

# **Regional and Global Climate Modeling at Oak Ridge National Laboratory**

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- PhD – Ocean Physics  
University of Puerto Rico
- MS – Physics  
University of Puerto Rico
- BS – Physics  
National University Bogota – Columbia



# Cheetah IBM Power4 Fastest Nonclassified Computer in the USA

# SciDAC Enabling Technologies

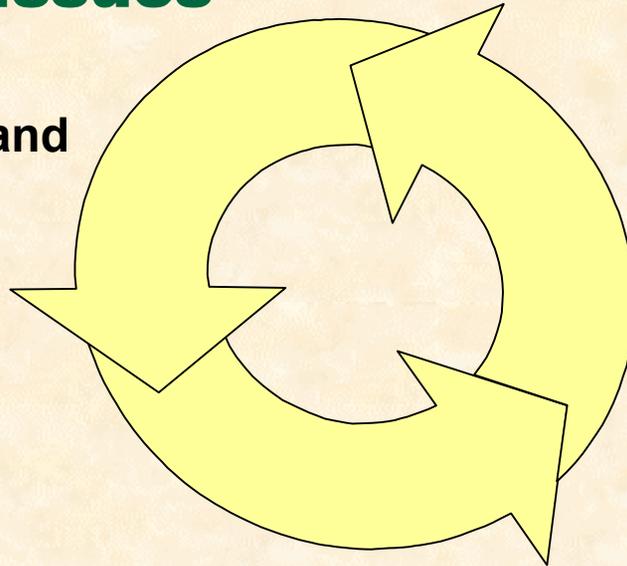
Leveraged ORNL expertise in enabling technologies to create the infrastructure for the Climate and Carbon Research (CCR) science research focus

- **Model coupling framework**
  - CCSM2 National coupled climate model
  - NASA ESMF - allow parallel models to plug together
- **Collaborative technologies**
  - Earth System Grid
  - Provides transparent access to analysis capabilities for researchers throughout the country
- **Integrated Software Infrastructure Centers**
  - Algorithms, solvers, applied mathematics

# Regional Climate Modeling

## Assessment Issues

- Energy: demand and emissions
- Water
- Agriculture
- Forest
- Coastal zones
- Human health



## Simulation

- Global Circulation Models: down -scale for assessment
- Regional models: up-scale for process science

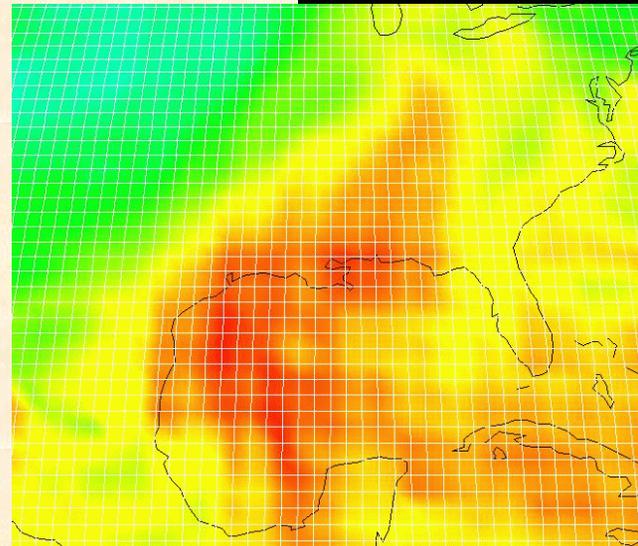
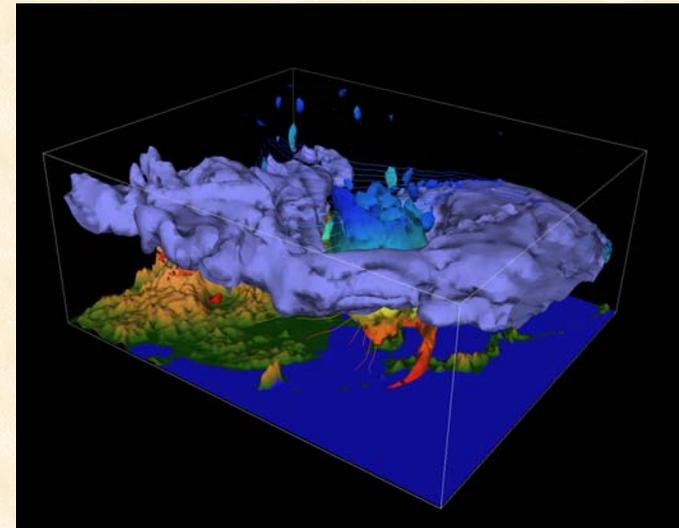
## Science Issues

