LCF Climate Science Computational End Station

Presented by

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Objectives of the Climate Science Computational End Station

- Predict future climate
  - Based on scenarios of anthropogenic emissions
  - Resulting from options in energy policies
- Deliver simulations that improve climate models
  - Scientific basis
  - Accuracy
  - Fidelity
- Inform national science policy
- Thus contribute to DOE science mission

Approach of the Climate Science Computational End Station

- Develop, maintain, and support the Community Climate System Model (CCSM)
- Execute high-priority simulations at LCF
- Outreach to research community
  - Simulation products
  - Analysis of model results
  - CCSM workshop
- Champion and execute research program to deliver CCSM4 in three years
  - In time for next assessment by the Intergovernmental Panel on Climate Change

CCSM4 development objectives

- Document, understand, and correct biases and systematic errors
  - Improve simulation of important quantities, like regional precipitation patterns
  - Higher resolution in dynamics
  - Higher fidelity in physical parameterizations
- Characterize dominant nonlinear dynamical mechanisms
  - Climate variability and abrupt transitions
  - Ice and ocean processes with long timescales but small characteristic length scales
- Quantify nature and timing of biogeochemical feedbacks
  - Atmosphere, ocean, and land
  - Impacting global carbon cycle

Unique value of the Climate Computational End Station

- Coordination of development and simulations
- Priority setting in climate-change research simulations
- Sharing of software expertise
- Development of scalable solutions

Roles within the Climate Science Computational End Station

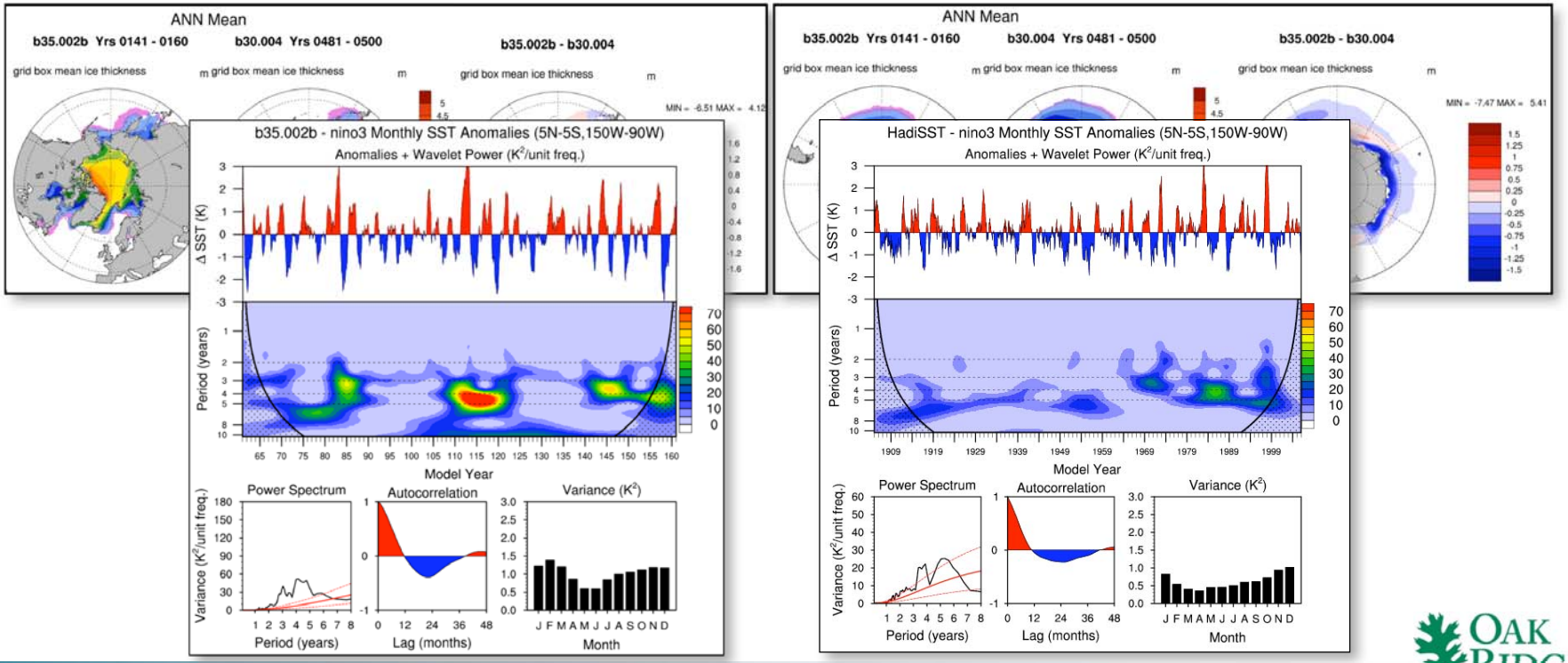
- National Center for Atmospheric Research
  - Higher-resolution atmosphere models
  - Improved physical processes that remove biases
  - Climate-change studies
- Los Alamos National Laboratory
  - Increased resolution of ocean and sea-ice models
  - High-resolution coupled experiments
  - Ocean biogeochemistry models
- Lawrence Livermore National Laboratory
  - Comparison and validation of new models
  - Scaled, distributed analysis infrastructure
  - Development and testing of high-resolution atmosphere models

