and differing scales of dynamical anomalies
- T341 shows the correct attribution of AR modulation by cold air ourbreaks over Asia as mostly due to intermediate frequency eddies

Computational Advances:

- A present-day T341 CAM4 simulation provides a wealth of high resolution data from which to compare large and small scale dynamical anomalies
- Illustrates utility of global high-res atmospheric simulations to enable an analysis of scale interaction

Jiang et al. (2014), J.G.R. Atmos. 119, 3723–3735, doi:10.1002/2013JD021209.

Predictability of “climate change hiatus” using initialized versus uninitialized climate models

Objective

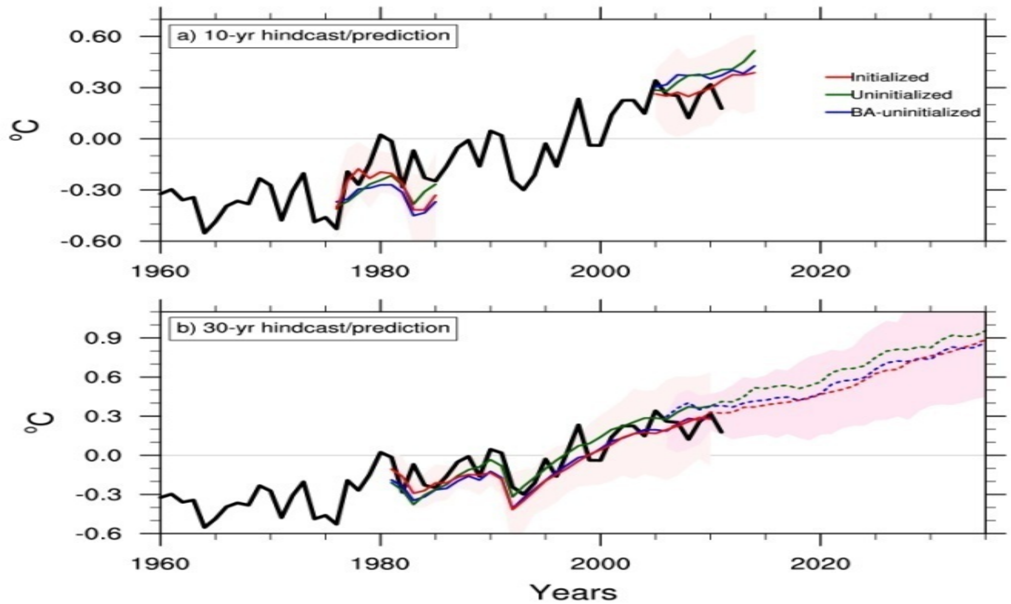
- Determine if climate models initialized with observations can improve predictability of the 1970s warming and the early 2000s hiatus, compared to uninitialized climate models.

Approach

- Using 16 CMIP models, Compare predictions for 2016-2035 from the CMIP5 initialized models with the CMIP5 uninitialized climate models. Initialize with 10 yr; then 30 yr.

Results

- Routinely (re-)initialized climate models show a 16% reduction of near-term global warming compared to the traditional uninitialized climate model projections.
- They also show increased capability in simulating past climate shifts, the early-2000s hiatus.



Globally averaged surface air temperature anomalies:

(a) 10 year initialized simulations (red) show greater warming for the 1970s shift and less warming for the early-2000s hiatus than uninitialized (green);

(b) less warming for a 30 year initialized prediction (red dashed) for 2016-2035 compared to free-running uninitialized projections (dashed blue), for the CMIP5 models.

Meehl, G.A., and H. Teng, 2014: CMIP5 multi-model initialized decadal hindcasts for the mid-1970s shift and early-2000s hiatus and predictions for 2016-2035. *Geophys. Res. Lett.*, doi:10.1002/2014GL059256.

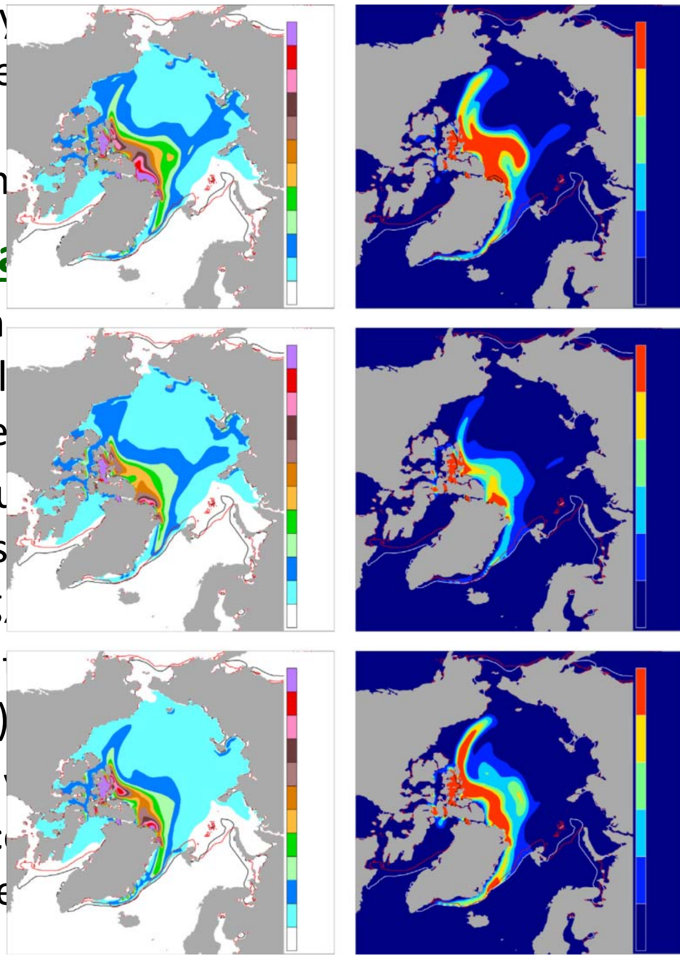
Sea ice volume and age: Sensitivity to physical parameterizations and thickness resolution in the CICE sea ice model

