



# **DOE/UCAR Cooperative Agreement Research Program**

## **Lead Scientists: Warren Washington and Gerald Meehl**

The U.S. Department of Energy (DOE) and the University Corporation for Atmospheric Research (UCAR) Cooperative Agreement (CA) supports fundamental climate and climate change research in the DOE/SC/BER Climate Change Prediction Research Program.

The research in the DOE/UCAR CA is in four coordinated domains related to understanding present/future climate change and improving the simulation of the Earth's climate system.

Our unique research activity is focused on carrying out simulations and analysis of 20<sup>th</sup> century and future climate change for the CMIP5 and the upcoming IPCC Fifth Assessment Report.



## **History Between DOE and UCAR/NCAR**

1. The contract between DOE and UCAR, which started in 1978, was for developing a model that could be used for studies of enhanced CO<sub>2</sub> concentrations on the Earth's climate system and related analysis of simulation results; DOE's research interest was on "estimation of CO<sub>2</sub> induced global/regional climate change"
2. Transition to Cooperative Agreement in 1997
3. Transition to DOE parallel computer systems, CHAMMP, etc.
4. Our past core effort was performing climate change simulations and analysis used in IPCC assessments
5. Approx. 20-25 peer-reviewed publications per year



## **Major Areas of Emphasis**

Research Program on Modeling Future Climate Change:  
Responses of the Climate System to Changes in Forcings:  
Warren Washington and Gerald Meehl PIs

Evaluation of and Improvements to Components of Climate System  
Models: David Williamson and Richard Neale PIs

Climate Modeling with Mesoscale Atmospheric Variability and  
Scale-Aware Physical Parameterizations: Joseph Tribbia PI

Future Changes in Earth's Hydrological Cycle and the Response of  
Ecosystems to Climate Change: Jeff Kiehl PI



