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Biogeosciences Discussions

Interactive comment on "Multi-nutrient, multi-group model of present and future oceanic phytoplankton communities" *by* E. Litchman et al.

Anonymous Referee #1

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Overall Comments

This is an interesting paper which describes and applies a phytoplankton model representing three functional groups. The approach carefully compiles and intelligently exploits quantitative understanding of the physiological differences of functional groups gained from laboratory cultures. It employs a novel Monte Carlo method to parameter optimization. I recommend publication but would like to see several questions and issues addressed first.

Outline of key points

This manuscript describes and explores a novel model of photo-autotrophic community structure in the oceans. The model explicitly represents three or four "functional

groups" of eukaryotic phytoplankton: diatoms, coccolithophores and green algae (and potentially dinoflagellates) and their interaction with the cycles of several nutrients (N, P, Fe, Si) and light field in an idealized, oceanic mixed-layer setting applied to two oceanic locations (North Atlantic and North Pacific mid-latitudes).

The description of nutrient uptake and limitation of phytoplankton growth is soundly rooted in the quota formulation after Droop and Caperon. Mixed-layer light availability and nutrient entrainment are formulated simply but appropriately. Phytoplankton losses arise from a simple mortality and grazing by a generic zooplankton class. A careful compliation of culture study results has provided mean values for key physiological parameters (maximum and minimum nutrient quotas, nutrient uptake half saturation values, etc...) by which the chosen functional groups are distinguished and significantly includes, where possible, a metric of the range of measured values (Table 2).

The model is applied to two mid-latitude (marginally subpolar) oceanic locations where observations of the seasonal succession of phytoplankton functional groups exist (NABE and OSP). "Verification" integrations, and studies of the sensitivity of community structure to changes in the physical and nutrient environment, are performed using a novel Monte Carlo approach to explore the ranges of parameter values determined by laboratory cultures.

Within the acceptable ranges of parameter values the model is able to capture key features of the observed seasonal cycles and succession. It illustrates that the relative control by different limiting nutrients varies with location and season (as has been seen in previous multi-functional group models) and allows a detailed analysis of how these controls operate in the model. Based on a "cost function" of multiple crieteria, the parameter sensitivity analysis reveals the most significant controlling parameters but notes that the sensitivities are different at the two locations, both in terms of which are most senstitive and the acceptable ranges.

"Global change scenarios" reveal the sensitivity of the model results to various changes

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in physical and nutrient environment.

Comments

This is an interesting manuscript with a number of well thought out and novel aspects, including the following:

1. This work brings a novel and interesting approach to the representation of multiple functional groups with a thoughtful physiological and taxanomic basis. 2. An objective approach to constraining to the ranges of possible values for physiological parameters based on a quantitative compilation of published values.

3. The novel use of a Monte Carlo approach to explore the sensitivity of the model solutions to the parameter values within the prescribed ranges.

4. The appropriate balance between idealization and application to real world settings.

5. The manuscript is generally well written and clearly presented.

I do have some questions and suggestions for the authors:

1. I would have liked to have seen a clearer motivation for selection of these particular functional types to be represented amongst a wider set of possibilities.

2. There should be a more detailed discussion of why dinoflagellates were always excluded in these settings.

3. I would have liked more discussion of the data compilation in Table 2. What is your confidence in the quantitative differences between functional groups?

4. The figures are very small and not at all clear in a printed version.

5. R* is a useful measure of resource control but ignores role of grazing losses so represents a very bottom up view. How is the R* analysis related to the outcome of the model?

6. The model assumes that the Fe supply is largely due to entrainment. Is this the

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case at the locations of interest? (I would have expected the atmospheric source to be a significant regulator). To what extent are the model results dependent on the seasonality of the iron source?

7. The paper is very dense with tabular information - seven tables, some very extensive. Are all table essential?

Interactive comment on Biogeosciences Discuss., 3, 607, 2006.