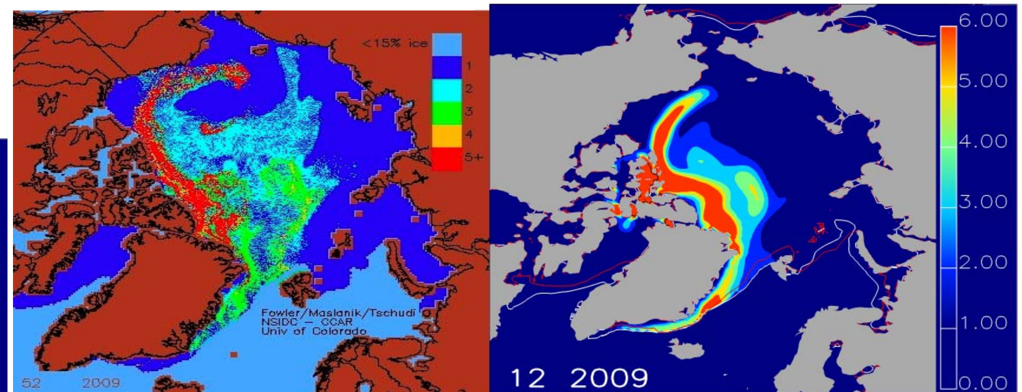
Objective

- To combine age and volume
  analy
  the e
  that
  term

Appro

- Com
  satel
  obse
- Evalu
  (anis
  drag
- Iden
  (ITD)
- Anal
  proc
  biase





Sea ice age (year) from (left) observations and (right) CICE, using the variable form drag parameterization.

ct

ve thickness categories
e insufficient to
solve ITD
namic-
ermodynamic
edback processes can
ve counter-intuitive
pacts on ice volume
d age.

6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0

Hunke, E. C. Sea ice volume and age: Sensitivity to physical parameterizations and resolution in the CICE sea ice model. Ocean Modelling, DOI: 10.1016/j.ocemod.2014.08.001. LA-UR-14-21531

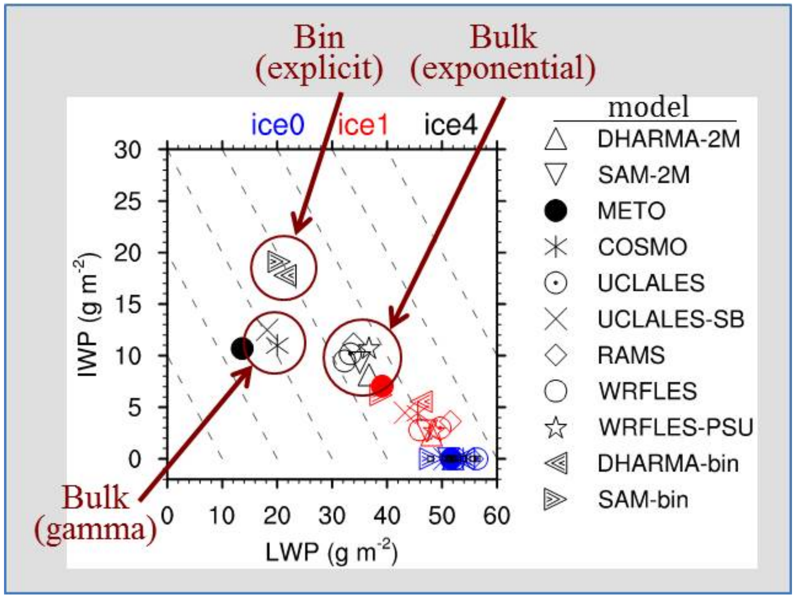
Modeling of Arctic mixed-phase clouds depends strongly on ice crystal size distribution assumptions

Objective

- Improve model representation of processes controlling the evolution and lifetime of Arctic mixed-phase clouds.

Approach

- Compare 11 large-eddy simulation (LES) models using an Arctic mixed-phase cloud case from the ARM Indirect and Semi-Direct Aerosol Campaign (ISDAC).
- Hold ice properties and radiation constant across the models, but vary the amount of ice and how the ice crystal size distribution is represented



Liquid (LWP) and ice (IWP) water paths predicted by 11 models in 3 sets of simulations with various ice concentrations illustrate the dominant effect of the ice particle size distribution representation.

Results

- Realistic representation of both ice crystal size distribution and ice amount is necessary to accurately partition liquid water and ice in mixed-phase clouds.
- Explicit bin size distribution schemes performed better than simpler bulk size distributions.

