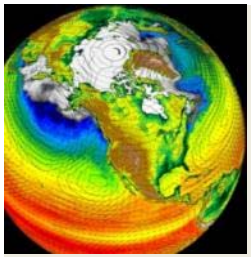
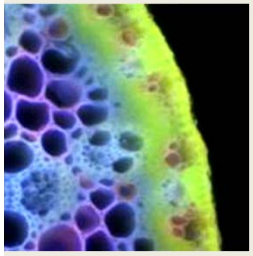
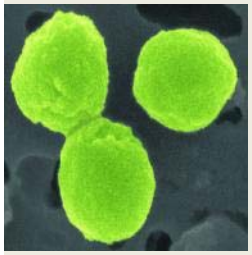


Climate and Environmental Sciences Division

BERAC update

October 28-29, 2013

G. Geernaert
BER/CESD

Climate and Environmental Sciences Division
(Gary Geernaert)
(K Carlson-Brown; L Runion; N Mekerdijian; A Flatness)

Jay Hnilo
Data
Informatics

Atmospheric Science

Atmospheric System Research
(Ashley Williamson; Sally McFarlane)

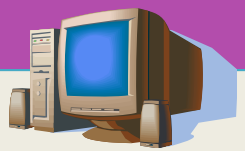
Atmospheric Radiation Measurement
(ARM) Climate Research Facility
(Wanda Ferrell; Rick Petty)

Climate and Earth System Modeling

Regional & Global Climate Modeling
(Renu Joseph)

Earth System Modeling
(Dorothy Koch)

Integrated Assessment
(Bob Vallario)

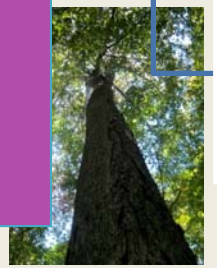


Environmental System Science

Terrestrial Ecosystem Science
(Mike Kuperberg, Dan Stover)

Subsurface Biogeochemical Research
(David Lesmes, Paul Bayer)

Environmental Molecular Sciences Laboratory
(Paul Bayer)



Management Update: Recent and projected FOA's

Funds	Program lead	Participating programs	Issued	Preapps	Proposals	Selected
FY14	ASR	ASR	Mar 13, 2013	123/146	111	Panel July 15 wk
FY14	TES (via NASA ROSES)	NASA, NOAA, USDA, NSF	Feb 13, 2013	391	235	Panel Oct-Dec
FY14	ASR	BER (RGCM, TES); FAPEAM, FAPESP	May 13, 2013	--	30	6
FY15	ESM	ESM, RGCM	*Nov 2013*	YES		
FY15	TES	TES	*Nov 2013*	yes		
FY15	ASR	ASR	*Nov 2013*	yes		
FY15	SBR	SBR	*Dec 2013*	yes		

Management updates: recent reviews (SFA decisions conveyed)

Lab	Program	Type	Date	Outcome
LBNL	SBR SFA	Renewal	April 2013	Approved
ANL	TES SFA	New	April 2013	Approved
BNL	ASR SFA	Renewal	Sept 9-10	Approved w/minor
LBNL	RGCM SFA	Renewal	Sept 11-12	Approved

Management updates: upcoming FY14 reviews

Lab	Program	Type	Date in FY14	Notification
LLNL, multi-lab	ESM SFA	New	March (mid)	Aug 1, 2013
LBNL	ASR SFA	Renewal	April (early)	Oct 2, 2013
LBNL	TES SFA	Renewal	April (early)	Jan 18, 2013
PNNL, multi-lab	ARM facility	Review	April 14-17	Pending
SLAC	SBR SFA	Renewal	May 5	Oct 3, 2013
PNNL	SBR SFA	Renewal	May 8	Oct 3, 2013
ORNL, multi-lab	RGCM SFA	New	May (mid)	Oct 11, 2013
LANL	RGCM SFA	Renewal, re-scoped	Sept 14	Oct 11, 2013
PNNL	EMSL facility	Review	Sept 22-26	pending

