Geophysical Research Abstracts
Vol. 13, EGU2011-9451, 2011
EGU General Assembly 2011

Coupling of a complex biogeochemical model with the Transport Matrix Method : quantification of the impact of margin iron input on the ecosystem.

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The Transport Matrix Method (TMM) is an offline method permitting accelerated simulation of passive tracers in ocean circulation models. The method is based on capturing the tracer transport of an ocean general circulation model in explicit matrix form. Some biogeochemical models have already been successfully coupled to the TMM. However their complexity is relatively low, with a number of state variables not greater than six.
We implemented PISCES, a complex biogeochemical model (24 compartments) in the TMM framework. PISCES distinguishes two phytoplankton, two zooplankton size-classes, three nonliving organic carbon compartments and different nutrients including iron. Carbonate and biogenic siliceous particles are modeled. In addition to the ecosystem description, PISCES simulates dissolved inorganic carbon and total alkalinity.
A spinup has been conducted with the TMM using MIT2.8 (2.8 degree resolution) ocean dynamics under matrix form till equilibrium. Total nitrogen and phosphorus is conserved and no drift in the different state variable concentration is visible after 4500 years. Surface and deep nutrients distribution are realistic and have been evaluated through cost functions.
As an application, two versions of PISCES-TMM have been used in this study. In both cases, iron is provided by dust deposition. However one version incorporates iron input by margins, whereas the other does not. This source of iron has a significant impact and permits to sustain high primary production, especially in high latitude.
We now have a “working horse” combining a complex biogeochemical model to a medium resolution dynamical model, which could achieve fast spinup of thousand years in a couple of days. This TMM-PISCES framework allows us to test quickly the sensitivity of the system to biogeochemical parameters and processes over relatively long time scales. Testing the impact of different dynamics could be done in an easy way too, as far as the matrix has been extracted from the original circulation model.