The Dynamic Green Ocean Model: 6 Plankton functional groups in an Ocean Global Circulation Model.

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15 GBC

ABSTRACT : Our goal is to improve the representation of biogeochemical fluxes in an Ocean General Circulation Model. The components of the project are improving model parameterisation, including a coastal model, improving the representation of the marine food web and extending model validation datasets. Here, we focus on the inclusion of six major phytoplankton groups in the model food web. This project is analogous to the inclusion of plant functional types in models of land biology. The basis for this project is the PISCES ocean biogeochemistry model (Aumont et al. in preparation), which includes the potentially limiting nutrients NO3, Fe3+ and SiO3 in colimitation with light. The PISCES model already includes diatoms, nanophytoplankton, micro- and mesozooplankton. The Green Ocean Model will further represent coccolithophorids, N. fineus, prochlorococcus and microphytoplankton. We show preliminary model results with three PFTs, and compare our results to observations. We discuss the selected plankton functional types and their parameterisation.

MODEL DESCRIPTION.

OCEAN BIOGEOCHEMISTRY. Highlights:

- 3 Nutrients (NO3, SO4, Fe3+): 3 Phytoplankton (nannophytoplankton, diatoms, coccolithophorids), 2 Zooplankton (meso-, microzooplankton), 3 Detritus (small POC, large POC, DOC)
- Additional passive tracers are DIC, alkalinity, O2, CaCO3, particulate Fe pools, particulate Chl pools, particulate Si pools
- The model has a fixed C:N ratio, and variable C:Si, C:Fe and C:C13 ratio.

OCEAN DYNAMICS. Highlights:

- Ocean dynamics from OFA ocean circulation model (Mader & Imbrenda 1996)
- 2° by (on average) 1.5° resolution, 31 vertical levels (Figure 2)
- LNN ice model (Fichefet & Menosu Maqueda 1999)
- Vertical eddy diffusivity and viscosity coefficients computed from a 1.5 order turbulent closure scheme (Gaspar et al. 1999)

RESULTS :

Table 1 : Parameter values for primary production.

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Description</th>
<th>Units</th>
<th>Description</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum-specific growth rate (µ at 0°C)</td>
<td>1/d</td>
<td>Interception of µ</td>
<td>0.6</td>
<td>Minimum growth temperature</td>
<td>1.066°F</td>
</tr>
<tr>
<td>Self-attrition constant for Chl</td>
<td>µM</td>
<td>Self-attrition constant for silicon</td>
<td>µM</td>
<td>Size for light</td>
<td>0.0105</td>
</tr>
<tr>
<td>Self-attrition constant for iron</td>
<td>µM</td>
<td>Size for light</td>
<td>µM</td>
<td>Microalgal Depth</td>
<td>997-2012</td>
</tr>
</tbody>
</table>

PARAMETERS :

Parameter selection is still at an early stage. The following parameterisation of primary production is based on a qualitative analysis of the PFTs. Based on sensitivity analysis of an earlier version of the model, POP use as an alternate source of phosphorus for coccolithophorids is not included in the present model version.

ACKNOWLEDGMENTS :

We thank K. Lee for providing the data of global CaCO3 export. We thank C. Prentice, S. Harrison and all the participants of the Dynamic Green Ocean Project (DGOM) project for their helpful discussions. For more information on the DGOM project, the group of scientists involved, and ways to contribute please see our web page http://www.bgc-jena.mpg.de/bgc_projects/projects/green_ocean/start.html

REFERENCES :

- Aumont O. and co-authors, PISCES in the OPA model (in preparation)
- Baker A. B. and co-authors, DIC in the OPA model (in preparation)
- Dray E. and co-authors, CaCO3 export, courtesy of K. Lee 2001
- Dray E. and co-authors, CaCO3 export, preliminary results

DISCUSSION :

The preliminary results after including coccolithophorids in PISCES show that the change in PO4 requirement of coccolithophorids has the largest impact on its global inventory (Figure 4). The combined coccolithophorids specific behaviour improves the ability of the model to correctly simulate the CaCO3 export (Figure 5). However, it also results in coccolithophorids becoming the dominant phytoplankton group in the tropics (Figure 4). It is known from sediment trap data that the coccolithophorids are important contributors to the phytoplankton community in the tropics, and there are methodological issues for expecting that the CaCO3 export in the tropics determined by Lee (2001) might be underestimated. Still, the extent to which coccolithophorids outcompete nanophytoplankton in the tropics in the model is not supported by current observations.

Another point that we are working on is zooplankton grazing. Grazing and other loss terms are an important factor in structuring the marine food web. We are currently working on a data compilation that would allow us to define more ecological niches for the other phytoplankton groups, that we think should be included in the biogeochemical model.