Roles within the Climate Science Computational End Station

- Pacific Northwest National Laboratory
  - Downscaling to investigate regional water resources
  - Embedded cloud-resolving models
  - Physically based replacements for cloud parameterizations
- NASA Goddard Space Flight Center
  - New observations and measurements to evaluate models
  - Advanced data-assimilation technologies
  - Improvements for policy formulation and impact planning
- Oak Ridge National Laboratory
  - Software integration
  - Coupled carbon-cycle simulation
  - Biogeochemistry feedbacks
- Additional experiments by university partners

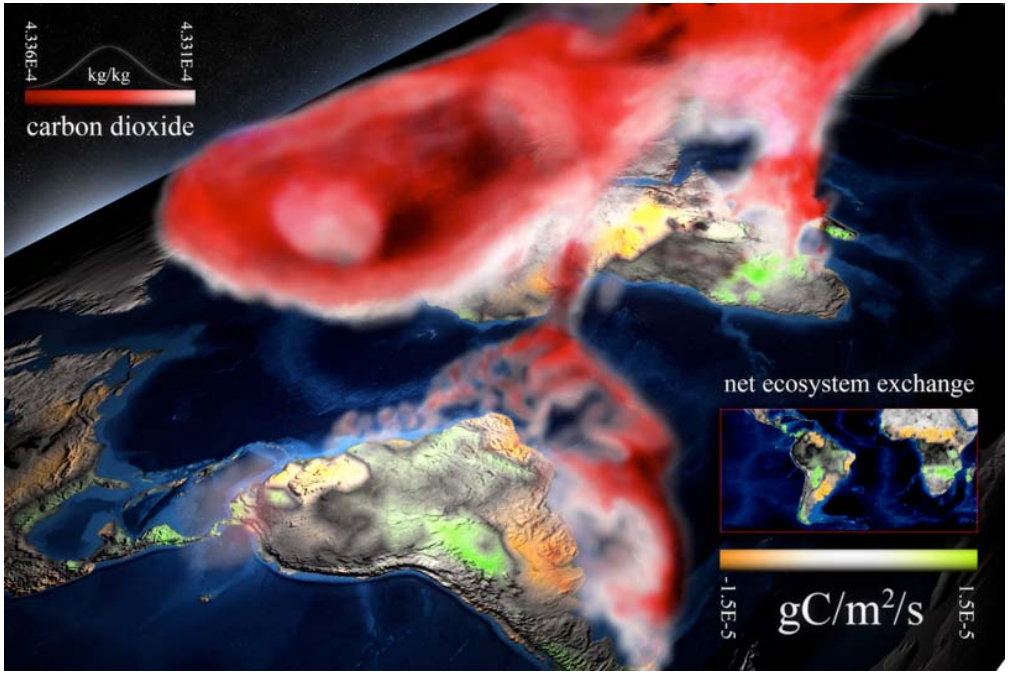
CCSM development (Peter Gent)