Ovchinnikov M, AS Ackerman, A Avramov, A Cheng, J Fan, AM Fridland, S Ghan, J Harrington, C Hoose, A Korolev, GM McFarquhar, H Morrison, M Paukert, J Savre, BJ Shipway, MD Shupe, A Solomon, and K Sulia. 2014. "Intercomparison of large-eddy simulations of Arctic mixed-phase clouds: Importance of ice size distribution assumptions." Journal of Advances in Modeling Earth Systems, 6(1), doi:10.1002/2013MS000282.

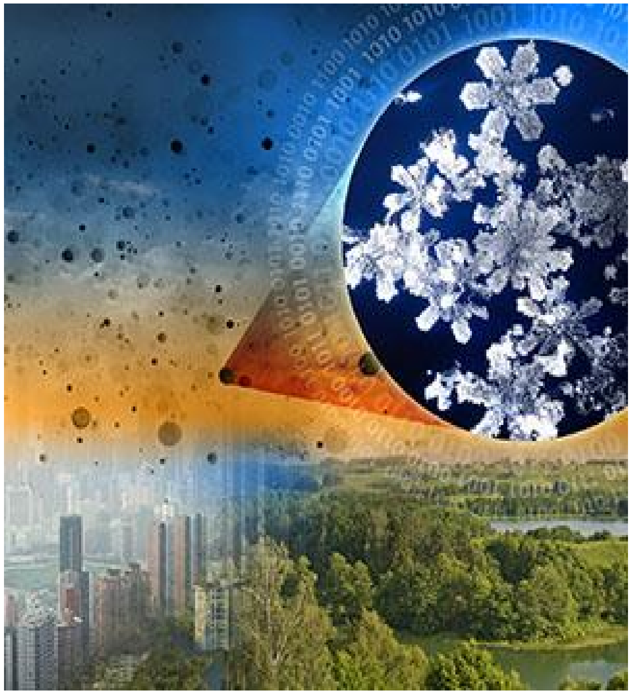
New Insights into Ice Formation in Clouds enabled by EMSL, ARM and ASR Collaboration

Challenge:

- Understand how ice crystals form from aerosol particles.

Approach and Results:

- Multi-institutional team obtained samples of particles that act as ice nuclei from central California (CARES campaign).
- Used micro-spectroscopy and chemical imaging methods to characterize the physical and chemical properties of individual particles.
- Results demonstrate that ice-nucleating particles are not distinct from other particles, and they do not represent a "needle in a haystack" challenge.
- Factors such as particle abundance and surface area my govern the ice nucleation rate and ice formation processes.



Significance and Impact:

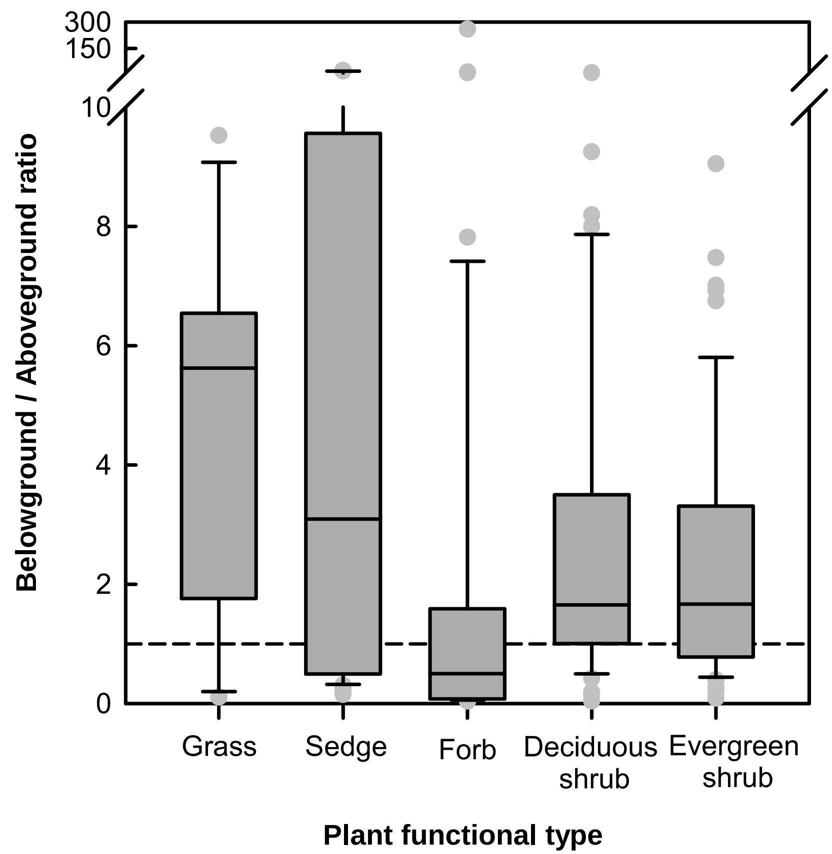
- Disproves the traditional view that there are very few but exceptional particles in the atmosphere that can become ice nuclei.
- Cloud models should therefore account for properties of the entire particle population as well as individual ice-nucleating particles.