- Climate change: CO<sub>2</sub>, trace gases
- Terrestrial Carbon Cycle
- Air Pollution: O<sub>3</sub>, chemistry, transport
- Hydrologic Budgets
- Land use patterns

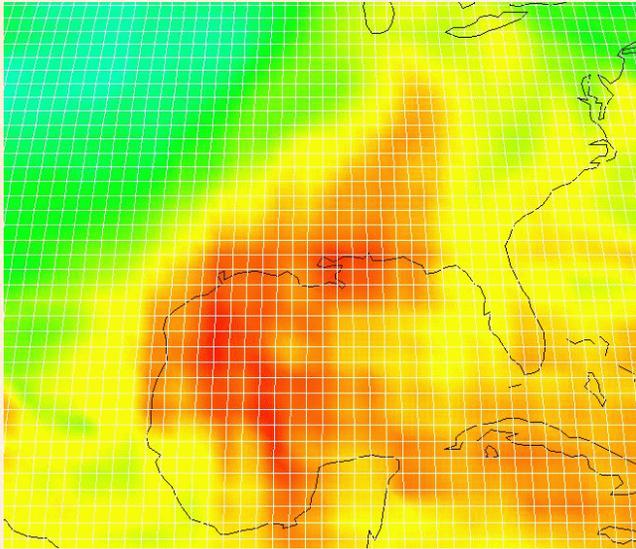
# Regional Models

## What is a regional climate model?

- Meteorological variables on (locally fine) 1km grid
- Nested in GCM to provide boundary conditions
- Fine scale process models
- Appropriate spatial scale for assessment activities



