THE CARBON-LAND MODEL INTERCOMPARISON PROJECT (C-LAMP): A MODEL-DATA COMPARISON SYSTEM FOR EVALUATION OF COUPLED BIOSPHERE-ATMOSPHERE MODELS

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ABSTRACT

The need to capture important climate feedbacks in general circulation models (GCMs) has resulted in new efforts to include atmospheric chemistry and land and ocean biogeochemistry into the next generation of production climate models, now often referred to as Earth System Models (ESMs). While many terrestrial and ocean carbon models have been coupled to GCMs, recent work has shown that such models can yield a wide range of results (*Friedlingstein et al.*, 2006), suggesting that a more rigorous set of offline and partially coupled experiments, along with detailed analyses of processes and comparisons with measurements, are warranted. The Carbon-Land Model Intercomparison Project (C-LAMP) provides a simulation protocol and model performance metrics based upon comparisons against best-available satellite- and ground-based measurements (*Hoffman et al.*, 2007). C-LAMP provides feedback to the modeling community regarding model improvements and to the measurement community by suggesting new observational campaigns (see Fig. 1).

C-LAMP Experiment 1 consists of a set of uncoupled simulations of terrestrial carbon models specifically designed to examine the ability of the models to reproduce surface carbon and energy fluxes at multiple sites and to exhibit the influence of climate variability, prescribed atmospheric carbon dioxide (CO_2), nitrogen (N) deposition, and land cover change on projections of terrestrial carbon fluxes during the 20th century. Experiment 2 consists of partially coupled simulations of the terrestrial carbon model with an active atmosphere model exchanging energy and moisture fluxes. In all experiments, atmospheric CO_2 follows the prescribed historical trajectory from C^{4}MIP. In Experiment 2, the atmosphere model is forced with prescribed sea surface temperatures (SSTs) and corresponding sea ice concentrations from the Hadley Centre; prescribed CO_2 is radiatively active; and land, fossil fuel, and ocean CO_2 fluxes are advected by the model. Both sets of experiments have been performed using two different terrestrail biogeochemistry modules coupled to the Community Land Model version 3 (CLM3) in the Community Climate System Model version 3 (CCSM3): the CASA$'$ model of Fung, *et al.*, and the carbon-nitrogen (CN) model of Thornton. Comparisons against Ameriflux site measurements, MODIS satellite observations, NOAA flask records,

TRANSCOM inversions, and Free Air CO_2 Enrichment (FACE) site measurements, and other datasets have been performed and are described in *Randerson et al.* (2009). The C-LAMP diagnostics package was used to validate improvements to CASA′ and CN for use in the next generation model, CLM4.
It is hoped that this effort will serve as a prototype for an international carbon-cycle model benchmarking activity for models being used for the Inter-governmental Panel on Climate Change (IPCC) Fifth Assessment Report. More information about C-LAMP, the experimental protocol, performance metrics, output standards, and model-data comparisons from the CLM3-CASA′ and CLM3-CN models are available at http://www.climatemodeling.org/c-lamp.

FIGURES

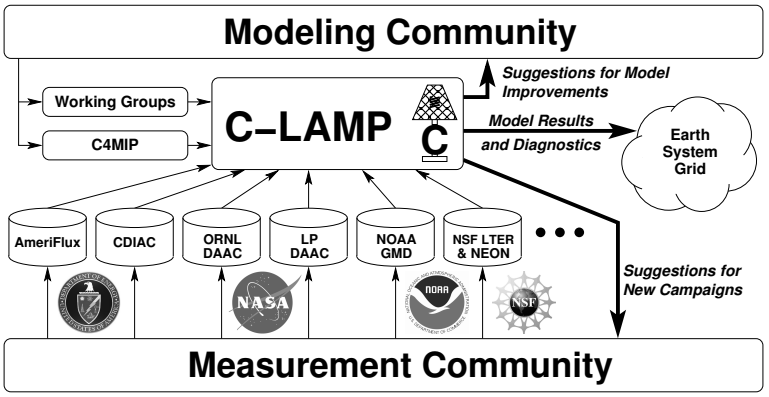

Fig. 1: The Carbon-Land Model Intercomparison Project (C-LAMP) helps to bridge the gap between the measurement and modeling communities by comparing models against best-available observational data sets. C-LAMP provides feedback to both communities by offering suggestions for model improvements and by suggesting new measurement campaigns. All C-LAMP model results and diagnostics are distributed via the Earth System Grid (ESG).

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