Participants: Stony Brook University, EMSL, Advanced Light Source at LBNL and University of the Pacific
Reference: Knopf et al. 2014. Journal of Geophysical Research – Atmospheres. DOI: 10.1002/2014JD021866

The unseen iceberg: Plant roots in arctic tundra - NGEE

New Science

- A new publication by scientists on the NGEE-Arctic team synthesized available literature on tundra roots, and their representation in Terrestrial Biosphere Models.
- The publication highlighted several key themes:
    1. Tundra root distribution and dynamics differ in many ways from those observed in other biomes.
    2. There are strong linkages between belowground and aboveground tundra plant traits.
    3. Edaphic and environmental conditions exert important controls over tundra root distribution and dynamics.
    4. There are clear priorities for future research on fine roots in tundra ecosystems (e.g., species-specific root function and root dynamics under changing environmental conditions).

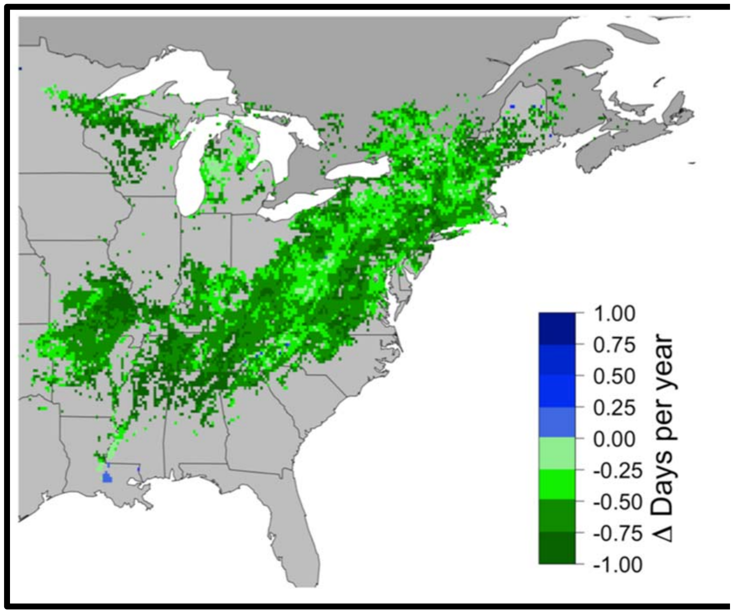


Significance

- Plant roots play a critical role in ecosystem function in arctic tundra. NGEE-Arctic facilitates a strong, iterative relationship between measurements and models to improve our understanding of the important role that roots will play in the response of tundra ecosystems to an uncertain future.

Citation: Iversen CM, Sloan VL, Sullivan PF, Euskirchen ES, McGuire AD, Norby RJ, Walker AP, Warren JM, Wullschleger SD. 2014. Tansley Review - The unseen iceberg: Plant roots in arctic tundra. New Phytologist DOI: 10.1111/nph.13003.

Increased carbon uptake through warming induced changes in temperate phenology

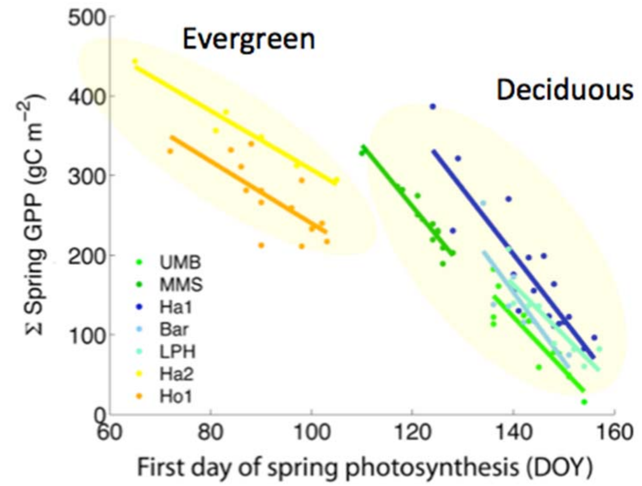


Goal

- Link ground observations of tree phenology, canopy-scale carbon fluxes (7 AmeriFlux sites), and MODIS remote sensing of phenology at a regional scale

Results

- Strong evidence for earlier onset of the growing season over the last 10-20 yr at all observation scales with rising temperatures diving earlier spring response.
- Earlier spring onset is associated with more forest uptake of C which over 20 yr resulted in the uptake of 28 million metric tones of C across the eastern deciduous forest



Conclusions

- By enhancing forest C uptake at a regional scale, shifts in phenology are a small but important negative feedback to climate change

Keenan, T.F., J. Gray, M.A. Friedl, M. Toomey, G. Bohrer, D.Y. Hollinger, J.W. Munger, J. O'Keefe, H.P. Schmid, I.S. Wing, B. Yang and A.D. Richardon. 2014. Net carbon uptake has increased through warming-induced changes in temperate forest phenology. Nature Climate Change 4:598-604 (doi:10.1038/nclimate2253)

The role of phosphorus dynamics in tropical forests – a modeling study using CLM-CNP

Objective

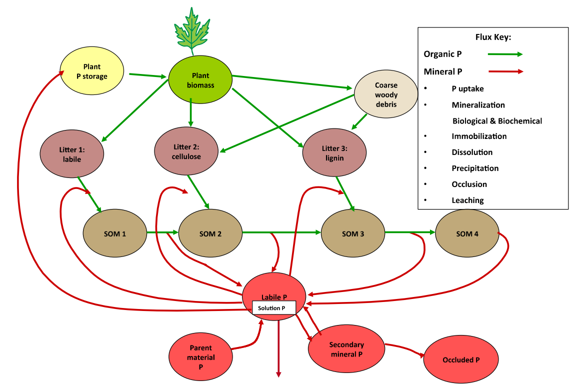
- Construct a modeling framework with P dynamics that will improve representation of C–nutrient interactions in tropical ecosystems
- Identify the important tropical processes involving P dynamics and C–P interactions that significantly affect the C–climate feedbacks but need better understanding and quantification

