

CCSM Biogeochemistry Working Group Meeting Report

March 28-30, 2006

NCAR, Boulder, CO

The CCSM Biogeochemistry Working Group (BGCWG) “common path” activities over the last nine months have focused on two main themes:

- the land carbon model comparison (C-LAMP) (see below for more detail) and
- the development of a pilot, low-resolution (T31x3), fully coupled CCSM3 carbon-climate control simulation.

At the Spring working group meeting, we discussed the progress and near-term priorities for these two efforts, as well as emerging needs for a future high-resolution, coupled CCSM3 (e.g., x1 ocean ecosystem/biogeochemistry spin-up); results from on-going, PI-lead entrepreneurial research within the working group; and outstanding research/model gaps (based on the science needs identified in the 2004 BGCWG White Paper). This report focuses on near and long-term priorities for C-LAMP, fully coupled CCSM3 carbon-climate and outstanding model gaps.

The CCSM Carbon LAnd Model intercomparison Project (**C-LAMP**) is a collaborative effort across the CCSM BGCWG and DOE partners (ORNL and LLNL/PMDCI) to rigorously evaluate the performance of several land carbon biogeochemistry models with standard forcing, diagnostics, etc. The overarching objective is to develop an improved, well-validated land-BGC model in CCSM for the next generation CCSM4. Over the last nine months, a sub-group has developed the C-LAMP experimental design protocols, data metrics, diagnostics, and timeline, all of which can be found at (<http://climate.ornl.gov/bgcmip>). Three models will participate in the initial C-LAMP effort, CLM-CN, CLM-CASA', and IBIS. C-LAMP complements and builds from the initial Phase 1 international C⁴MIP, and through the PMDCI data portal/diagnostics lays the groundwork for future routine model intercomparisons (e.g., for IPCC 5th Assessment).

Efforts are well under way on a pilot, low-resolution (T31x3), CCSM3 fully coupled carbon-climate model. Based on our experiences (and difficulties) with CSM1.4-Carbon, the group decided to push forward with preliminary coupling experiments now with existing components, rather than wait for a “final” new land BGC model based on the results of C-LAMP. Currently, the experiments are being conducted with CLM-CN (CCSM land model coupled with the carbon/nitrogen model from Peter Thornton) and an ocean biogeochemistry-ecosystem model “DML” from Doney, Moore, and Lindsay. We are following the sequential coupling procedures described for CSM1.4-Carbon (Doney et al., *J. Climate*, in press). Preliminary work over Fall 2005 and Winter 2006 led to a fully coupled simulation with excessive drift in the land/ocean carbon reservoirs. We are re-spinning up the land model in stand-alone mode with coupled physics to see if we can create a more stable control. New versions of land (or ocean) BGC models will be incorporated as they become available and are validated. In a similar manner, we are using a nearly “out-of-the box” version of the T31x3 CCSM3 physics release. We expect to upgrade to new versions of CCSM-3 physics as major developments in the physical models are completed (e.g., finite volume dynamical core; improved tropical variability)

but keeping in mind the need for model stability during periods of intensive BGC development and evaluation.

The CCSM BGCWG priorities below are dominated by tasks to build and evaluate a “standard” version of CCSM (CCSM4) with coupled carbon for IPCC 5th assessment by December 2008.

Short-term Priorities (before June-October 2006 time frame and in order of priority):

1. C-LAMP Experiment 1 (stand-alone land model forced by prescribed atmospheric data) (run the 3 land models at T42—see protocol. To be done at ORNL under Climate End Station)
 - a. Need new N deposition from J-F. Lamarque (including ammonia)
 - b. Convert surface datasets to T42 (?)
 - c. Finish model validation on Cray X1 (Hoffman)
 - d. Goal: begin runs week of April 3rd (Hoffman); runs and first cut analysis using PI diagnostic packages (e.g., NCAR in-house package for CLM-CASA’ and CLM-CN) done by June 2006 CCSM meeting; most of analysis work done by March 2007
 - e. Goal: have observations pulled together (first cut) by June 2006 CCSM meeting (Steve Running /Inez Fung). More details on this below.
 - f. On-going: Transfer model simulation results and observations to DOE/PCMDI for posting to data portal; complete development and testing on diagnostics package for full analysis (Covey)
2. Fully coupled carbon cycle runs T31x3 with CCSM3 (done on CSL bluevista)
 - a. Re-spin up land model with coupled model output (years 201-225 from BGC coupled runs) (Thornton)
 - b. Start fully coupled runs with partially spun up ocean (from year 225 from previous runs) (Lindsay)
 - c. Goal: finish spin up and have some control runs done by June meeting
 - d. Subgroup to develop proposal to be presented at June 2006 CCSM workshop for experiments to run over summer (e.g., repeat CSM1.4-Carbon 20th and 21st simulations in Fung et al., *PNAS*, 2005; include more sophisticated treatment of climate forcings for 20th and 21st centuries; targeted sensitivity experiments.
3. Ocean DML ecosystem-biogeochemistry at x1 resolution (to be done at ORNL under Climate End Station)
 - a. Ocean model with DML incorporated is almost vectorized: needs to be finalized and model porting validation finished. (Lee/Lindsay)
 - b. Goal: start by April 15: have spin up completed by June 2006 meeting
4. Land model spin up for fully coupled runs (T42)
 - a. Take spun up land model (chase 1) from Experiment 1 (task 1) and spin up more with fully coupled output at T42x1.
5. Start fully coupled CCSM3 spin up for T42x1.

