Results from the Carbon–Land Model Intercomparison Project (C–LAMP) and Availability of the Data on the Earth System Grid (ESG)

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Introduction
As general circulation models (GCMs) evolve and improve, there is increasing interest in applying them to understand the potential for global climate change. The global carbon cycle is of particular importance since it is thought to have a significant impact on global temperatures. A wide array of carbon models have been coupled to GCMs, and recent work has shown that coupled interactive biogeochemical models can yield results useful for climate change studies. The objective of the C–LAMP is to run a series of model experiments using these three such models coupled to the Community Climate System Model (CCSM). Two of these models, CASA’ and IBIS, were previously coupled to GCMs, and a brand new model—CLM3–CN has been coupled to CCSM.

CCSM Carbon Land Model Intercomparison Project (C–LAMP)

- A comparison of terrestrial biogeochemistry models running in the CCSM framework is being organized by the CCSM Biogeochemistry Working Group (BGCWG).
- The objectives are to compare model capabilities and effects in the coupled climate system and to understand processes important for inclusion in the coupled model for simulations supporting the IPCC Fifth Assessment Report.
- Current terrestrial models running within the CCSM framework are: CLM3–CASA’, CLM3–CN, and LSX–IBIS.
- The experimental protocol is being developed by Inez Fung, Jim Randerson, and Peter Thornton with input from all members of the CCSM BGCWG.
- The protocol involves a series of simulations at T42, gr3v resolution that borrows from but improves upon the CCFM Phase 1 protocol.
- Experiment 1: “offline” biosphere model runs (CCSM 1 configuration) forced with NCEP/NCAR reanalysis datasets (A. Dai et al.).
- Spin-up: 1.13 GHz and 8 GB of memory per interleaved node (partitioned)
- Control run (1798–2004)
- Climate varying run (1948–2004)
- Climate and carbon dioxide varying with nitrogen deposition (1798–2004)
- Climate and carbon dioxide varying with nitrogen deposition and landuse
- Experiment 2: coupled land–atmosphere model runs (CCSM F configuration) with prescribed SSTs, sea ice and carbon dioxide
- Spin-up: 1990–2004
- Control run (1990–2004)
- Climate varying run (1990–2004)
- Climate and carbon dioxide varying with nitrogen deposition (1990–2004)
- Climate and carbon dioxide varying with nitrogen deposition and landuse
- Complete protocol, metrics, and output approach are described and available for comment at http://www.climatedatamodeling.org/bgcm/

C–LAMP Datasets and Model Output

- Special attention is being given to the development of intercomparison metrics and diagnostics relevant to the carbon cycle.
- Seasonal and diurnal cycles will be analyzed and compared with observational datasets from Ameriflux Fluxnet towers, MODIS/satellites, and GlobalView.
- Model output and post-processing data will be made available to the wider science community by PCMDI via the Earth System Grid (ESG) for further analysis.
- The first model output datasets will soon be available on the ESG server at http://esg2.ornl.gov/

Computational Climate Science End–Station

A Leadership Computing Facility (LCF) Project

C–LAMP is a subproject of the Computational Climate Science End–Station (Dr. Warren Washington, PI) a Leadership Computing Facility (LCF) project of the National Center for Computational Sciences (NCCS) located at ORNL.

- Experiments 1 and 2 outlined above, along with corresponding ocean biogeochemistry runs, are presently being performed on the Cray X1E.

Cray X1E

- 256 interleaved “dual–core” SMP nodes
- 4 Multi–Streaming Processors (MSPs) per node
- 4 Single Streaming Processors (SSPs) per MSP
- Two 32–stage, 64–bit wide vector units running at 1.13 GHz and one 2–way superscalar unit running at 400 MHz per SSP
- 2 MB L2 cache per SSP
- 6 GB per memory per interleaved node (partitioned)

1024 processors (MSPs), 2048 GB of memory, and 18.08 TFlops/s peak performance.

Phenixin

Diagnostics and Visualization

Taylor (2001) Diagrams will be used to statistically show the degree to which model results agree with observational datasets, like those shown here.

In these simulations, the carbon dioxide from various sources is advected into the atmosphere. A leadership computing facility such as the Cray X1E has a lower sensitivity to rising carbon dioxide because of increasing nitrogen deposition.

Preliminary Results from Experiment 1

Control Run Comparisons of CLM3–CN and CLM3–CASA’

- Both models achieved steady state.
- Net primary production differs by a factor of two.
- Spatial columns of annual NPP differ between the models.

Comparison with FLUXNET Observations (BOREAS)

- Seasoanal exchanges are weak in both models.
- Seasonal NPP is lower in CASA’.

Transrun Comparisons of CLM3–CN and CLM3–CASA’

- CASA’ exhibits a stronger fertilization response to increasing atmospheric carbon dioxide.

CLM3–CN has a lower sensitivity to rising carbon dioxide because of increasing nitrogen deposition.

Model Output Delivered via the Earth System Grid

The Earth System Grid (ESG) is a virtual collaborative environment that will provide access, monitor, catalog, transport, and distribute data. The next generation ESG Center for Enabling Technologies (ESG–CET) will support petabyte dataset volumes in a distributed environment through the federation of data centers.

MPC hardware running climate models

http://esg2.ornl.gov/

ESG Sites

The C–LAMP model output from Experiment 1 will soon be available to the community on the new ESG node at Oak Ridge National Laboratory.

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