New Science

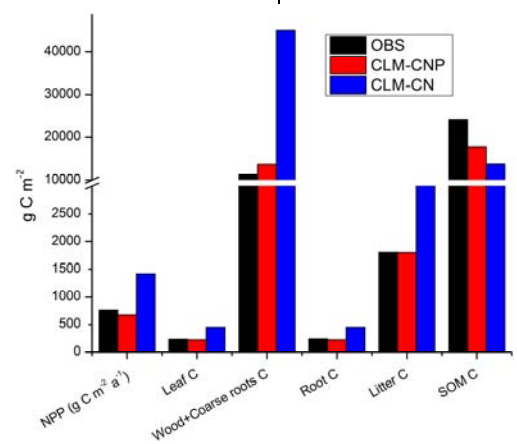
- Model simulations at sites along the Hawaii chronosequence show that the introduction of P limitation greatly improved model performance at the P limited site.
- The model simulations of the Amazonian forest sites show that CLM-CNP is capable of capturing the overall trend in NPP along the P availability gradient.
- Our model experiments highlighted the importance of two insufficiently understood pathways (biochemical mineralization of organic P and desorption of secondary mineral P) that can significantly affect P availability and determine the extent of P limitation in tropical forests

Significance

- This study represents an important step forward in representing C–nutrient interactions in earth system models.
- This study identifies current knowledge gaps related to processes controlling soil P availability in tropical forests, providing guidance for future field observations of carbon and nutrient cycling.



Pools and fluxes of P components in CLM-CNP



Comparison between model simulations (CLM-CNP and CLM-CN) and the observations at the P-limited site in the Hawaii chronosequence.

Yang, X., Thornton, P. E., Ricciuto, D. M., and Post, W. M.: The role of phosphorus dynamics in tropical forests – a modeling study using CLM-CNP, Biogeosciences, 11, 1667-1681, doi:10.5194/bg-11-1667-2014, 2014

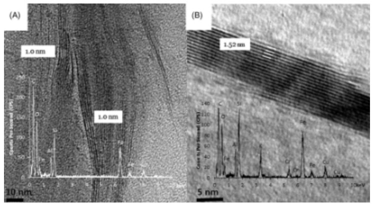
Stimulating Bacteria to Immobilize Chromium in Groundwater

Challenge:

- Understand the interactions of iron-reducing bacteria with clay minerals to create ferrous iron, which can indirectly immobilize chromium.

Approach and Results:

- Clay-rich samples from the Hanford Site and specimen clays were bioreduced by *Geobacter sulfurreducens*, and the resulting ferrous iron was found to reduce aqueous hexavalent chromium under several temperature treatments.
- Samples were analyzed using several EMSL chemical imaging capabilities.
- Nutrient addition significantly stimulated the bacteria to reduce ferric iron; chromium was reduced as the temperature was increased.
- Reaction kinetics were determined.

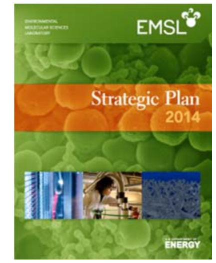


Significance and Impact:

- New insights into ways to reduce the hexavalent chromium transport in groundwater.
- The kinetic parameters can not be incorporated into models used to predict the transport of hexavalent chromium.

Participants: Miami University and EMSL
Reference: Bishop et al. 2014. Geochim Cosmo Acta. DOI: 10.1016/j.gca.2014.02.040.

Recent and Upcoming Activities at EMSL



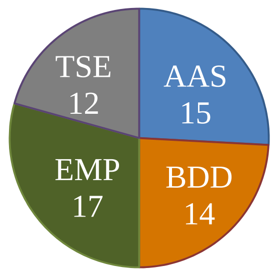
Strategic Planning

- Draft EMSL Strategic Plan
  - Sub-plans for: Q Wing, Rad Annex, HRMAC
- Multi-scale Modeling workshop (T. Scheibe/J. Smith) – Aug 26th

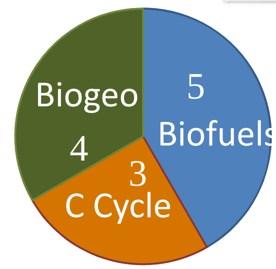
Proposal Awards for 2015

- Science Theme projects – 58
- EMSL-JGI projects - 12

Science Theme Awards

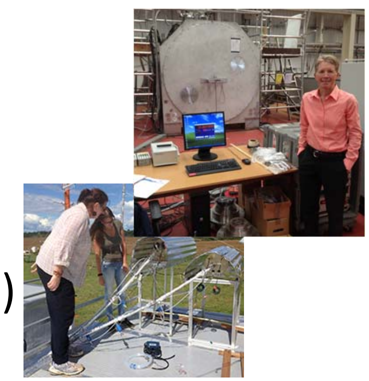


EMSL-JGI Awards



Science & Capabilities

- HRMAC: magnet at field (21T); spectrometer and data controls on track
- GOAmazon - Aerosol Mass Spec (AMS) deployed for Fall campaign.
- Cascade supercomputer ranked #15 (June).
- *NWChem:* version 6.5, > two dozen new functionalities (photo-oxidation)