Pulling together observations for C-LAMP:

By 2006 CCSM Workshop in Breckinridge have station locations and field and remote sensing data sets identified that we want and will get data for:

Inez will be point person for data: send data to her.

In situ terrestrial data:

EMDI: Peter Thornton

Ameriflux: Steve Running, Matt Post

FACE: Mac Post

Euroflux: Reto Stöckli

Fluxnet: Kathy Hibbard

LBA: Kathy Hibbard

High latitude data: Kathy Hibbard

Radiocarbon obs: C14: Chris Swantson

Oregon transect: Steve Running

Other transects: Kathy Hibbard

In situ atmosphere data:

Globalview: station (ship, aircraft) (how to sample the data):

Satellite derived:

LAI, GPP, FPAR: Steve Running

Long-term: looked at gaps identified in BGC White paper in 2004 and updated (in red):

Developmental needs:

We discussed methane in more detail: need cows/rice paddies for some problems and natural wetlands for others. Substantial development required, small bits 'started'

Methane:

Cows/rice paddies

Natural wetlands

Land model:

- Improved hydrological model (including):
 - Dynamic lake levels **proposed**
 - Subsurface flow
 - Human water use (reservoirs, irrigation, ...)
 - Changes in local water table (go into land)
 - Peatlands???
 - Wetlands **proposed**
 - Riverine transport proposed
 - Coastal zones

- High-resolution grid **in progress**
- Urban grid cells in progress
- Updating BVOCs in progress
- Phosphorus cycle
- Historical/future? land use disturbance/land-use (and parameterization) in progress
- Tracers in land model (isotopes) C13 in, C14 in progress, water in progress
- NO, N₂O emissions from soils
- Fire emissions **progress**

Atmospheric Chemistry model:

- Higher resolution grid/urban for chemistry
- Secondary organic aerosol composition **progress**
- Aerosol microphysics (internal mixtures) **progress**
- Aerosol-cloud microphysics (**in progress** but could be done better)
- Fire plume model (chemistry within the plume-wildfire initiative???)
- Time varying emissions of reactive chemicals
- Wetland emissions **partly proposed**

Ocean model:

- Coastal ocean parameterization/nested regional models of biogeochemistry and physics nested regional models in progress???
- Virtual flux/natural boundary conditions for tracers not in plan?
- Ocean sediment model proposed
- Methane and N₂O emissions in ocean biogeochemistry DMS, CO, in progress
- VOC emissions from oceans
- Validated off-line tracer code in progress
- Implicit BGC equilibrium solver – proposed
- Advection schemes
- Fully interactive C14, C13 in co₂, O18, D in water and oxygen: in progress
- Calcium carbonate cycling

Atmosphere model:

- Downscaling of atmospheric boundary layer to higher resolution land
- Water isotopes in progress/entrepreneurial

For all modules: diagnostic tracers for biogeochemical processes (carbon dioxide and water isotopes in land, atmosphere and ocean, C13 fractionation (non MHC, CO>CO₂), Sulfur isotopes; C14, HDO, H₂dO18, HTO distributions in ocean)

Attendees of the Joint BGCWG and Land Model Working Group:

Jeff Hicke	CSU
Scott Elliott	LANL
Peter Lawrence	CU
David Xiaodong Zeng	U of AZ
G. Bala	LLNL
Scott Doney	WHOI
Jim Randerson	U CA Irvine
Curtis Covey	PCMDI/LLNL
J. Keith Moore	U of CA
Inez Fung	U of CA
Christopher Swanston	LLNL
Francois Primeau	U of CA
Dave Erickson	ORNL
Mac Post	ORNL
Andrew Slater	CIRES/CU
Atul Jain	Univ of IL
Kyle Halliday	PCMDI/LLNL
Lixin Lu	CSU
Reto Stockli	CSU
Marcia Branstetter	ORNL
Zong-Liang Yang	U TX
Ken Eggert	LANL
Ian Baker	CSU
Steve Running	U MT
Babatunde Abiodun	Iowa State
Gopi Goteti	GA Tech
Forrest Hoffman	ORNL
Muhammad J. Shaikh	GA Tech
Francois Primeau	Univ of CA at Irvine
Kevin Schaefer	NOAA/GMD
Liming Zhou	GA Tech
Neil Smits	CSU
Gordon Bonan	NCAR
David Lawrence	NCAR
Natalie Mahowald	NCAR
Sam Levis	NCAR
Peter Thornton	NCAR
Keith Lindsay	NCAR
Nan Rosenbloom	NCAR
Mariana Vertenstein	NCAR
Keith Oleson	NCAR
David Gochis	NCAR
Beth Holland	NCAR
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Andrea Hahmann
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