Management updates: FY14 - PI meetings, workshops

Title	Program(s)	Location	Date in FY14
ASR working groups	ASR, (ARM)	Rockville	Nov 4-8
Molecular Sciences Workshop	BER-wide	(DOE?)	Feb 19-20
Land Use Land Cover Workshop	IA / USGCRP	Wash DC	Feb 24-26
Population dynamics workshop	IA / USGCRP	Wash DC	Feb 27-28
PI meeting	ASR	Bolger	March 10-12
Regional Modeling Intercomparison Project	RGCM, IA	Tbd	April (tbd)
PI meeting	TES, SBR	Bolger	May 6-7
PI meeting	ESM, RGCM, IA	Bolger	May 12-15
Workshop on mechanistic models of terrestrial environments	SBR, TES, ESM	Tbd	Summer/fall

Research Highlights

- Integration: CESM Framework
- Modeling and Analysis
  - Attribution
  - Polar Warming Amplification – feedbacks
  - Planetary waves and future heat waves
- Atmosphere
  - Deep convection
  - High resolution modeling
  - Cloud microphysics
- ARM update w/GOAMAZON
- ESS: Mercury methylation
- EMSL update

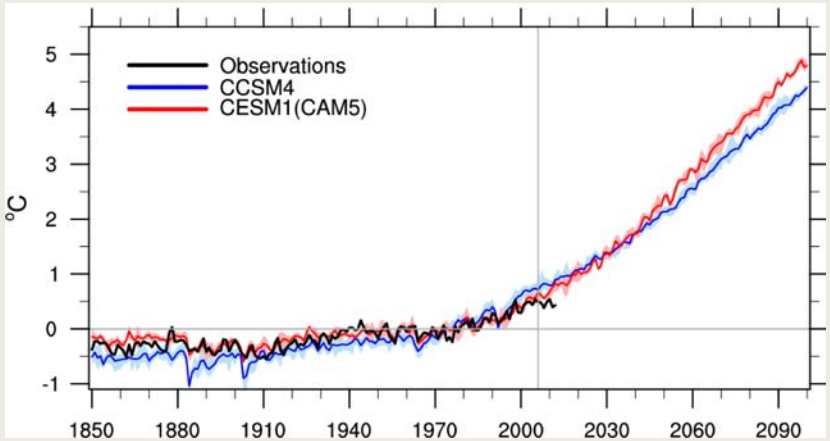
The Community Earth System Model: A Framework for Collaborative Research

Objective

- Develop a community model of the coupled Earth system: atmosphere, ocean, land, sea ice, land ice, and terrestrial and marine biology

Approach

- Used satellite and surface-based retrievals, quality weather data, and measurements from intensive field studies to test each model component–atmosphere, land, ocean, sea ice, and land ice– separately first and then coupled together
- Performed multi-century simulations to spin up the carbon cycle, the deep ocean, and Greenland ice



The rise in global mean surface air temperature simulated with CAM5 in the CESM1 is more realistic than that simulated with CCSM4

Impact

- Simulated important interactions such as aerosol effects on clouds and climate effects on the carbon cycle using newly developed CESM1
- Many aspects of the climate system are simulated more realistically than previous generations of the Community Climate System Model (CCSM)
- Future applications are to simulate the termination of the Pleistocene ice age, and ocean sea level rise as Greenland ice melts

Reference: James Hurrell, MM Holland, S Ghan, J Kay, J-F. Lamarque, D Lawrence, K Lindsey, W Lipscomb, M Long, N Mahowald, D Marsh, R Neale, P Rasch, D Bader, WD Collins, PR Gent, JJ Hack, J Kiehl, P Kushner, WG Large, S Marshall, S Vavrus, and M Vertenstein. 2013: The Community Earth System Model: A framework for collaborative research. *Bulletin of the American Meteorological Society*, doi:10.1175/BAMS-D-12-00121 .

