Spin-up and Tuning of the Global Carbon Cycle Model Inside the GISS ModelE2 GCM

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Introduction

Planetary carbon cycle involves multiple phenomena, acting at variety of temporal and spatial scales. The typical times range from minutes for leaf stomata physiology to centuries for passive soil carbon pools and deep ocean layers. So, finding a satisfactory equilibrium state becomes a challenging and computationally expensive task. Here we present the spin-up processes for different configurations of the GISS Carbon Cycle model for the model forced with MODIS observed Leaf Area Index (LAI) and prescribed ocean and the model fully coupled to the dynamic ocean and ocean biology. We investigate the time it takes the model to reach the equilibrium and discuss the ways to speed up this process. All simulations were done for preindustrial climate conditions.

NASA Goddard Institute for Space Studies General Circulation Model (GISS ModelE2) is currently equipped with all major algorithms necessary for the simulation of the Global Carbon Cycle. The terrestrial part is presented by Ent Terrestrial Biosphere Model (Ent TBM), which includes leaf biophysics, prognostic phenology and soil biogeochemistry module (based on Carnegie-Ames-Stanford model). The ocean part is based on the NASA Ocean Biogeochemistry Model (NOBM). The transport of atmospheric CO\textsubscript{2} is performed by the atmospheric part of ModelE2, which employs quadratic upstream algorithm for this purpose.

Acknowledgements

This research was supported by NASA Modeling, Analysis and Prediction (MAP) program.

Computing resources were provided by the NASA High-End Computing (HEC) Program through the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center.

Observational data were provided by:

- IRIS World Soil Information
- NASA Orbiting Carbon Observatory-2 (OCO-2)
- NASA Cooperative Global Data Integration Project


Preliminary results

Pre-industrial simulations, prescribed ocean

Land CO\textsubscript{2} fluxes of Gross Primary Productivity (GPP), plant respiration, soil respiration and Net Ecosystem Exchange (NEE)

- Annual mean, GPP=106.2 Gt C/year
- Monthly mean, January
- Monthly mean, July
- CO\textsubscript{2} concentration at the surface (ppm)
- Modern observations (GLOBALVIEWplus)
- Preindustrial simulations – land fluxes only
- Preindustrial simulations – land+ocean
- Modern observations (OCO-2)
- Atmospheric column average CO\textsubscript{2} (ppm)
- Conclusions and future work

- GISS ModelE2 GCM is capable of producing reasonable carbon cycle for preindustrial conditions
- Typical spinup time for terrestrial ecosystem model is 300 years, ocean biophysics requires longer spinup
- 20th century simulations are needed for validation of the model with observations

http://www.giss.nasa.gov/projects/gcm/