Outreach and User Activities

- Significant update to EMSL web site: http://www.emsl.pnl.gov/emslweb/
- Three recent *Molecular Bond* issues: team projects, aerosols, subsurface.
- Virtual Tour: http://tour.pnnl.gov/emsl.html

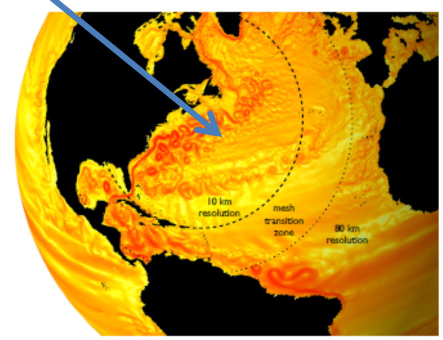
Accelerated Climate Model for Energy

ACME is a new multi-laboratory project to develop a climate prediction model, in support of the Department of Energy's science mission.

- **Fully coupled at 15-25 km resolution, yet have advanced adaptive-mesh to resolve important regions on resolutions well below 10 km.**
- **Able to utilize next-generation DOE computers.**

Science focus areas support energy and societal planning:

a) **Improving projections of water availability**
b) **Projecting changes to ice sheets and sea-level**
c) **Estimating land-atmosphere exchange of carbon**



ACME was formed from 7 multi-Lab projects, and spans 8 Labs and 6 non-Laboratory institutions. It is managed by a Council of 8 Lab scientists.

NGEE – Tropics

Goal: "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."

- Improve our understanding of precipitation, temperature, nutrient cycling and disturbance in tropical forests

"**NGEE – Tropics**" will:

- be a model informed field study that results in iterative refinement of process rich, scalable 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.

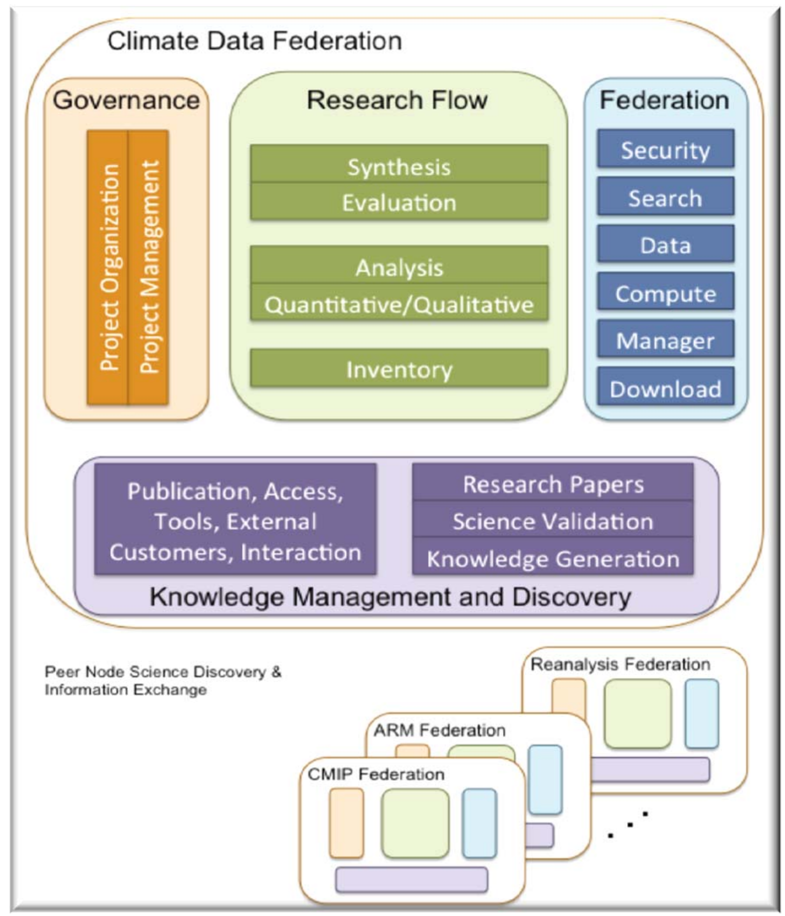
Update:

- Launched in July 2014 with a consortium of labs lead by LBNL (Jeff Chambers and Lara Kueppers, PI)
- Vision & approach whitepaper received and approved (July)
- "Approach to measurements" presentation to BER (August)
- Scoping meeting in Puerto Rico (September)
- Phase I proposal due December 10th
- NGEE activities will be highly multidisciplinary, and provide a framework for collaboration.

