

4th WCRP International Conference on Reanalyses



DOE's Climate Modeling Efforts

PMs: Dorothy Koch, Renu Joseph, Bob Vallario

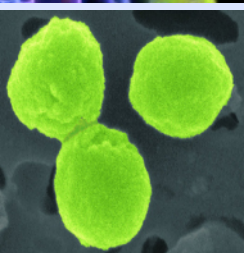
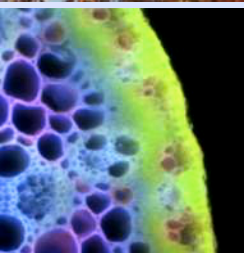
Division Director: Gary Geernaert



Climate Modeling Programs

Climate and Environmental Sciences Division

Biological and Environmental Sciences



Renu Joseph
May 11, 2012



U.S. DEPARTMENT OF
ENERGY

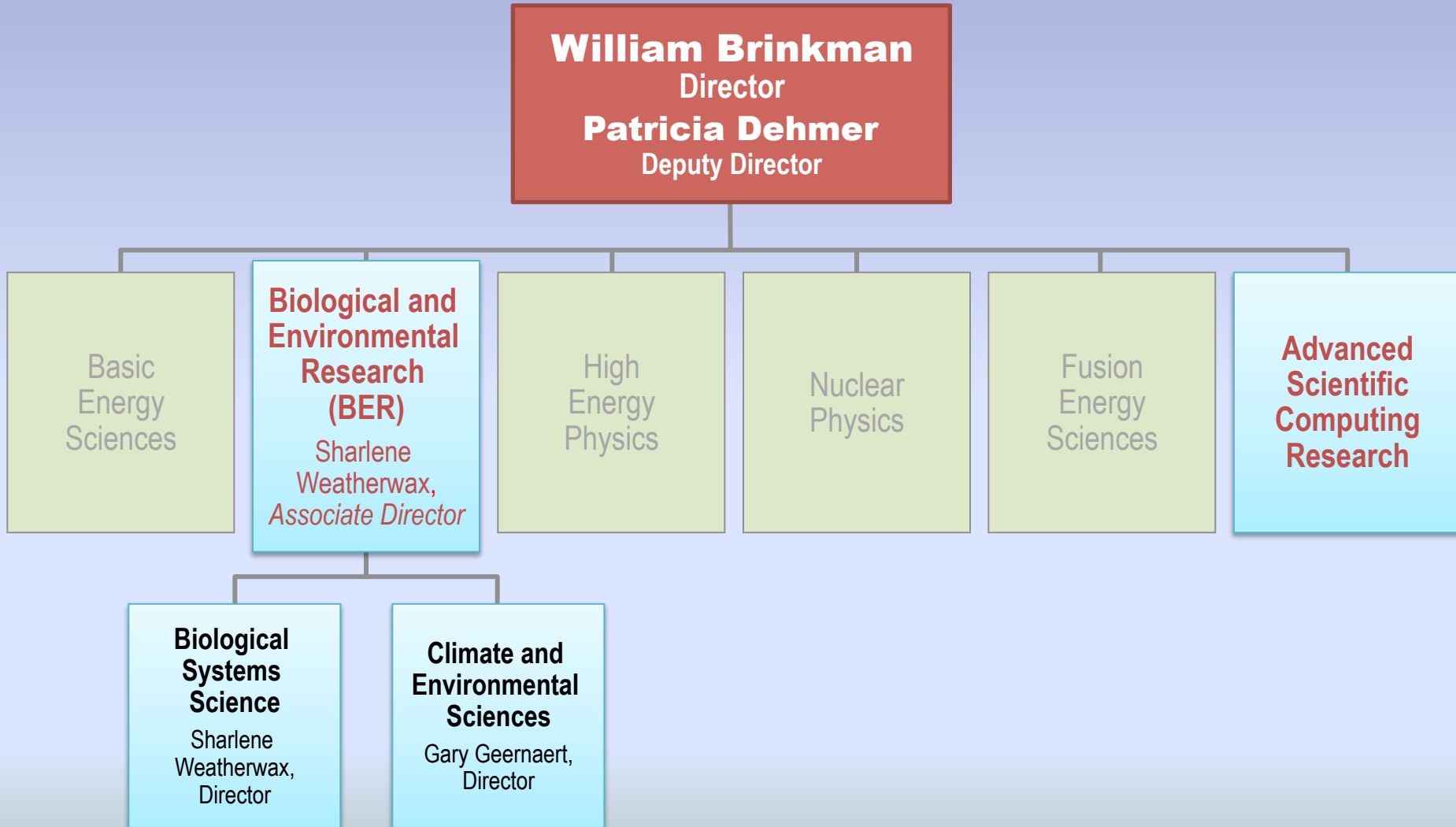
Office of Science

Office of Biological
and Environmental Research

Discussion Topics

- A. Current and future plans, programs and priorities for developing and/or **fostering the use of reanalysis products.**
- B. Agency perspectives on associated **opportunities and challenges to develop a common understanding.**
- C. **Requirements of agencies/entities** and the scientific community to fulfill **their respective mission.**
- D. How the **agencies** and the **scientific community** can sustain each other in this process in a **collaborative way**

DOE's Office of Science



Why DOE?

The Energy-Climate Nexus

Greenhouse gases are emitted during energy production...
and climate change will impact energy production

DOE seeks to:

- Understand the effects of GHG emissions on Earth's climate and the biosphere
- Provide world-leading capabilities in climate modeling and process research on clouds and aerosols, and the carbon cycle
- Provide unique, world-leading capabilities in cloud and aerosol observations and large scale ecological experiments
- Build foundational science to support effective energy and environmental decision making



Climate and Environmental Sciences Division

Climate and Environmental Sciences

Atmospheric Science

Atmospheric System Research
(Ashley Williamson)

Atmospheric Radiation Measurement Climate Research Facility
(Wanda Ferrell)



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)

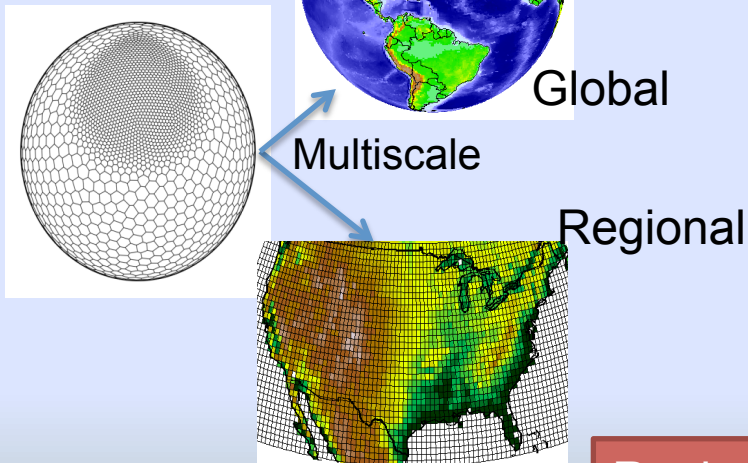
Environmental Molecular Sciences Laboratory
(Paul Bayer)



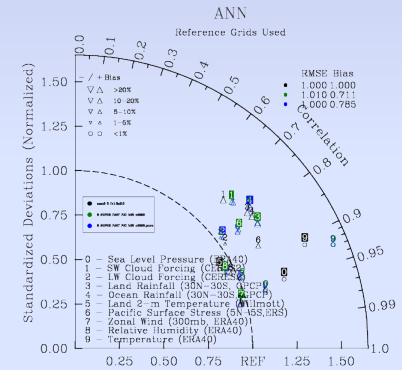
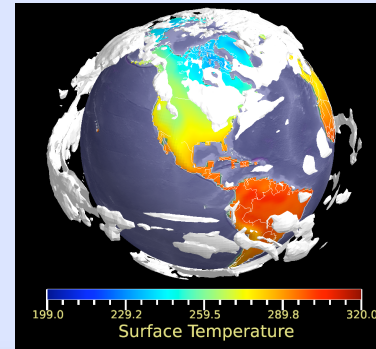
Overarching Goal for Climate Modeling

To advance fundamental understanding of climate variability and climate change by *developing* and *analyzing* Climate and Earth System Models at temporal scales ranging from decades to centuries and spatial scales ranging from global to regional to understand climate and energy impacts at global and regional scales.

