

Interactive comment on “PhytoSFDM version 1.0.0: Phytoplankton Size and Functional Diversity Model” by Esteban Acevedo-Trejos et al.

Anonymous Referee #1

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General Comments:

The manuscript presents a modeling framework for simulating phytoplankton community structure. There is a brief description of a full 'discrete' model and of four simpler approximations of that model. This is followed by a comparison between the full model and the four approximations.

The manuscript is well written and easy to follow. I found the presented results to be informative, and I believe the manuscript merits publication in GMD, after some modifications.

My main concern is that the discrete model represents a somewhat easy target for the moment-based approximations. This is a problem, because the impression given by the authors is that the approximations are better in a number of ways relative to

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the discrete model. This is not only because the approximations are computationally cheaper, but also because they can sustain more diversity. My concern is that they can only do this by adding arbitrary processes that were expressly designed to sustain diversity. The moment-based approximations are also incapable (at the moment) of representing some processes that can be relatively easily incorporated into the discrete model.

To give an example, the discrete model could (relatively) easily be extended to include a diverse zooplankton population, and this would increase diversity as an emergent property. It seems that the moment-based approximations would fare pretty poorly in this case, because the resultant (multimodal) biomass distribution would not be well approximated by the total biomass, mean cell size and variance of cell size.

I realize that accounting for this sort of disruptive selection is a major challenge with the moment-based approach, and I am not suggesting the authors need to account for it. I would, however, like them to acknowledge that it is a challenge. At the moment the Discussion section ("strengths and weaknesses of moment-based approximations") is very general, and a bit too philosophical. I would prefer if the authors focused on specific examples, and also tried to identify what challenges remain.

Specific comments:

Line 88 - "We define n . . . phytoplankton types". Which value of n did you use?

Line 90 – "The distribution of phytoplankton cell size" Would it be better to say "The distribution of biomass along the size dimension", or words to that effect? Please also specify here that you define only one nutrient, one zooplankton, and one detritus.

Line 93 – "constrains" should be "constraints".

Line 93 – "limits" should be "limit".

Line 94 – "more than 100 μm " How much more?

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Eqn. 3 – Is the maximum growth rate size-independent? If so, this seems like a strange decision. Please explain.

Eqn. 6 – alpha and beta have different subscripts in the equation relative to the definition that follows.

Eqns. 6 – 8: I apologise for my ignorance, but does the form $\alpha e^{\log(\text{size})\beta}$ correspond to a power law in your log-transformed formulation? If yes, please say so, if no, please say why you are using a different form.

Eqn. 7 – please specify that there is one zooplankton population that eats all phytoplankton. Please also add some justification/explanation for this choice.

Line 176 – "we treat I as a density-dependent process" Please explain why.

Eqns. 24-26. I think these equations need a little unpacking. It is a bit hard to see where they come from. For example, they look like they are based on the mean size phytoplankton, but I cannot see where (or how, and indeed if) the variance comes into it. Please try to make this a bit clearer.

Line 191 – "concentration of nutrients below the upper mixed layer (N_0)". Please define this more clearly. A first guess would suggest the average concentration between the ML and the seabed, but this doesn't make sense, because N_0 goes to zero in the summer.

Line 208 – Temperature would probably also be limiting in winter.

Lines 246 – 248: This stuff about exogenous and endogenous sources of biomass needs further explanation if I am to believe it is the fundamental cause of the observed differences.

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