DEVELOPMENT OF THE COUPLED CLIMATE-TERRESTRIAL CARBON CYCLE MODEL

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ABSTRACT

The terrestrial ecosystem carbon cycle model, Sim-CYCLE, was combined with the CCSR/NIES/FRCGC AGCM5.7b (including a land surface model: MATSIRO). That coupled model shows a reasonable distribution of the LAI, NPP and other carbon storages after the 1000yrs spin-up run. This presentation introduces the preliminary results of the coupled run in 20th century.

INTRODUCTION

Interactions between the climate and the terrestrial carbon cycle have the potential to provide major feedbacks on climate change, but major uncertainties in the magnitude of these feedbacks persists [*Friedlingstein et al.*, 2003]. To clarify these uncertainties, we developed the coupled climate-terrestrial carbon cycle model and investigated the interactive effect between the atmosphere and the terrestrial ecosystems (including the land use change) in the transient run of the 20^{th} century.

MODEL

Coupled Climate-Terrestrial Carbon Cycle Model

The terrestrial ecosystem carbon cycle model, Sim-CYCLE (Ito and Oikawa, 2002), derives the climate data from the CCSR/NIES/FRCGC Atmospheric General Circulation Model (AGCM) 5.7b and gives the LAI, CO_2 concentration and Net Carbon Budget (net ecosystem production minus carbon emission due to the land use change) to the AGCM through the variable coupler in the land surface model, MATSIRO (Fig. 1), which calculates the heat and hydrological dynamics at the land surface [*Takata et al.*, 2003]. The coupled model applied the T42 horizontal grid system (128 (Lon.) x 64 (Lat.) grid) and the 20 vertical atmospheric layer system (for the AGCM), and the processing time steps of 40 min for the AGCM, 3 hour for the MATSIRO and 1 day for the Sim-CYCLE.

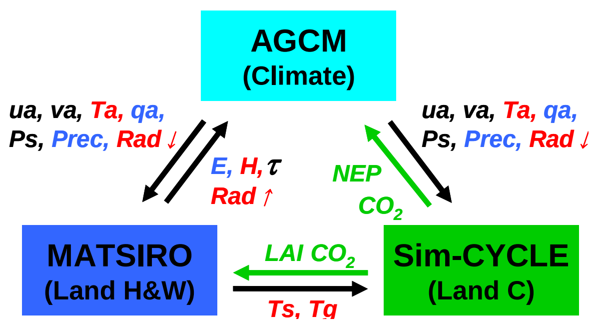

Fig. 1. A schematic diagram of the coupled climate-terrestrial carbon cycle model

Land use change processes

The additional components were attached to the Sim-CYCLE to simulate the influence of land use change on the global carbon budget according to the Grand Slam Protocol [*Houghton et al.*, 1983]; if the fraction of cropland increases, i.e. land use changing from natural vegetation to cropland, the corresponding carbon mass of original natural vegetation biomass is emitted to the atmosphere with different rates among each biomes and each parts of ecosystem carbon pool; if the fraction of cropland decreases, i.e. land use changing from cropland to natural vegetation, the original natural biome restart to grow gradually from very small in the corresponding limited area.

Simulation processing for the 20th century's run

To create the initial data of terrestrial carbon pools (leaf, stem, root, litter and soil biomass) at the pre-industrial situation, the offline (i.e. only using the Sim-CYCLE) spin-up run was conducted for 1000 years using the physical climatic data of 25 years, derived from the coupled model run for 1875-1899, with the 40 time-repetitions. Then, using these results as an initial data, the coupled spin-up run was made for 75 years, three times of 25years (1875-1899), to equilibrium the terrestrial carbon pools. Finally, the coupled transient run was performed for the 20th century (1900-1999) with changing the fraction of crop production area, of which data were derived from the SAGE group web site (http://www.sage.wisc.edu).

RESULTS AND DISCUSSION

The result of the spin-up process

The plant biomass increased quickly during the initial 200 years, and after that, reached the maximum status soon. On the other hand, the soil+litter biomass increased gradually and reached their maximum at the 1000 years after the spin-up start. Consequently, at the end of spin-up simulation, the annual global NPP was 55.4 Pg C yr^{-1} and considerable to other model researches (61.0 Pg C yr^{-1}; average value of the 17 model results; Cramer et al., 1999). The global plant and soil+litter biomass became 610 and 1500 Pg C, and were as much as the literature values; 561 and 1600 Pg C, respectively [*Schimel*, 1995]. This enabled us to think that this spin-up process had created the initial data of terrestrial carbon pools successfully.

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