Development



Analysis



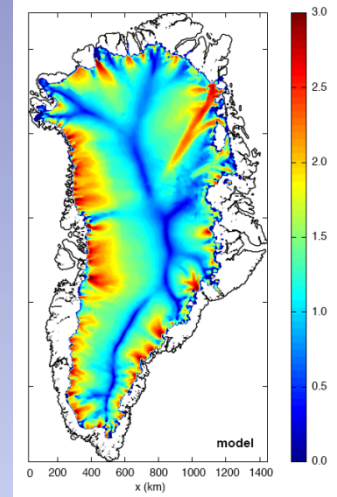
Earth System Modeling

Regional and Global Climate Modeling

Integrated Assessment Research Program

Earth System Modeling

- **Develop** model physics of system components (CESM)
- **Couple** individual components
- **Test** and improve components using observations (“Test-bed”)
- **SciDAC** partnership with Advanced Scientific Computing (ASCR)
- **Optimize** computationally intensive processes and codes
- **Evaluate** process feedbacks and potential for abrupt climate change



Regional and Global Climate Modeling

What: Evaluation and application of Regional and Global Climate Models to understand high resolution patterns and causes of climate change

Why: Need to **understand climate variability and change** as evidenced in model projections; need to **provide feedback on improving model components and coupled system to model developers**

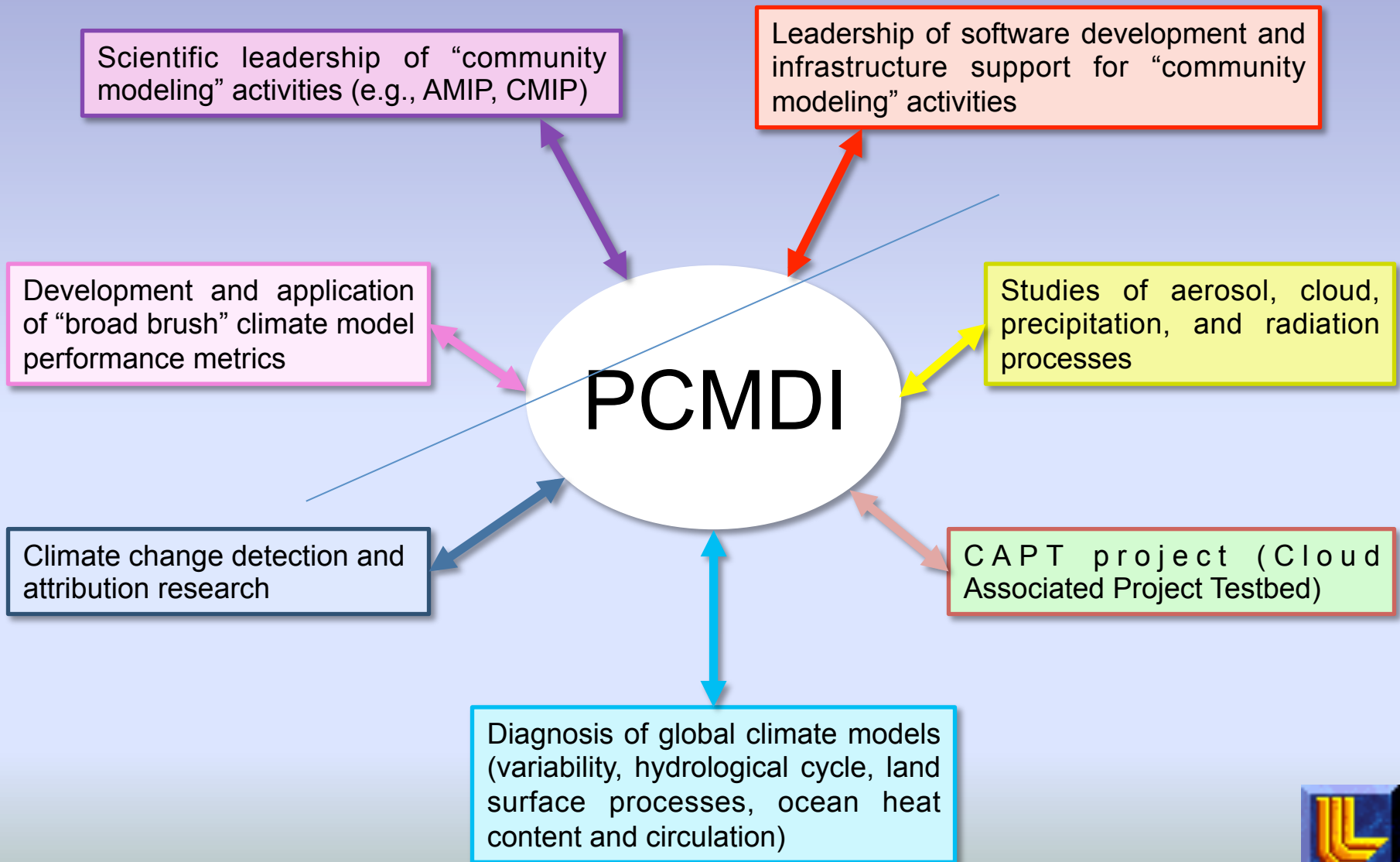
DOE Niche:

- **Model Intercomparison Efforts**
- **Data dissemination and Visualization for Model Intercomparison efforts and evaluation**
- **Metrics for evaluation of climate models**
- **Uncertainty Quantification to inform model development**
- **Detection and Attribution**
- Arctic System Modeling

Collaborations: NSF, NOAA & USDA

If successful, impact: Credible scientific input to decision makers at a local scale.

Program for Climate Model Diagnosis and Intercomparison: PCMDI

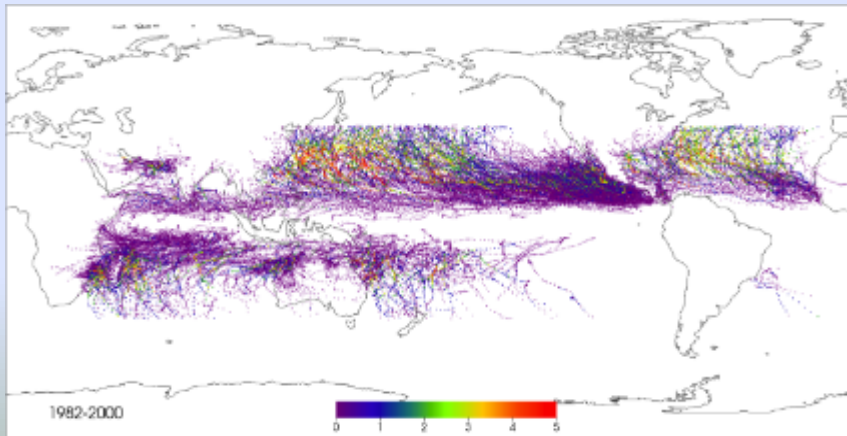


Plans and Priorities for fostering the use of reanalysis products

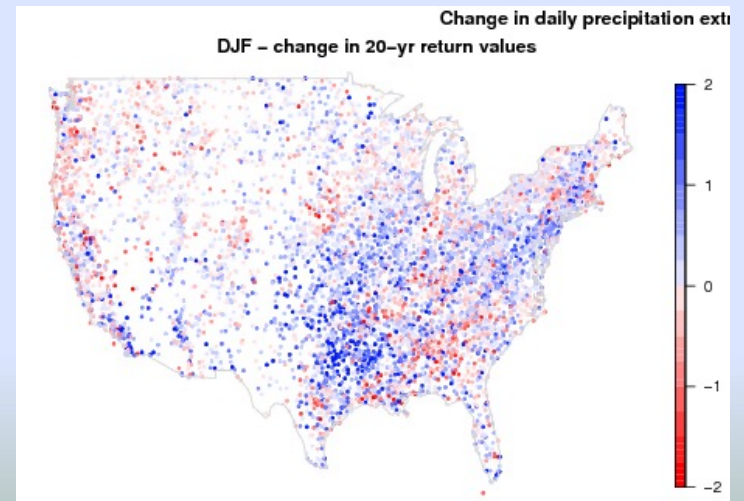
Developing Diagnostic tools for:

- **Easy analysis and diagnostics capabilities:** Dedicated infrastructure to support increasing data volume and focused investments in “user-friendly” software tools to work with the data.
- Working on getting MERRA on the portal

Cyclone Detection



Spatial Extreme Value Analysis



Plans and Priorities for fostering the use of reanalysis products.

LLNL CAPT project:
CAM atmospheric simulation (fixed SSTs).

