Introduction

Over the last five years, the SciDAC Climate Consortium Project has contributed to software engineering and model development of the Community Land Model (CLM) within the Community Climate System Model (CCSM). Early software engineering activities included implementation of cache-friendly blocking structures (called “clumps”) resulting in better performance and improved load balancing. Mem transposition between land surface “clumps” and atmospheric physics “chunks” sped up communications between the two models, and vectorization of the CLM for use on the Earth Simulator in Japan and the Cray X1 at ORNL.

Recent efforts include vectorization of the CN (Carbon-Nitrogen) biogeochemistry model within the Community Land Model Version 3 (CLM3); implementation, testing, and spin-up of the CASA’ biogeochemistry model within CLM3; and regular maintenance of vectorizable code in the model. The results of the CASA’ implementation as well as ongoing work on a Prognostic Canopy Air Space algorithm are described here.

The CASA’ Biogeochemistry Module

The Carnegie/Ames/Stanford Approach (CASA’) biogeochemical model, previously modified for use in global climate simulations (Randerson et al. 1997) and coupled to LSM1 in the Climate System Model Version 1.4 (CSIM1.4; Fung et al., 2005), was adapted to CLM3 biogeochemistry as described in CCSM3.

Now called CASA’, this module computes net primary production (NPP) from CLM’s gross primary productivity (GPP) and distributes carbon among three live pools: leaf, root, and wood. These pools feed nine dead pools which include litter, coarse woody debris, and various soil pools with different turnover times. CASA’ calculates heterotrophic respiration and net ecosystem exchange as well as growth and mortality of pools and areas

The net primary production (NPP) for CASA’ has the correct seasonal cycle and distribution by hemisphere.

CASA’ Net Primary Production

CASA’ was spun up with the GCM version of CCSM in the F configuration (i.e., active land and atmosphere) on the Cray X1e at T3T resolution (about 3.75x3.75 degrees). Carbon pools were initialized with spin-up pools from a previous CSIM1.4 simulation. The new pre-industrial spin-up run, forced with Hadley sea surface temperatures, extended out beyond 500 years.

The net primary production (NPP) for CASA’ has the correct seasonal cycle and distribution by hemisphere.

CASA’ Carbon Pools

Having started with partially spun-up carbon pool states from CSIM1.4, the CASA’ carbon pools equilibrate in CCSM3 within about 300 years.

CASA’ Carbon Turnover Times

Mean Turnover Time of the Six Fast Soil Carbon Pools combined is 4.7 years

Mean Turnover Time of the Three Slow Soil Carbon Pools combined is 77.2 years

CLM3–CASA’ was used in conjunction with the finite volume atmosphere at 2x2.5 degree resolution in a short fully coupled experimental simulation often referred to as the SciDAC Deliverable Run. Read more about this simulation on the following poster.

A Coupled Biogeochemistry Physical Climate System

by the DOE SciDAC Team

CLM3–CASA’ is presently being used for terrestrial biogeochemistry model intercomparisons experiments on the Climate End Station at the Leadership Computing Facility (LCF) at ORNL. Read more about these intercomparisons experiments on the following poster.

Terrestrial Biogeochemistry Intercomparison Experiments

by Forrest Hoffman et al. and the CCSM Biogeochemistry Working Group

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