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Biogeosciences
Discussions

Interactive comment on "Flexible C : N ratio enhances metabolism of large phytoplankton when resource supply is intermittent" *by* D. Talmy et al.

Anonymous Referee #1

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Summary

The authors construct a new model and tune its parameters based on the measured response of a few different phytoplankton (differing in size and taxa) to changing light and nutrient conditions. The model represents the storage of (non-functional) pools of both C and N within the cell, as a function of cell size and light and nutrient availability. They then use this model to simulate the response of phytoplankton to different light and nutrient conditions, with particular emphasis on fluctuating nutrient supply and irradiance.

The main result is that cells of larger size are predicted to have faster average growth

rates under conditions of fluctuating nutrient supply and even more so under conditions of fluctuating irradiance. The latter effect is most pronounced for cells that were pre-acclimated to low-nutrient conditions prior to exposure to intermittent irradiance.

Overall evaluation

This is a solid contribution, using an empirically-based model to demonstrate the potential of C storage to confer an advantage to large phytoplankton in fluctuating environments. As the authors state, further studies are necessary in order to conclusively determine the extent to which this mechanism actually determines the relative dominance of large vs. small phytoplankton species in natural environments.

Finally this study also demonstrates (Fig. 9) that pre-acclimation can be particularly important to the modelled response in fluctuating environments. Using an optimality-based model of photoacclimation (of quite different structure compared to the model in the present study), Wirtz and Pahlow (Mar. Ecol. Prog. Ser. 402: 81–96, 2010) similarly showed that pre-acclimation to different conditions has the potential to strongly impact the outcome of laboratory experiments, and furthermore that the acclimation timescale may be longer than typically assumed for the set-up of continuous culture experiments. Taking this a step further, I would like to suggest that for future studies there may be a good reason to try some optimality-based approaches for studying the effect of C storage capacity. Although I understand and appreciate the value of the authors' approach of grounding their model formulation firmly in the response measured by controlled experiments, the results of this study and of Wirtz and Pahlow (2011) suggest that there is some danger in extrapolating from quite limited experimental results, which may themselves include the un-appreciated effects of pre-acclimation. In other words, if pre-acclimation did impact the experimental results, would this not be cause for questioning the predictions of any model, which does not account for such pre-acclimation in its formulation or tuning of parameter values?

Minor Comments

p. 5186, just below eq. 12

The statement, "...because we do not follow individual cell quotas explicitly, we assume a fixed cell carbon content, ..." needs to be revised. It is particularly confusing given that the model simulates not only the whole-cell C:N ratio but also the pools of functional and non-functional C and N, respectively. The C:N ratio of the functional components is assumed constant, but the non-functional components (and hence the whole-cell C:N) are explicitly modelled. Thus, the sentence as stated does constitute any clear reason for assumption of a fixed cell carbon content, and as best I understand it this C content per cell is NOT fixed in this model.

p. 5195, line 5-7 "Their subsequent assimilation into proteins must lead to a net gain in at least one additional elemental quota." This overstates the case, because the overall net effect will of course depend on the environmental conditions. I would suggest something like: "Their subsequent assimilation into proteins must lead to an increase in the capacity for assimilating C, N, or both."

Interactive comment on Biogeosciences Discuss., 11, 5179, 2014.