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.

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General layout of the model
For presented simulations we use MODIS vegetation cover data set which was converted to 16 plant functional types, MODIS observed seasonal LAI and MODIS vegetation height.

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)

SOIL RESPIRATION g\textsubscript{C}/m\textsuperscript{2}/day                  JAN E020ia_lai_a
GROSS PRIMARY PRODUCTIVITY g\textsubscript{C}/m\textsuperscript{2}/day        JAN E020ia_lai_a

SOIL RESPIRATION g\textsubscript{C}/m\textsuperscript{2}/day                  ANN E020ia_lai_a
GROSS PRIMARY PRODUCTIVITY g\textsubscript{C}/m\textsuperscript{2}/day        ANN E020ia_lai_a

SOIL RESPIRATION g\textsubscript{C}/m\textsuperscript{2}/day                  JUL E020ia_lai_a
GROSS PRIMARY PRODUCTIVITY g\textsubscript{C}/m\textsuperscript{2}/day        JUL E020ia_lai_a

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