The Carbon-Land Model Intercomparison Project (C-LAMP): A Protocol and Metrics for Model-Data Comparison
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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 may create a significant positive feedback on global warming. A wide array of carbon models have been coupled to GCMs, and recent work has shown that coupled-interactive biogeochemical models can yield useful, but wide-ranging, results for climate change studies (e.g., Friedlingstein et al. 2006).

Described here are model-data intercomparison experiments of general use for measuring the scientific performance of global biosphere models. Originally designed to test the performance of three such models coupled to the Community Climate System Model Version 3 (CCSM3), the Carbon-Land Model Intercomparison Project (C-LAMP) has evolved into an international protocol and a growing set of metrics for scoring the performance of models by comparison with best-available observational datasets, from satellite-based to leaf-scale measurements. C-LAMP is expected to serve as a prototype for biosphere model benchmarking for IPCC AR5.

Modeling Community

By making use of the web of observational datasets measured, collected, and distributed by government agencies, C-LAMP identifies areas in which improvement can be made to models as well as identifying needs for new kinds of measurements. In addition, all the C-LAMP model output is distributed via the Earth System Grid (ESG) and model diagnostics are available on the Web for use by the wider scientific community.

C-LAMP Protocol

Experiment 1: Intercomparisons with Observations

- Zonal mean net primary production compared with MODIS satellite observations
- Net primary production compared with precipitation compared with SEB measurements

Experiment 2: Partially coupled land-atmosphere model runs with prescribed sea surface temperatures (SSTs) and sea ice cover

- Spin-up run
- Control run (1798–2004)
- Climate, carbon dioxide, and nitrogen deposition varying run (1798–2004)
- Climate, carbon dioxide, nitrogen deposition, and land use varying run (1798–2004)

Experiment 1.4 results from the CLM3-CSA and CLM3-CN models are being used for the NACP Regional Interim Synthesis

Feature of the CLAMP model results

- Comparison with MODIS MODIS IT2A2 for month of maximum leaf area index (LAI). While direct comparison of model results with MODIS LAI values is problematic, it is possible to evaluate whether the month of maximum LAI from MODIS lies within the model uncertainty range.
- Comparison of aboveground biomass (g C m⁻²) estimated by Saitchi et al. 2006.

Climate/Carbon Cycle Visualization

In these simulations, the carbon dioxide from various sources is advected individually as tracers in the atmosphere model. Here, carbon dioxide from land, originating as the net ecosystem exchange shown in color on the land surface, is advected throughout the atmosphere, shown as plumes along the land surface.

The Computational Climate Science End-Station: A DOE INCITE Project

C-LAMP simulations performed using CCSM3 are a part of a subproject of the Computational Climate Science End Station (Dr. Warren Washington, PI), a U.S. Department of Energy Innovative and Novel Computational Impact on Theory and Experiment (INCITE) Project using resources at the National Center for Computational Sciences (NCCS) located at Oak Ridge National Laboratory (ORNL).

Model Output Delivered via the Earth System Grid (ESG)

The Earth System Grid is a virtual collaborative environment that links distributed centers, users, models, and data in a Grid computing environment. The primary goal of ESG is to support the infrastructure needs of the international climate community by providing technology to securely access, monitor, catalog, transport, and distribute data. The next generation ESG Center for Enabling Technologies (ESG-CE) will support petabyte dataset volume in a single output, high performance data movement through a federation of data centers.

The C-LAMP model results are available to the community on a new ESG node at Oak Ridge National Laboratory at http://esg.ornl.gov/

This ESG node will provide the infrastructure for an international community biosphere model benchmarking activity for IPCC AR5.

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