A BER Virtual Laboratory

The data grid will become part of large robust work environment

- An environment where data access and computations are coupled.
- It represent the merging of observational, modeled and experimental data
- Offers a spectrum of compute platforms that can be tailored to specific needs
- Data fusion, discovery and intelligent search capabilities
- Data mining and knowledge generation
- Comprehensive visualization and analytic engines
- Modular and scalable in design



September 30, 2014

Integrated Data Ecosystem

Collection and Data Management

- Sensors, field and lab experiments
- Data Models
- Transport and Communications
- Data Quality and uncertainty
- Storage, provenance and discovery

Critical Complex Systems

Data-intensive Computing

- Architectures – persistent data to streams
- Programming environments
- Human Computer Interface

Pattern Discovery

- Descriptive statistics
- Graph analytics
- Machine Learning
- Signal and image processing

Predictive Models

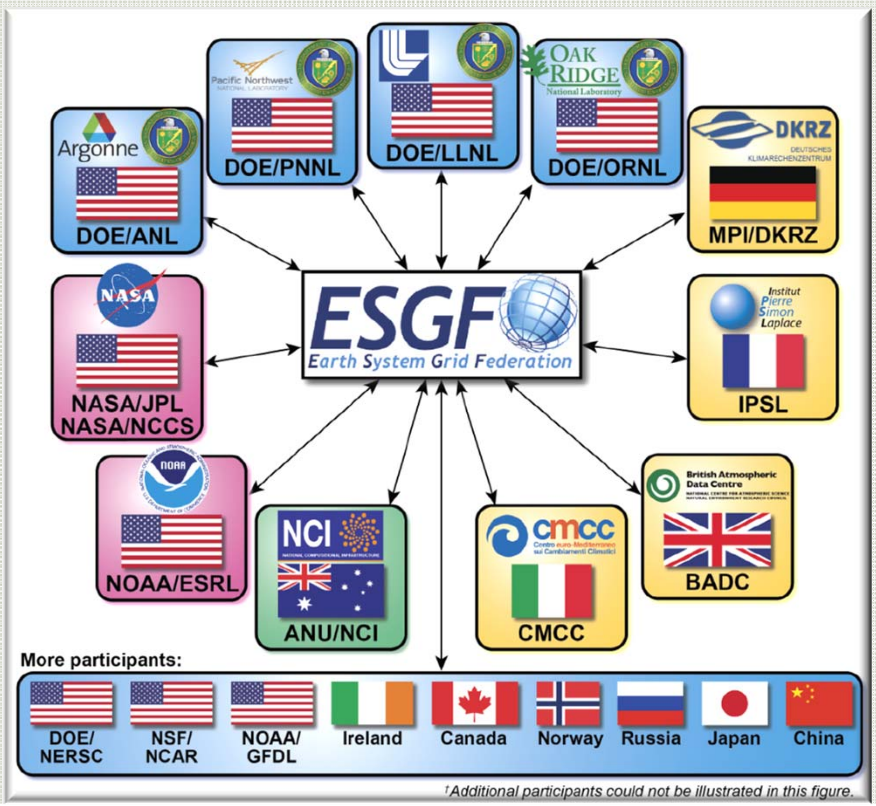
- Statistical prediction, classification, and anomaly detection
- Steering discrete-events and continuous simulations

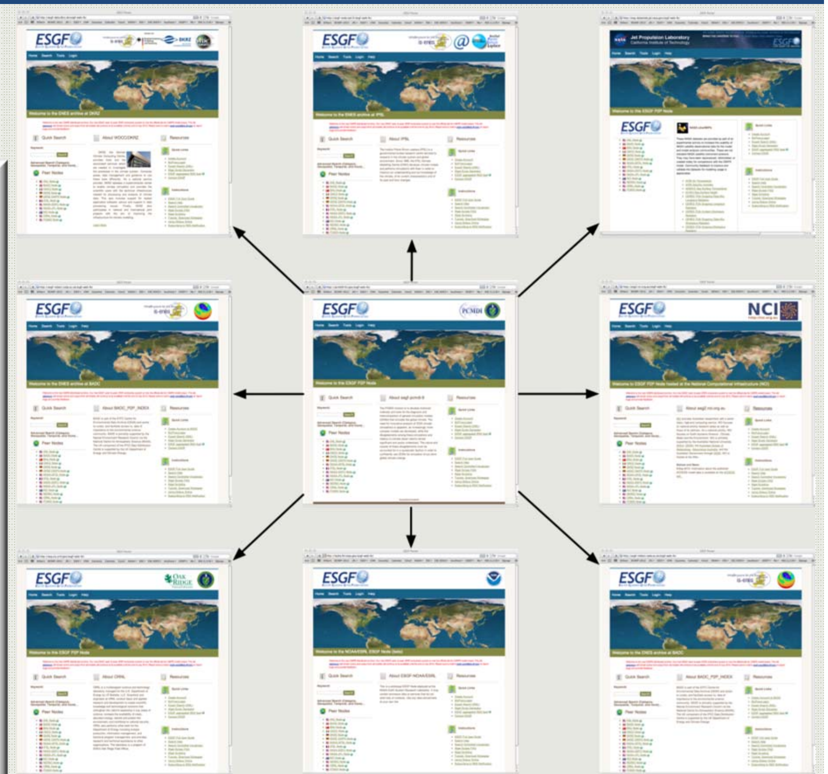
Decisions and control

Design optimization
Policy making
(Humans)