- Three 100-year control runs of new CCSM 3.5
- Tuned snow albedos for best simulation of Arctic sea ice
- Much-improved El Nino / Southern Oscillation
- Critical-path development of CCSM4 for the IPCC AR5



Dynamic-ecosystem feedback simulation (Hoffman)

- Tests of ocean advection schemes on ecosystem tracers
- Spin up of terrestrial carbon in CLM-CASA and CLM-CN for Carbon Land Model Intercomparison Project



Courtesy of Jamison Daniel, ORNL

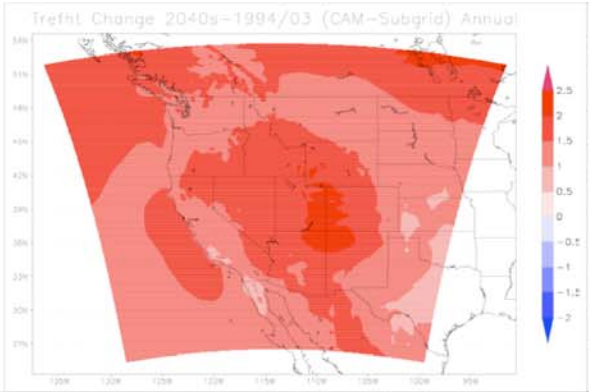
Regional downscaling

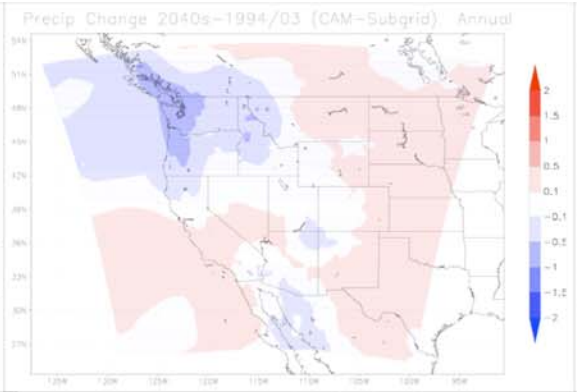
- Goal: Improve simulation and surface hydrology in regions of complex orography
- Simulations of orographic effects on western United States
  - Regional simulation with Weather Research and Forecasting (WRF) model
  - Subgrid parameterization with global Community Atmosphere Model (CAM)