Human and Natural Influences on the Changing Thermal Structure of the Atmosphere

Objective

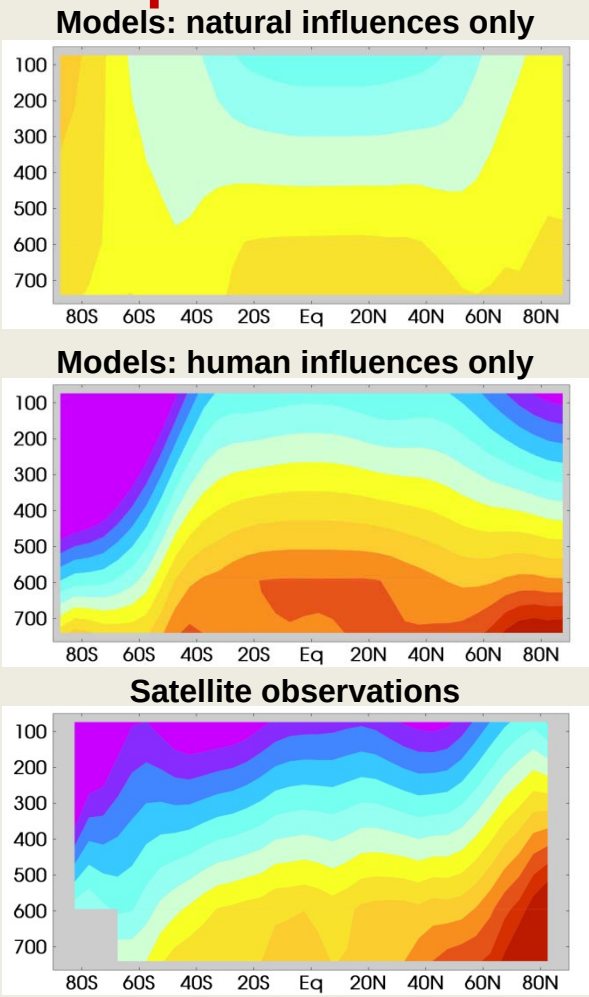
- To compare modeled and observed patterns of the vertical structure of atmospheric temperature change

Research

- To determine whether anthropogenic "fingerprint" is statistically identifiable in satellite observations
- To determine whether identification of a human-caused fingerprint is robust to current uncertainties in climate models and observations

Impact

- A human-caused latitude/altitude pattern of atmospheric temperature change can be identified with high statistical confidence in satellite data – we show clear evidence of a discernible human influence on the thermal structure of the atmosphere
- A human-caused fingerprint is identifiable not only relative to internal "climate noise", but also relative to the larger total natural variability arising from changes in solar irradiance and volcanic forcing



Atmospheric temperature trends in CMIP-5 models (top 2 panels) and in satellite observations from Remote Sensing Systems. For further details, refer to Fig. 2 in Santer *et al.* (2013)

Reference: B. D. Santer , **J.F. Painter**, **C. Bonfils**, C.A. Mears, S. Solomon, T.M.L. Wigley, **P.J. Gleckler**, G.A. Schmidt, **C. Doutriaux**, N.P. Gillett, **K.E. Taylor**, P.W. Thorne, and F.J. Wentz (2013): Human and natural influences on the changing thermal structure of the atmosphere. *Proc. Natl. Acad. Sci.*, doi: 10.1073/pnas.1305332110.

Decomposition of Feedback Contributions to Polar Warming Amplification

Objective

Polar surface temperatures are expected to warm 2-3 times faster than the global mean surface temperature. What are the individual process contributions to the polar warming amplification?

Approach

- Use coupled feedback response analysis method (CFRAM)
- Decompose annual and zonal mean vertical temperature response within a transient 1% yr^{-1} CO_2 increase simulation
- Use the CCSM4 relative to the 1850 pre-industrial control simulation into individual radiative and non-radiative climate feedback process contributions.