Climate run
Initialized with ECMWF , Day 2

Errors are similar and intrinsic to model

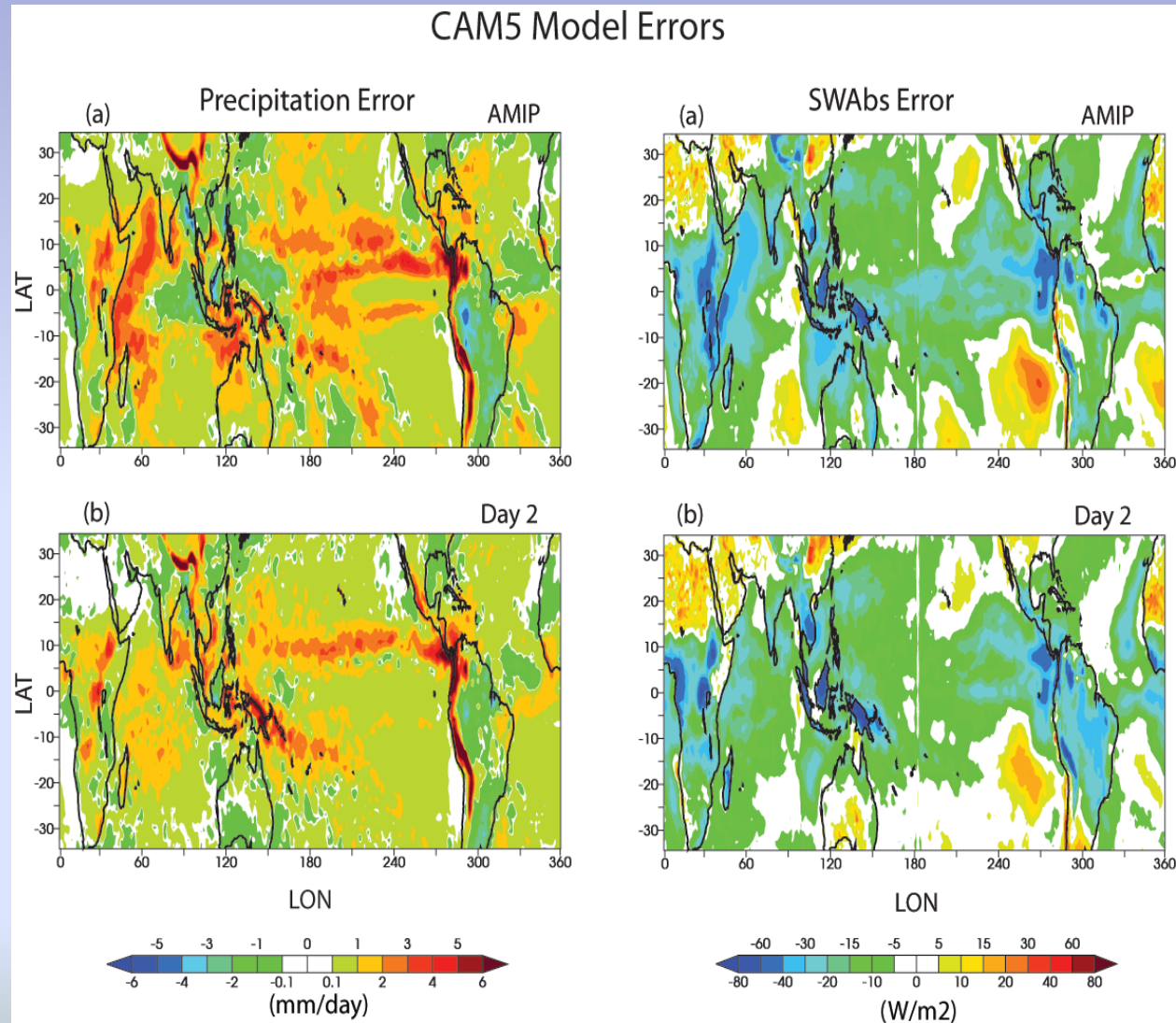
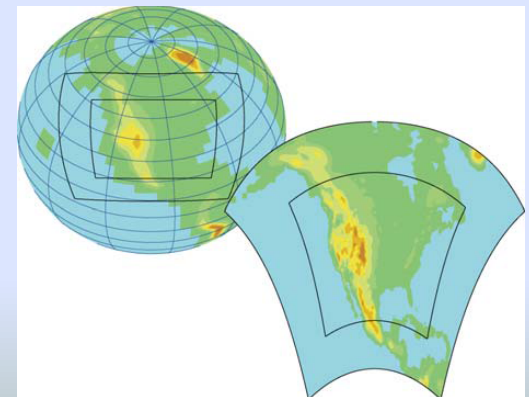
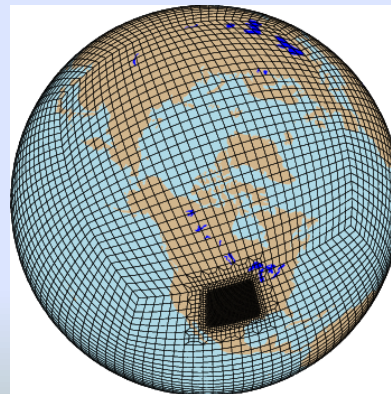
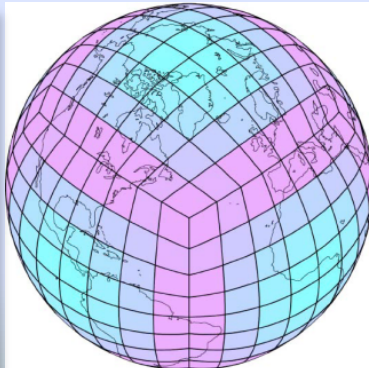
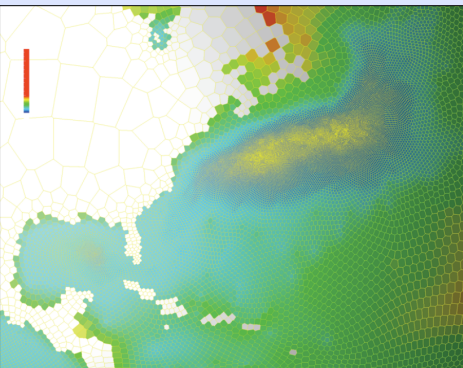