# Regional Modeling

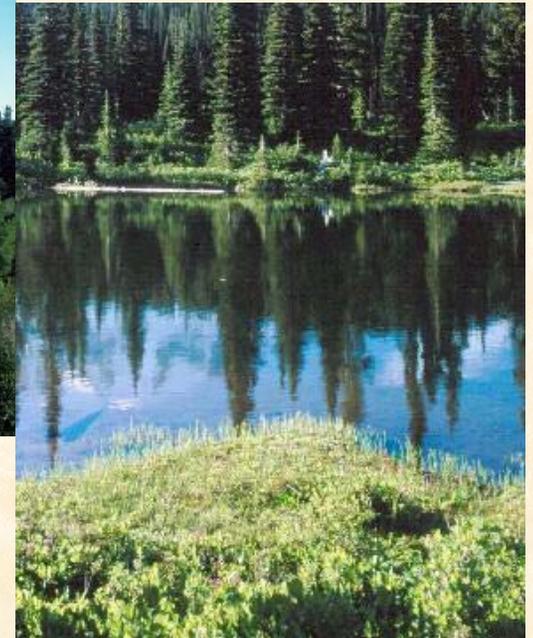


**Nested in GCM to provide  
boundary conditions**

**Appropriate spatial scale for  
assessment activities**



**Meteorological variables on  
(locally fine) 1km grid**

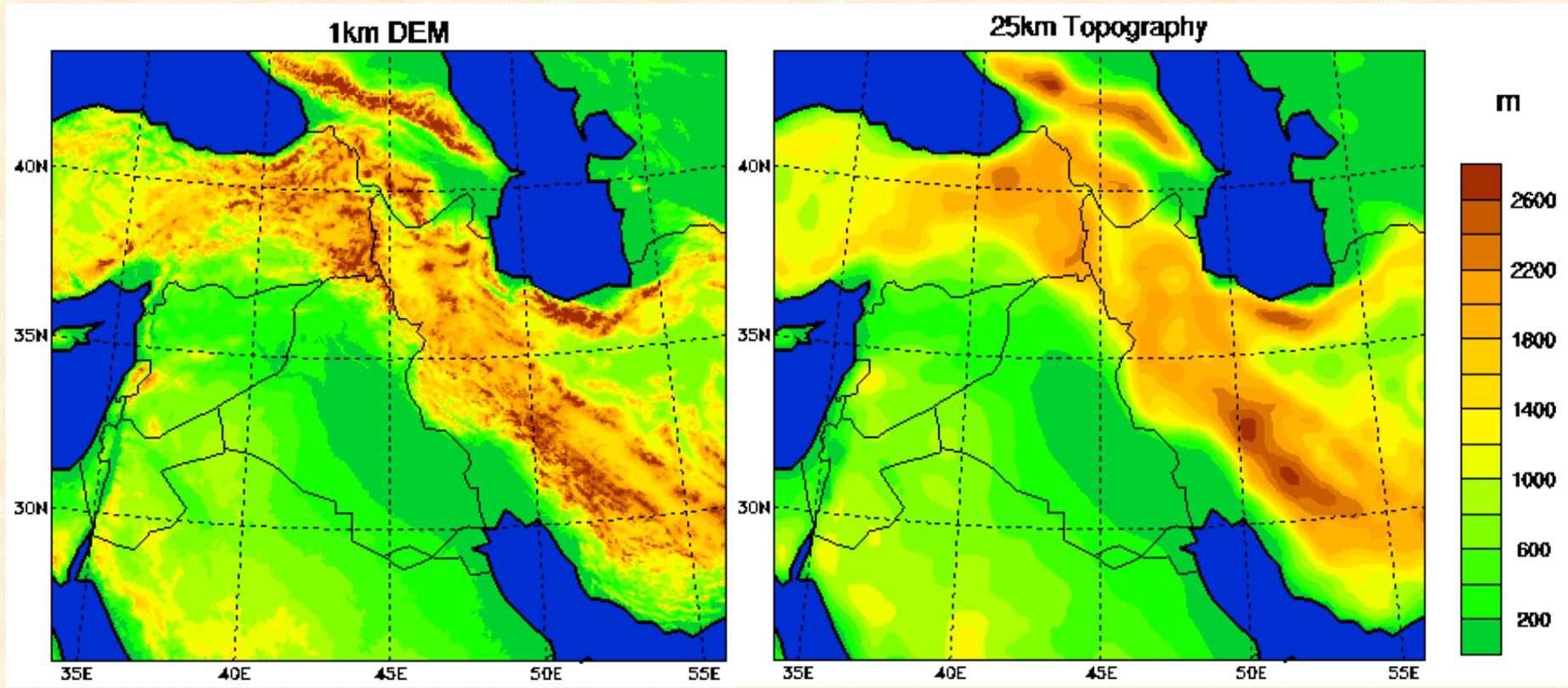


**Fine scale process models**

# Regional Climate Model

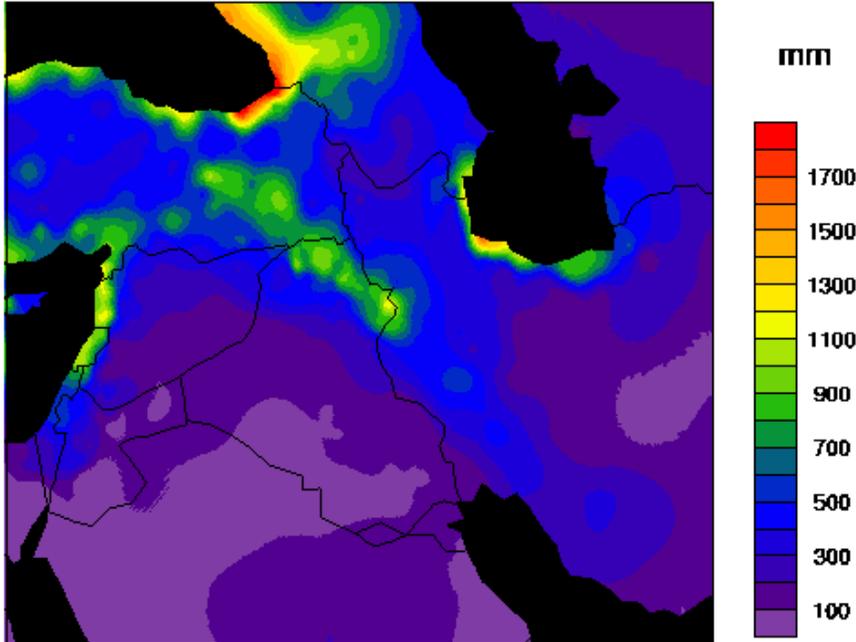
- Centered at 45N 35E
- ~8,000,000km<sup>2</sup> total domain
- Topography and land use are interpolated from a global 10 min dataset
- Initial and boundary conditions are extracted from the ECMWF TOGA analysis
- Begins 1<sup>st</sup> January 1990 (1<sup>st</sup> month of run is discarded)
- Covers 5 years
- Grid spacing = 25 km
- Time step = 90 s