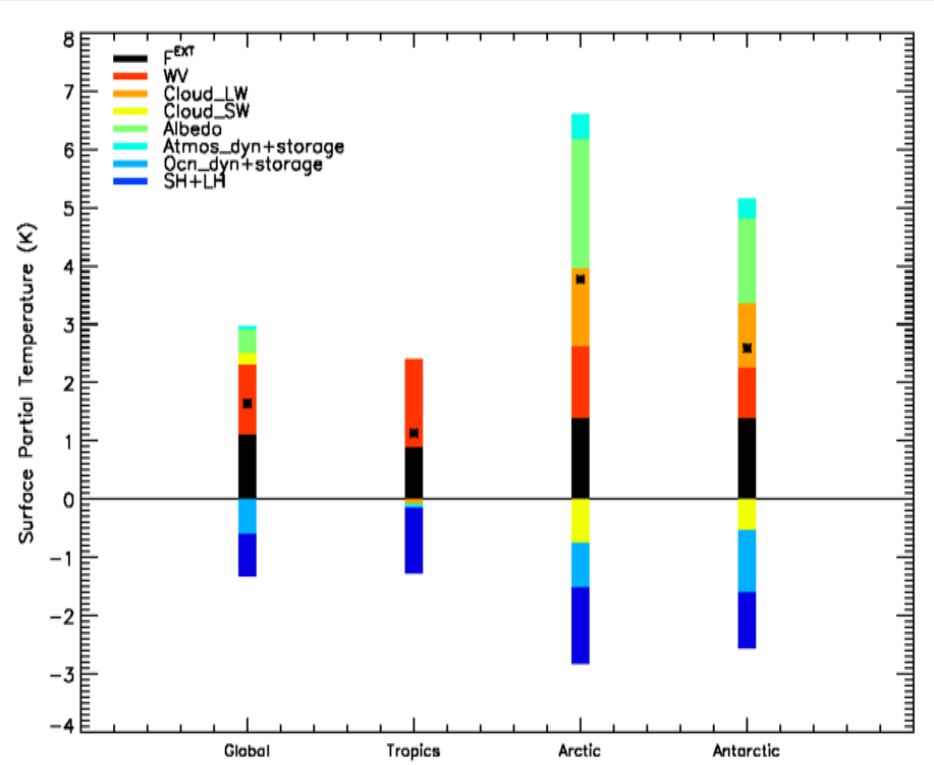
Most important PWA feedbacks

Strong positive feedbacks:

1. surface albedo feedback contributes the most to the polar amplified warming
2. net cloud response
3. externally forced atmospheric dynamics

Negative (yet weak) feedbacks

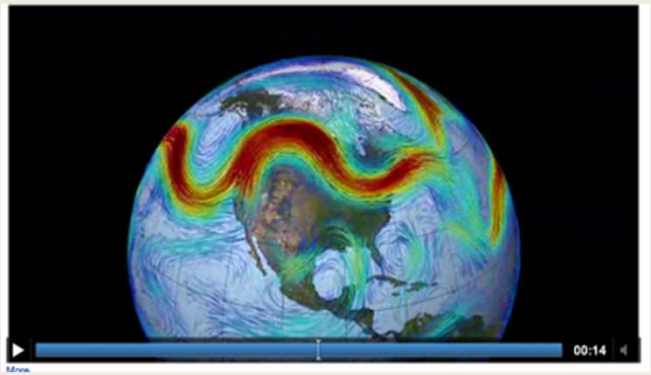
water vapor, ocean heat transport storage, and surface turbulent flux