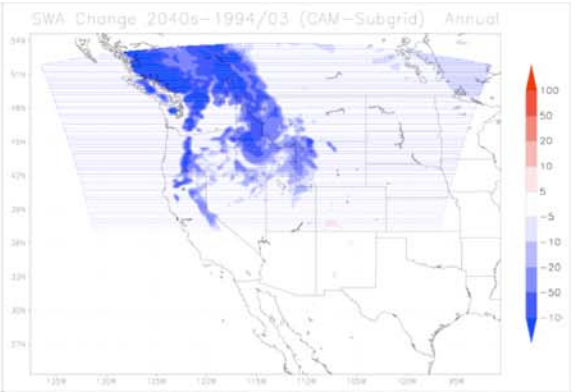
Regional downscaling

Surface temperature | Precipitation | Snowpack

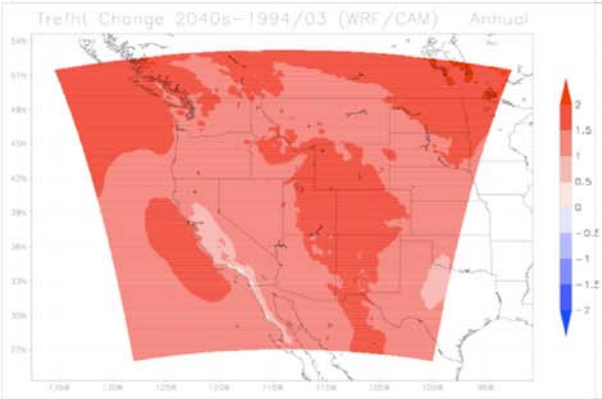
Subgrid CAM

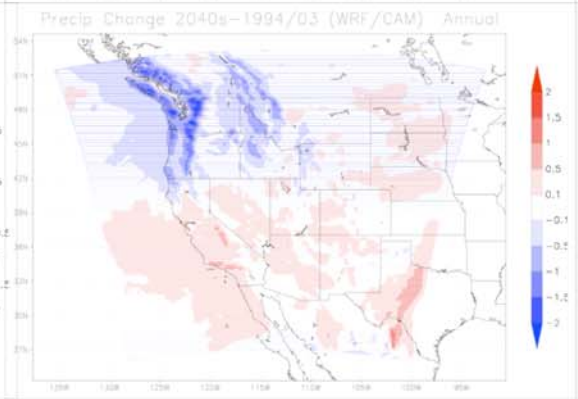


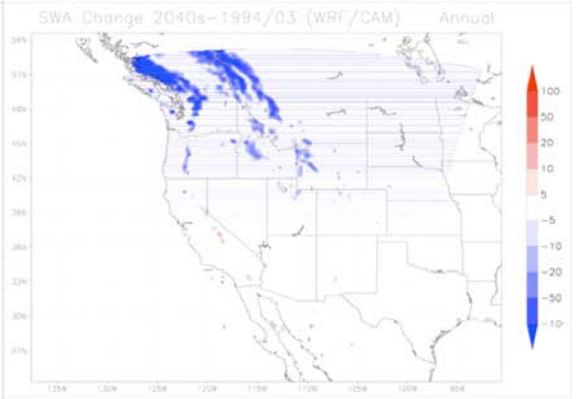




WRF

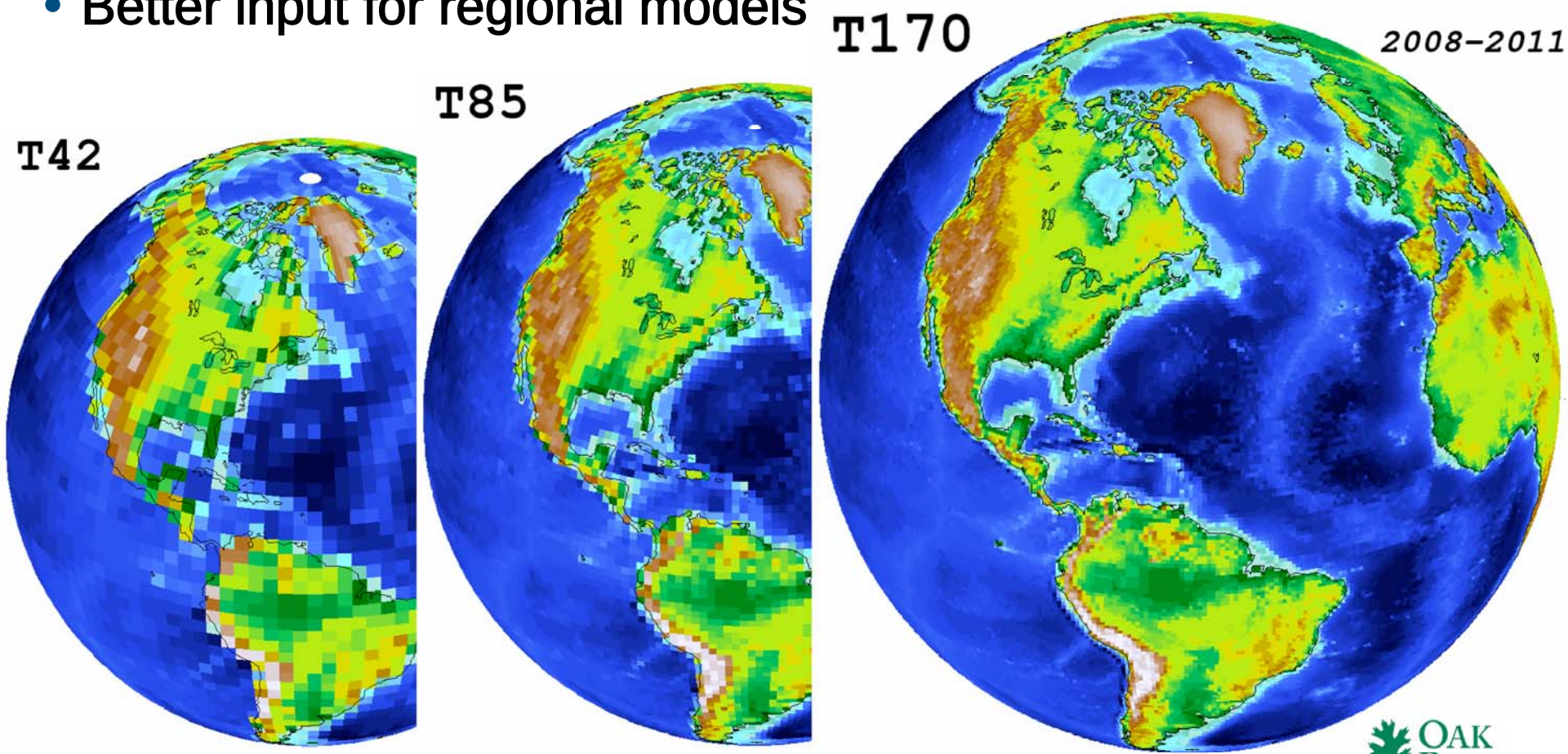






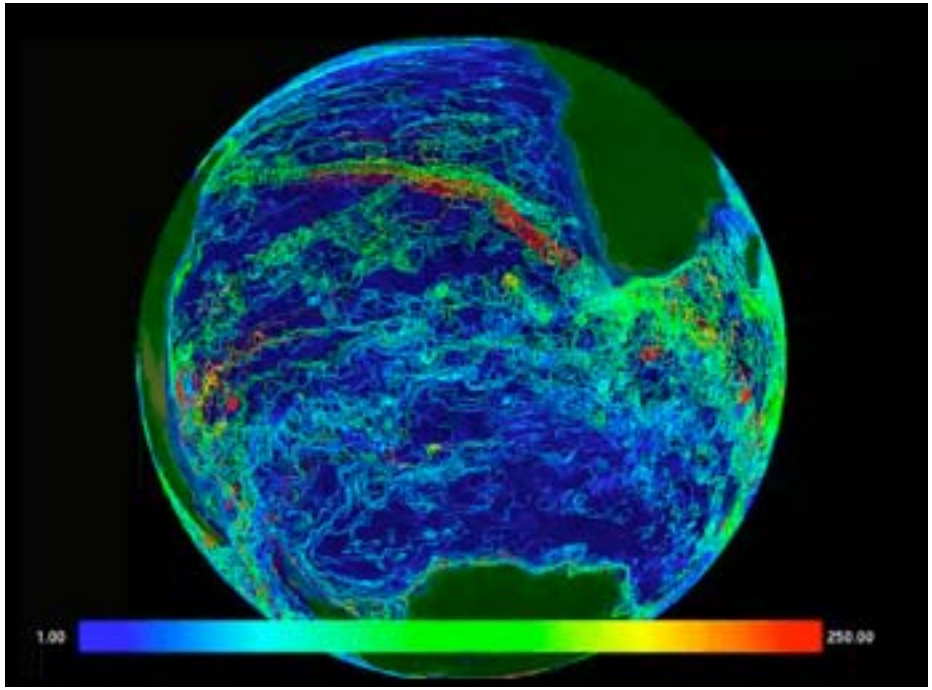
Resolution studies

- Fully coupled simulations at T170 resolution (versus T85 for last IPCC)
- Improved simulation of tropical cyclones and transients
- Better input for regional models



High-resolution ocean

- Several simulated years of spinup at 0.1° resolution
- Resolve inconsistency in surface forcing
- Tested new modules
  - Lagrangian particles
  - High-frequency time-series output
  - Passive-tracer transport