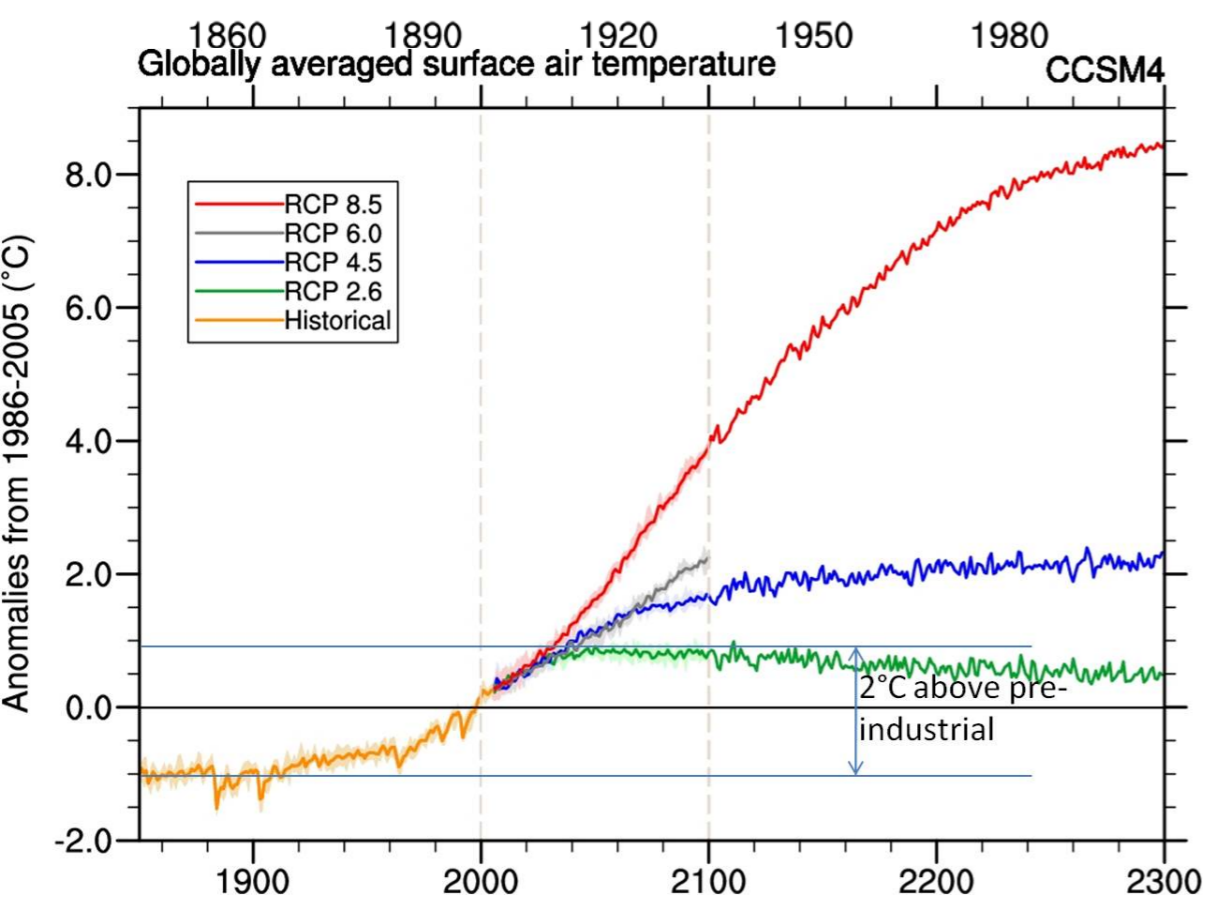
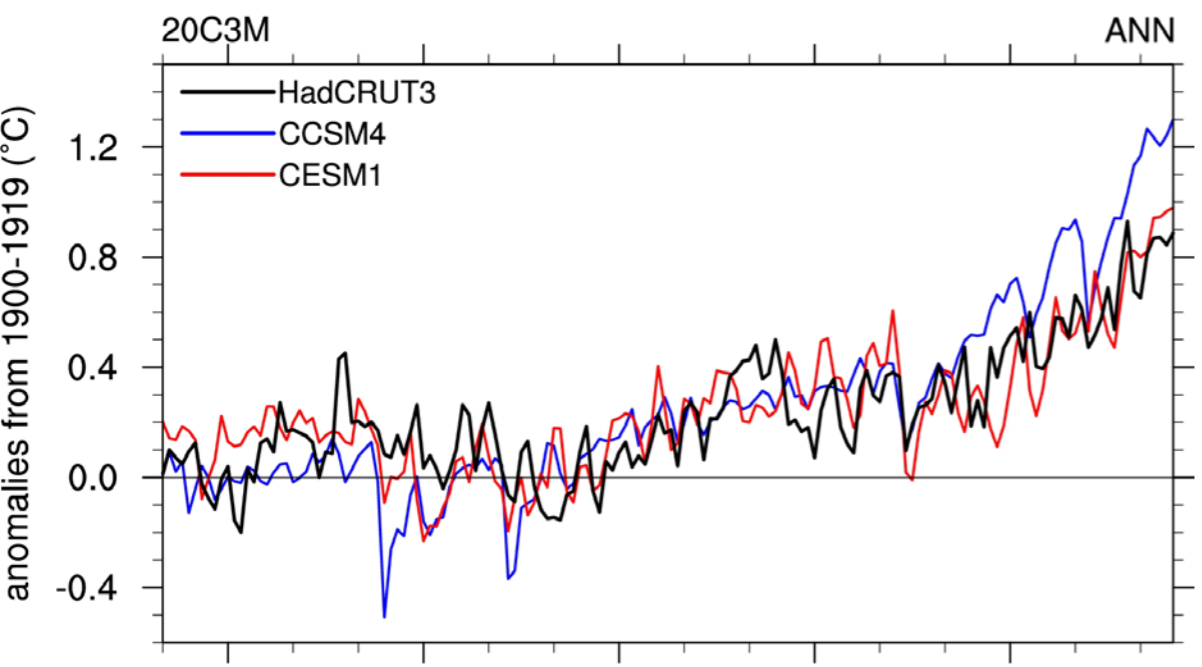
# **Our unique research activity is focused on carrying out simulations and analysis of 20<sup>th</sup> century and future climate change for the CMIP5 and the upcoming IPCC Fifth Assessment Report**

1. The Cooperative Agreement supports the Climate Variability and Change Working Group (CVCWG) through the Climate Change Prediction Group (CCP) at NCAR
2. The CVCWG, with support from DOE as noted above, performs the climate change simulations with CCSM/CESM (e.g. CMIP5, U.S. National Assessment, etc.)
3. The CCP group performs analyses of the climate change simulations to expand the frontiers of our knowledge of climate variability and change, and to inform energy policy issues relevant to climate change adaptation/mitigation that are part of DOE's mission
4. The CCP group performs additional sensitivity experiments with CCSM/CESM to diagnose processes and mechanisms of climate variability and change, e.g. single forcing simulations to assess which forcing is causing changes to the climate system or uniquely modifying a forcing to diagnose the processes involved in response of the climate system such as increasing carbon aerosols over the South Asian monsoon region.