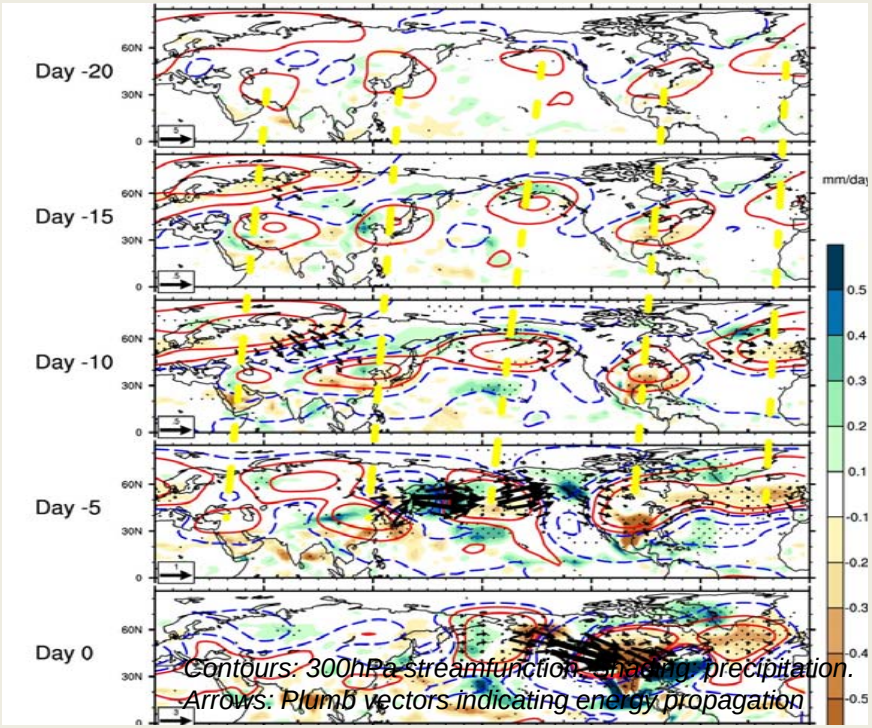


Individual process contributions to the Global, tropical (20° N-20° S), Arctic (60° N-90° N), and Antarctic (60° S-90° S) regional average surface temperature response.

Reference: Taylor, P. C., M. Cai, **A. Hu**, G. A. Meehl, W. M. Washington, G. J. Zhang, 2013, **A Decomposition of Feedback Contributions to Polar Warming Amplification**, *J Climate*, doi:10.1175/JCLI-D-12-00696, accepted.

Probability of US Heat Waves Affected by a Subseasonal Planetary Wave Pattern





Contours: 300hPa streamfunction. Shading: precipitation. Arrows: Plumb vectors indicating energy propagation

Objective

What will heat wave intensities and distributions be in future climates?

Approach

- Large number of CAM3 simulations
- Study the dynamics and statistics associated with Rossby wave patterns

Results

- identified a striking zonal wavenumber-5 Rossby wave pattern that is responsible for many US heat waves.
- This pattern can improve probability forecasts of US heat waves to 15 days in advance in the model – a one or two standard deviation wave5 event makes a future heat wave twice or four times as likely to happen.
- This pattern resembles the leading pattern of subseasonal variability in nature. It has been associated with some historical droughts that lasted longer than subseasonal time scales (e.g. the 1952-1954 , 1988 droughts).

Impact

- Improves weather forecasting
- Improves understanding of future heat waves, if wave-5 events become more frequent.

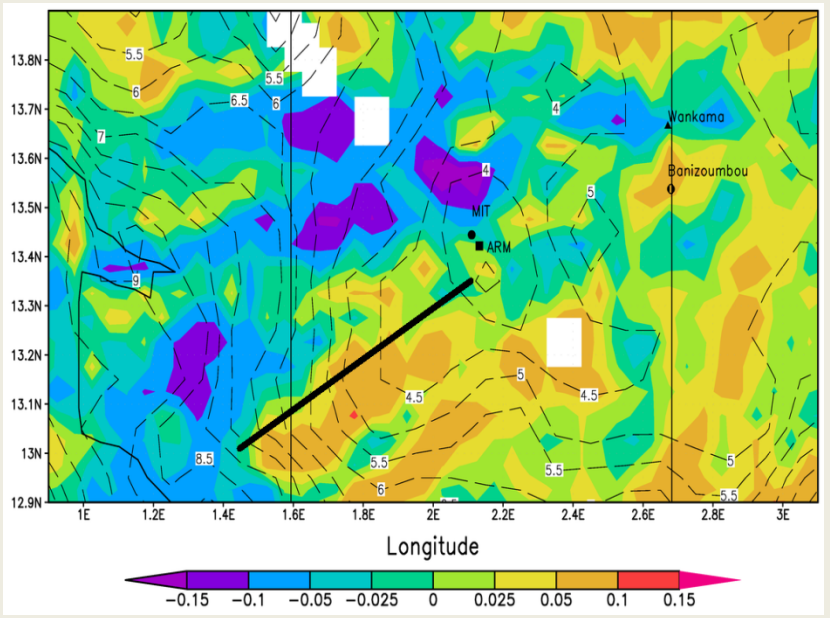
Teng, H., G. Branstator, H.Wang, G.A.Meehl, W.M.Washington, 2013: Probability of US heat waves affected by a subseasonal planetary wave pattern. Nature Geoscience, accepted.