# Topography

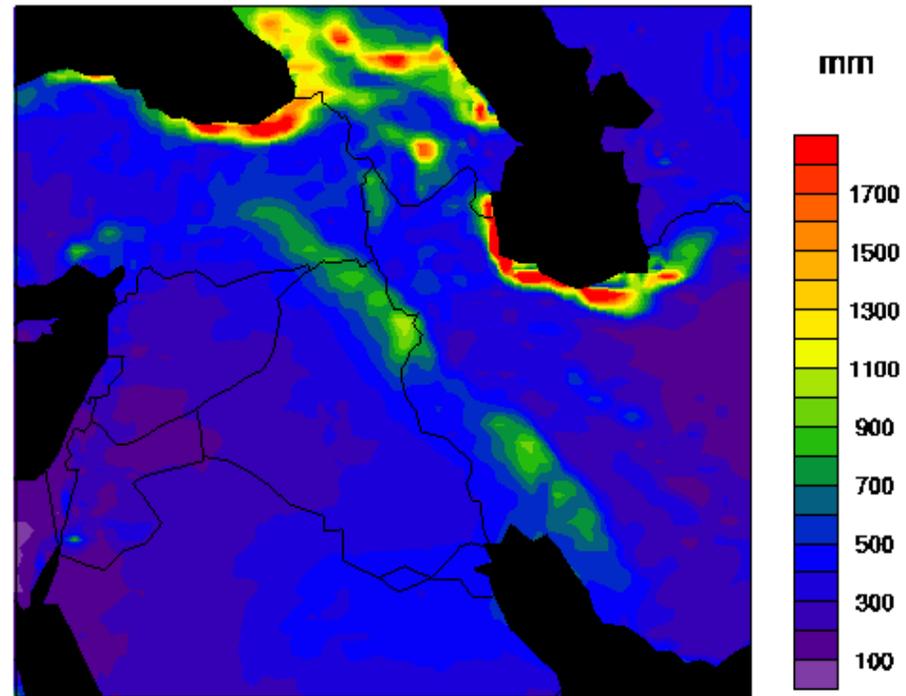


# Annual Precipitation

Observed Mean Annual Precipitation

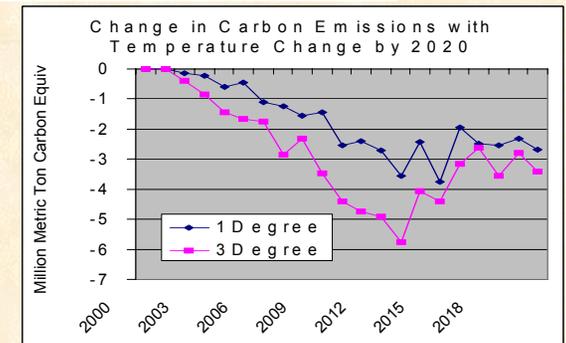
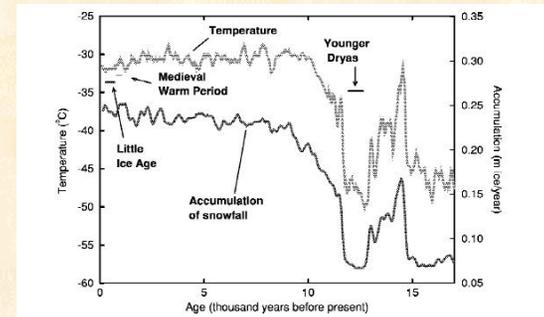
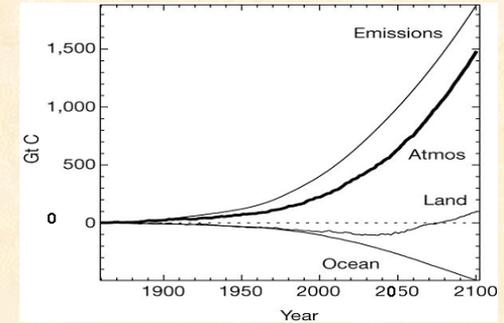


