Climate change prediction with new generation models: moderate and high resolution studies

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RESEARCH OBJECTIVES

The main purpose of this research is to use the Parallel Climate Model (PCM) and the Community Climate System Model version 2 (CCSM2) for studies of anthropogenically forced climate change simulations with higher resolution and more detailed model components. Because it is difficult to separate anthropogenic climate change from natural climate variability, it is necessary to carry out ensembles of simulations in order to find the statistically significant climate change signal.

COMPUTATIONAL APPROACH

(1) With collaborators, we have developed an ocean component that uses the finite difference Parallel Ocean Program (POP) with a displaced North Pole. This model was modified from the original average resolution of 2/3° latitude and longitude to allow increased latitudinal resolution near the equator of approximately 1/2°. (2) The sea ice model component is entirely new. The thermodynamic part of the model uses the physics from C. Bitz’s University of Washington ice model. It allows for five or more ice thickness categories and elaborate surface treatment of snow and sea ice melt physics. The elastic-viscous-plastic physics uses the E. Hunke and J. Dukowicz approach to the solution of the ice dynamics. (3) The atmospheric component is the massively parallel version of the NCAR Community Climate Model version 3 (CCM3). This model includes solar and infrared radiation, boundary physics, and precipitation physics. (4) The coupler’s design allows the component models to execute concurrently as separate executables, or sequentially within a single executable, with the information exchange achieved by message passing (MPI). Since the component grids are different, there is an interpolation scheme for passing information between the atmosphere component grid and the ocean/sea ice grid, which has been designed to run efficiently on distributed memory architectures. Chris Ding and collaborators at NERSC have improved the performance of the coupler on parallel computers.

ACCOMPLISHMENTS

During this past year, we completed many climate change simulations. Some of the simulations are of “business as usual” scenarios, in which there are no constraints on the use of greenhouse gases and aerosols. We have also performed various stabilization simulations. In both cases we completed five simulations that have different initial conditions. Using an ensemble is essential for evaluating the natural variability and to separate the climate change signal from the climatic noise. The societal interest is increasingly on regional changes.

SIGNIFICANCE

The DOE Climate Change Prediction Program is focused on developing, testing and applying climate simulation and prediction models that stay at the leading edge of scientific knowledge and computational technology. The intent is to increase dramatically both the accuracy and throughput of computer model-based predictions of future climate system response to the increased concentrations of greenhouse gases. The PCM and CSM simulations have been highlighted in many parts of the latest report from the Intergovernmental Panel on Climate Change (IPCC).

PUBLICATIONS


http://www.cgd.ucar.edu/pcm