Figure courtesy of Steve Klein, LLNL

Opportunities and Challenges fostering the use of Reanalysis Products

Next Generation Analysis Needs:

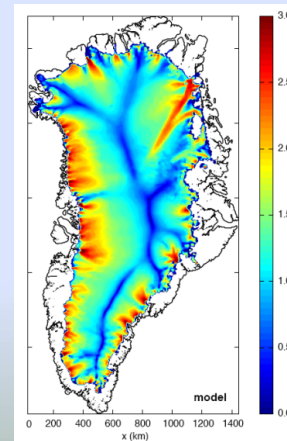
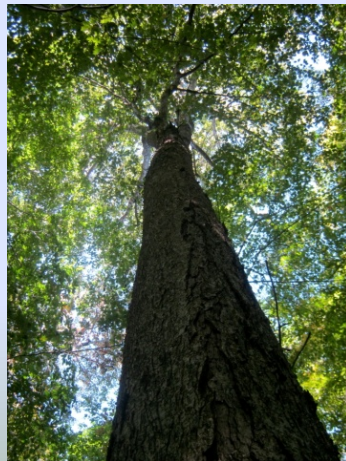
- **Validation and Verification of high resolution models:**
There is considerable interest in high resolution models, with uniform or variable resolution models including the ability to ingest observations from field campaigns
- Need higher resolution reanalysis products



Opportunities and Challenges fostering the use of Reanalysis Products

Next Generation Analysis Needs:

- **Validation and Verification of high resolution models:** There is considerable interest in high resolution models, with uniform or variable resolution models including the ability to ingest observations from field campaigns
- **Validation of more components of the ESMs:** As climate models evolve into more complex ESMs is there an opportunity to create reanalysis products for more variables.
 - Reanalysis for new evaluation of new components like the Carbon cycle
 - What are the other new fields that can be produced?



How **DOE** and the **scientific community** can sustain each other in this process in a **collaborative way**

- The Lab-University funding distribution is 50-50 in most programs
- All our funding is peer reviewed
 - Through solicitations
 - Science Focus Areas
- Workshops
- Interagency activities
 - USGCRP
 - US CLIVAR
 - ESPC
 - Interagency Solicitations (EaSM, NMME, etc)