Modeled Mean Annual Precipitation

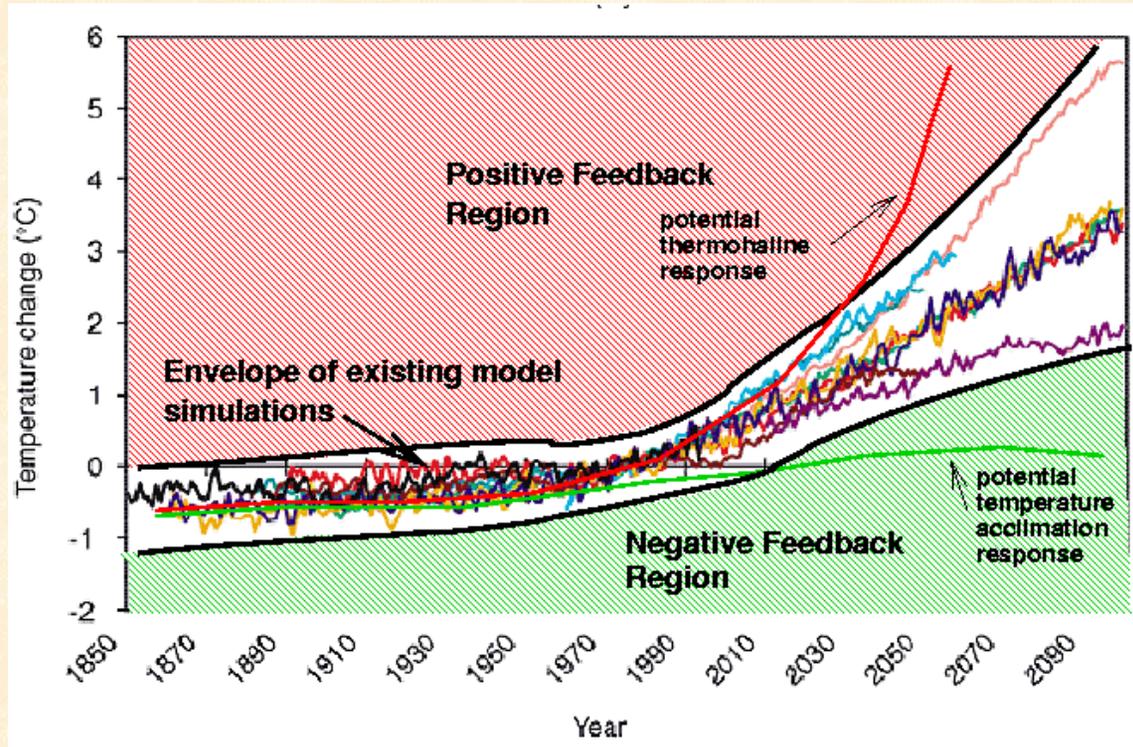


# Three Focused Basic Science Research Tasks

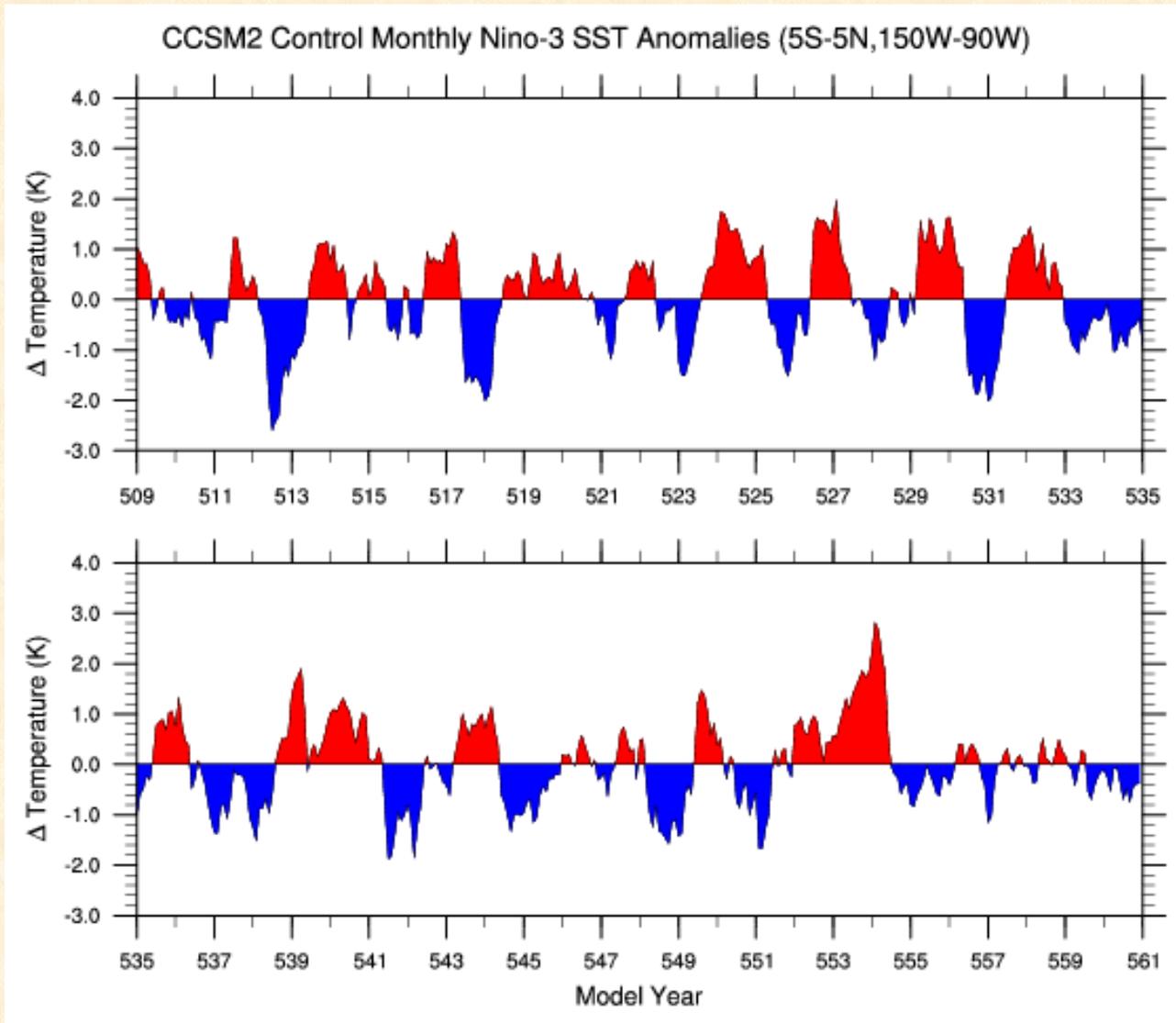
- **Carbon cycle feedbacks**
  - a) temperature acclimation
  - b) diffuse radiation
- **Water cycle feedbacks**
  - a) ocean circulation
  - b) soil moisture
- **Energy/economics feedbacks**
  - a) heating/cooling day change
  - b) technology adaptation



# Climate Feedbacks May Result in 'Outside the Envelope' Results



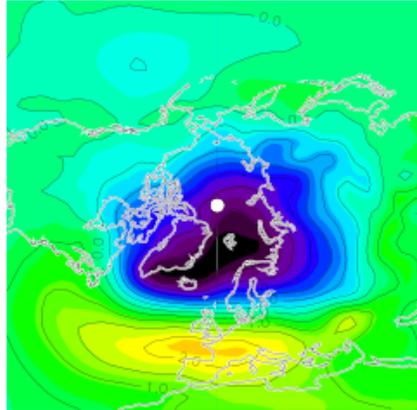
Computed global mean temperature for the time period 1850 – 2100



# NAO SLP Pattern

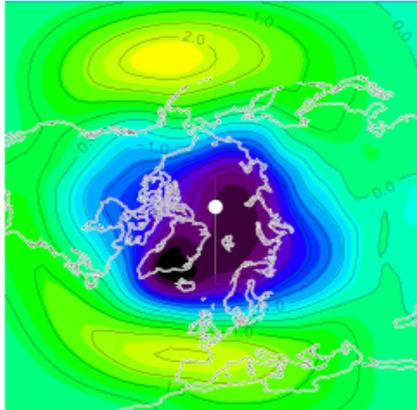
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Regression slp pc1 and slp - OBS



From 50 Years  
of NCEP  
Reanalysis

Regression slp pc1 and slp



From 300  
Years of  
CCSM2  
Control  
Simulation

Based on Nov-April seasonal average Sea Level Pressure

# ORNL Regional Climate Modeling Focus

- ORNL has devoted world class computational capabilities to climate simulation
- ORNL has extensive experience in using several regional and global climate models
- ORNL anticipates significant scientific education and technology transfer with regard to climate simulation

# Oak Ridge National Laboratory Computational Sciences Building

March 4



May 29



June 27



August 9



September 17



October 17



[www.ccs.ornl.gov](http://www.ccs.ornl.gov)

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**OAK RIDGE NATIONAL LABORATORY**  
**U. S. DEPARTMENT OF ENERGY**