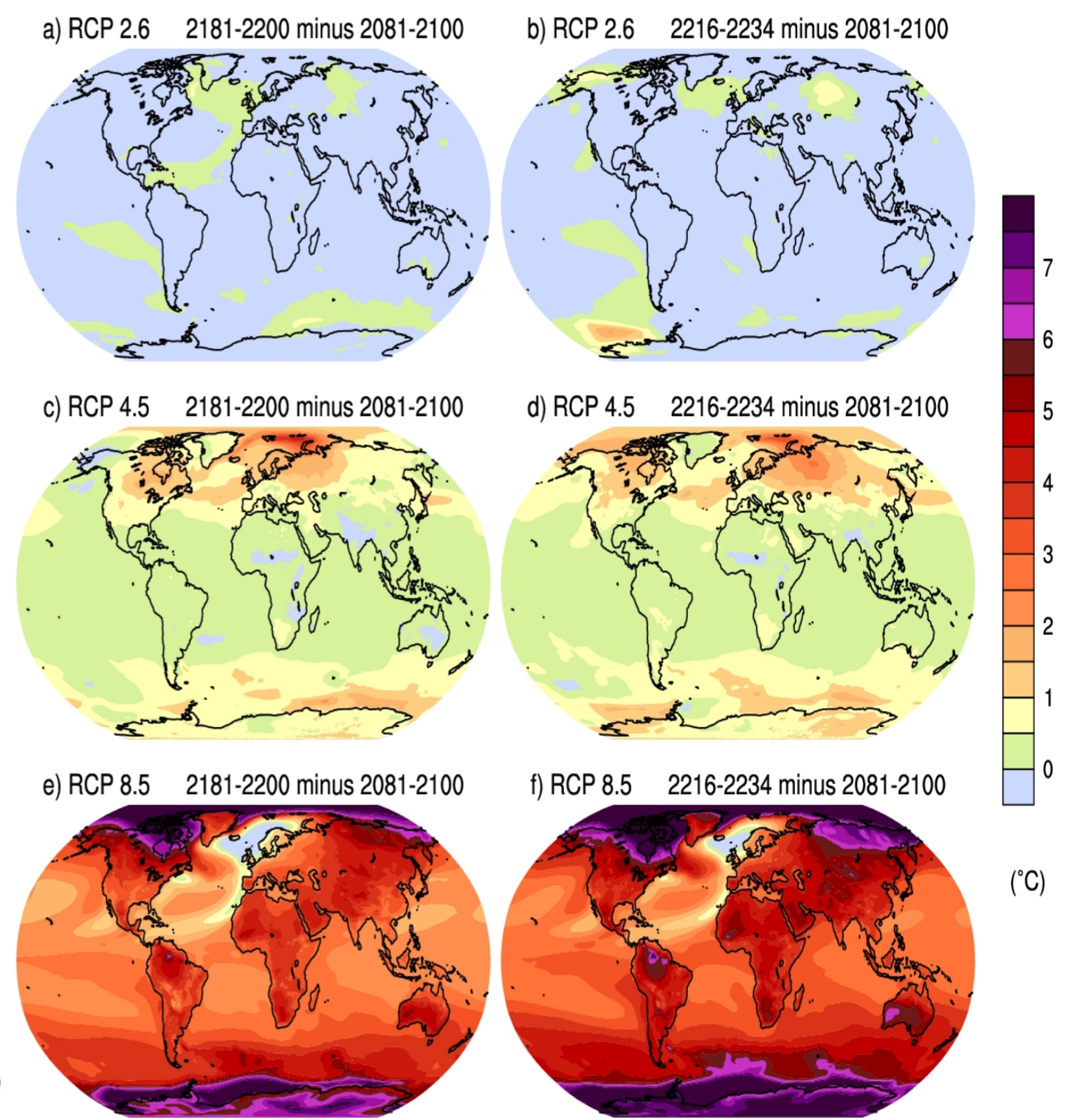


# Performing and Analysis of Climate Change Simulations (350)

Globally averaged surface air temperature



CCSM4 surface air temperature changes





# **Overall research activities**

- 1. Diagnosing cloud-climate feedbacks**
- 2. Decadal Prediction of Atlantic overturning**
- 3. Simulation of Earth's hydrology**
- 4. Global and regional extremes comparisons with observed data**
- 3. Tracer transport on the sphere**
- 4. Intense precipitation in high resolution models**
- 5. Diagnosing cloud and non-linear feedback: new technique**
- 6. CESM submission to Coupled Model Intercomparison Project: 350 simulations and going**
- 7. Role of Bering Strait on glacial climate stability**
- 8. Role of permafrost and permafrost hydrology**
- 9. Black carbon heating effects on the India-South Asian Monsoon and beyond**
- 10. Climate simulations at regional resolution**
- 11. Aquaplanet simulations with interactive aerosols**



**Report on the DOE/BERAC Workshop**

**Identifying Outstanding Grand Challenges in  
Climate Change Research: Guiding DOE's  
Strategic Planning**

September 5, 2008

**Chaired by Bob Dickinson and Jerry Meehl**

**Scientific Grand Challenges**

CHALLENGES IN CLIMATE CHANGE SCIENCE AND  
THE ROLE OF COMPUTING AT THE EXTREME SCALE

November 6-7, 2008 • Washington D.C.

U.S. DEPARTMENT OF  
**ENERGY**

*Sponsored by the Office of Biological and Environmental Research and the Office of Advanced Scientific Computing Research*

**Chaired by Warren Washington**



# **Presentations**

## **Climate System Response to External Forcings and Climate Change Projections in CCSM4**

G. Meehl, W. Washington, J. Arblaster, A. Hu, H. Teng, C. Tebaldi (Climate Central), B. Sanderson, W. G. Strand and J.B. White III

## **Towards Climate Simulations at Regional Resolution**

J. Caron, J. Tribbia , J. Truesdale and J. Hack (ORNL)

## **The Role of the Bering Strait on Glacial Climate Stability**

A. Hu

## **Simulating Earth's Hydrological Cycle**

J. Kiehl, C. Shields and D. Williamson