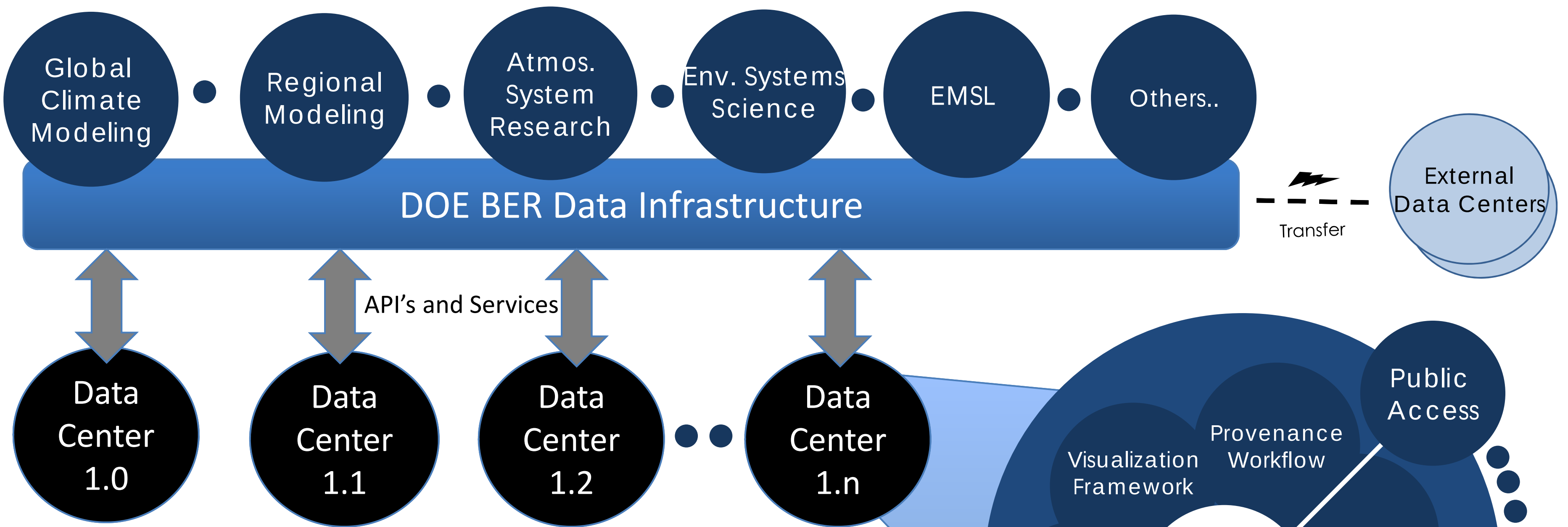
Earth System Grid Federation

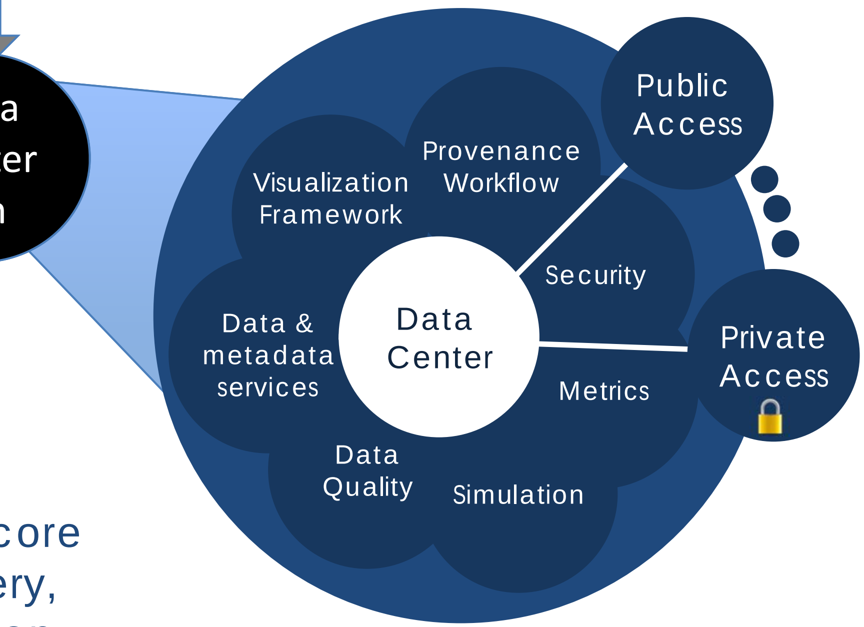
Nodes exist both domestically and Internationally (supports more than 40+ projects)





Enabling
Integrated Earth System Research

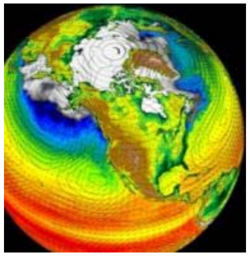


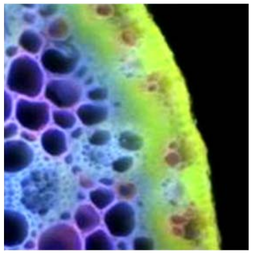
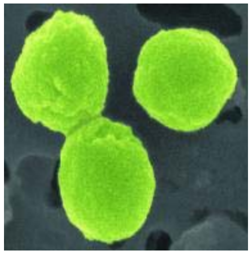


Virtual Laboratory Infrastructure

An Integrated Cyber-infrastructure leveraging core Office of Science resources to enable discovery, analytics, simulation, and knowledge innovation

Data Center & Interoperable Services



Thank you!

Gary Geernaert
Gerald.Geernaert@science.doe.gov
http://science.energy.gov/ber/research/cesd/

U.S. DEPARTMENT OF ENERGY

Office of Science

Office of Biological and Environmental Research