Dynamics of convection over the Sahel, using ARM data

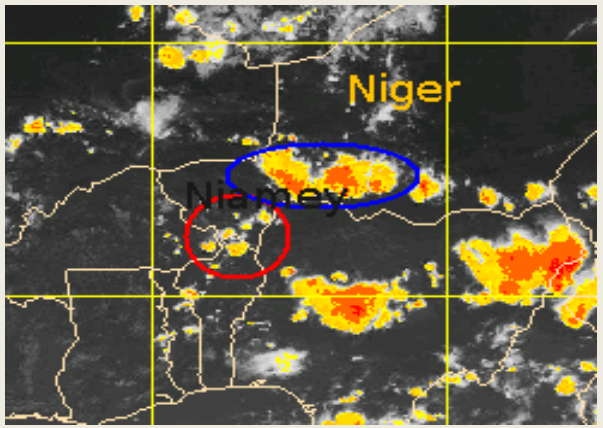
Objective
What triggers early monsoon deep convection?

Approach
- Use ARM and MIT radar and wind profilers, plus satellite observations, near Niamey, Niger, during AMMA
- Analyze triggers and dynamics through a monsoon season

Results:
- Large occurrence of locally-initiated deep convection and with gust fronts, with multiple data sets.
- Daytime growth of the atmospheric boundary layer and vertical profile of divergence in low-levels play an important role on the type of moist convection observed during that period.
- Convection lines, growing within the morning clear air roll-organizations, and gust fronts are found to be precursors of local deep convection.



Surface temperature and moisture heterogeneities near Niamey



Dione C, M Lothon, D Badiane, B Campistron, F Couvreau, F Guichard, and S Sall. 2013. "Phenomenology of Sahelian convection observed in Niamey during the early monsoon." *Quarterly Journal Royal Meteorological Society*, ACCEPTED

Nonhydrostatic nested climate modeling

Motivation

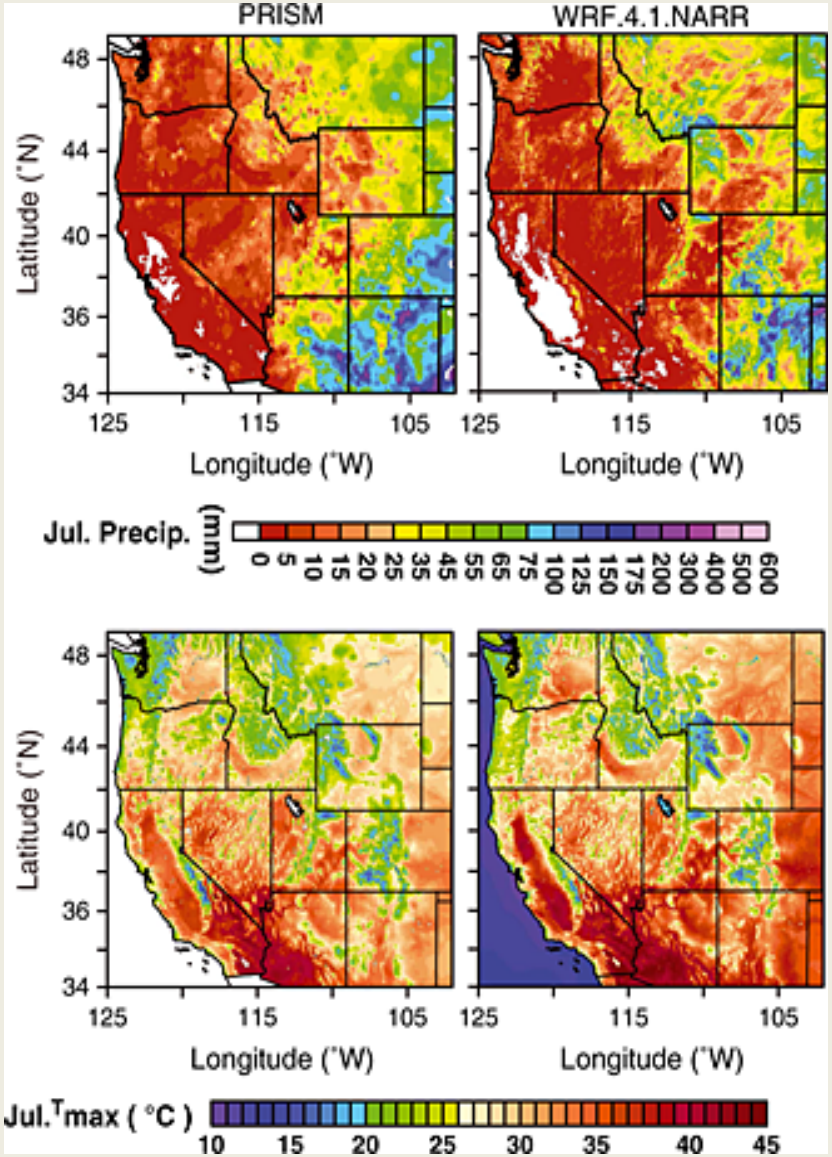
Projecting local-scale climate phenomena motivates development of approaches to enable computationally feasible nonhydrostatic climate simulations with improved accuracy.