## **The Cause of Unrealistic, Intense Precipitation Events in High Resolution Simulations with CAM4**

D. Williamson

## **Regional Projections of Climate on Decadal Time Scales: High Resolution Global Predictions and Regionally Resolved Source Response Studies**

J. Tribbia





# Posters

## **The Community Earth System Model (CESM) Submission to the Coupled Model Intercomparison Project Phase 5 (CMIP5)**

W. G. Strand

## **Advances in Earth System Model Representation of Permafrost and Permafrost Hydrology and the Impact on Permafrost Projections**

D. Lawrence, S. Swenson and A. Slater (CU)

## **Can Large Black Carbon Aerosol Heating in the Indian-South Asia Monsoon Region Cause Future Changes in the Local and Global Circulation?**

W. Washington, H. Teng and G. Branstator

## **Aquaplanets with Interactive Aerosol: Are They Earth-Like?**

B. Medeiros

## **Diagnosing Cloud and Nonlinear Climate Feedbacks with a Novel Radiative Kernel Updating Technique**

B. Sanderson

## **High-Performance High-Resolution Semi-Lagrangian Tracer Transport on a Sphere**

J.B. White III and J. J. Dongarra (UTK)

## **The Influence of SSTs on Global and Regional Temperature Extremes from Observations & Models**

J. Arblaster (CAWCR/BMRC/NCAR) and L. Alexander (Monash U./Hadley Centre)



# Plans for Climate Change Simulation







- Coupled 1° CAM4 simulations
  - Decadal prediction
  - CESM(BGC)
- Coupled 1° CAM5 simulations
  - 20<sup>th</sup> century, RCPs, extensions
  - 20<sup>th</sup> and 21<sup>st</sup> century single forcings
  - Decadal prediction
- High-resolution time-slice experiments
  - 1/4° CAM4 vs. CAM5, FV vs. SE, then 1/8°
- High-resolution coupled simulations
  - 1/2°, 1/4°, 1/8° atmosphere and land
  - 1°, 1/10° ocean and sea ice
  - Control, 20<sup>th</sup> century, RCP, decadal prediction





# Computing Plans

- Coupled CAM4
- Coupled CAM5
- High-Resolution Time Slices
- High-Resolution Coupled

						
Coupled CAM4	✓					
Coupled CAM5	✓	✓	✓			
High-Resolution Time Slices		✓	✓	✓	✓	✓
High-Resolution Coupled		✓	✓	✓	✓	✓