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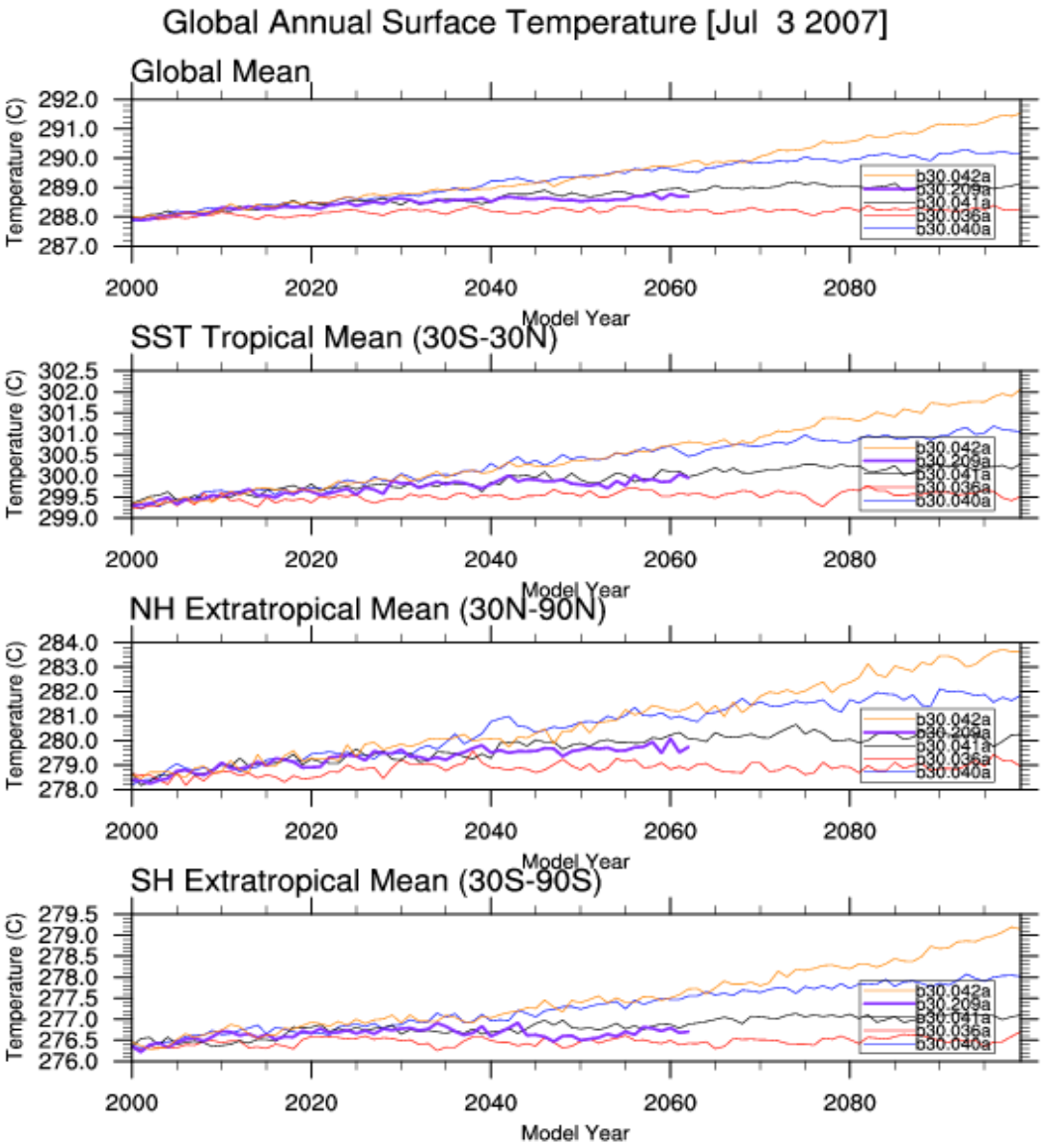
Emissions-reduction scenarios

- 450 ppm CO_2 case
- First of a series of Climate Change Science Program scenarios examining alternative future energy and emissions reduction pathways



450 ppm
IPCC commitment
B1
A1B
A2

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