Approach

- WRF used to evaluate nested nonhydrostatic model at 4 km resolution, combined with 25km and 50km hydrostatic modeling.
- Focus on 11 western states. Summer 2010.
- Compared against station observations and reanalyses.

Results

- Nonhydrostatic simulations nested within reanalysis yields best agreement with observations.
- Weaknesses include introduced biases for regional precipitation, circulation, and moisture flux.
- Further developments suggested: super-parameterizations and variable-resolution nonhydrostatic modeling.



Lebassi-Habtezion and Diffenbaugh, Nonhydrostatic nested climate modeling: A case study of the 2010 summer season over the western United States. J. Geoph. Res., Atmospheres. 11 OCT 2013 DOI: 10.1002/jgrd.50773
http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50773/full#jgrd50773-fig-0002

New Method Simulates 3D Ice Crystal Growth Within Clouds

Motivation

- Ice crystals grow along multiple axes at non-uniform rates that depend on temperature and humidity.
- Current models of ice crystal growth used in global climate models assume ice crystals grow along a single axis at a uniform rate, resulting in errors in ice crystal properties that impact climate simulations.

Approach

- Develop a new method that allows simulated ice crystals to grow along multiple axes simultaneously.
- New model predicts evolution of crystal aspect ratio; growth rates along each axis are related to each other using parameters derived from laboratory studies of ice crystals.

Impact

- New method can reproduce simultaneous variations in ice crystal mass, maximum dimension, and fall speed, unlike current methods used in climate models.
- Reduces the errors in ice mass mixing ratio, mean axis lengths, and mass-weighted fall speeds in mixed phase clouds from 20-40% to less than 5%.
- Allows more realistic simulation of the evolution of ice and mixed phase clouds and their climate impacts.

References: Harrington JY, K Sulia, and H Morrison. 2013. "A method for adaptive habit prediction in bulk microphysical models. Part I: theoretical development." *Journal of the Atmospheric Sciences*, 70(2), doi:10.1175/JAS-D-12-040.1.
Harrington JY, K Sulia, and H Morrison. 2013. "A method for adaptive habit prediction in bulk microphysical models. Part II: parcel model corroboration." *Journal of the Atmospheric Sciences*, 70(2), doi:10.1175/JAS-D-12-0152.1.

ARM Climate Research Facility

- Data are now flowing from the Oliktok and Azores sites.
- MAGIC and Cape Cod campaigns successfully completed.
- AMF1 enroute to Brazil and AMF2 to Finland.
- Biomass burning experiment using the G-1 ongoing.

GOAMAZON: January 2014-December 2015

- Science: study tropical coupled atmosphere-land systems, under clean and polluted conditions
- Collaborations across BER, across agencies and among nations, especially U.S. - Brazil
- Measurements by ARM Mobile Facility and aircraft, EMSL mass spectrometer, TES ecosystem measurement, Brazilian towers, radars and aerosol measurements, NSF aerosol measurements, and German flux towers and aircraft.
- ASR, TES, RGCM, NSF, FAPEAM, and FAPESP will support research using these data.
- The experiment is designed to study how biogenic aerosols and surface fluxes influence cloud cycles under clean conditions, as well as how aerosol and cloud life cycles, including cloud-aerosol-precipitation interactions, are influenced by pollutant outflow from a tropical megacity.

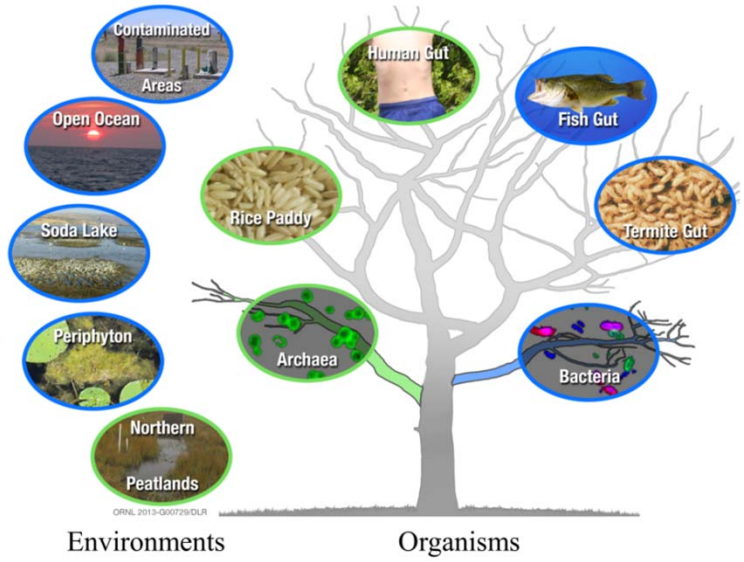
Mercury Methylation by Novel Microorganisms from New Environments

Objective

- Investigate whether the broad spectrum of bacteria predicted to be capable of mercury methylation, due to the presence of two recently discovered genes, would actually methylate mercury.

Approach

- The presence of the two genes is a reliable predictor of bacterial mercury methylation capability.
- Besides sulfate- and iron-reducing bacteria, methanogens and fermenters were also shown to methylate mercury.



Newly discovered Archael (green) and Bacterial (blue) organisms that are free-living or within another organism on the tree of life, and their larger environments, pictured on the left.

Findings and Significance

- Established a direct link between a gene marker and bacterial methylation ability.
- Bacteria capable of mercury methylation are more diverse than previously understood.
- Provides an improved ability to quantify mercury methylation in a specific environment/location.

Gilmour, C, et al. 2013. "Mercury Methylation by Novel Microorganisms from New Environments." *Environ. Sci Technol.* DOI: 10.1021/es403075t.

Recent Developments and Activities at EMSL

Scientific Leadership

- Alex Guenther leads new Atmospheric/Aerosol Chemistry science theme.
- Tim Scheibe leads EMSL's Molecular Science Computing.
- Scot Martin on EMSL Science Advisory Committee.

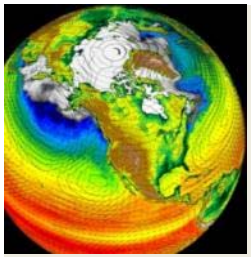
Science

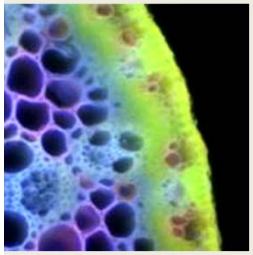
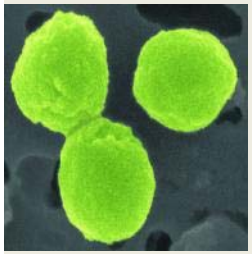
- 8 proposals selected for new EMSL-JGI collaboration; planning underway for 2014 call.
- 2006 User publication on hybrid modeling of large biomolecules selected by *J Chemical Physics* as one of the 80 best in the journal's 80 years.

Capabilities

- Aerosol Mass Spectrometer (AMS) en route to Brazil for GOAmazon campaign.
- Users being migrated to new 3.4 PFlop supercomputer (Cascade).
- *NWChem* version 6.3 released with new functionality for molecular-scale simulations and ability to use NVIDIA GPU technology.

Valiev, M and K Kowalski. 2006. "Hybrid Coupled Cluster and Molecular Dynamics Approach: Application to the Excitation Spectrum of Cytosine in the Native DNA Environment." *J Chem Phys* 125: 211101:1-4. DOI: 10.1063/1.2403847.



Thank you!

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