Geoscientific

Model Development

Discussions

[GMDD]

Interactive

comment

Interactive comment on "CITRATE 1.0: Phytoplankton continuous trait-distribution model with one-dimensional physical transport applied to the Northwest Pacific" *by* Bingzhang Chen and S. Lan Smith

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Reviewer #1 This paper describes a trait-based continuum plankton model, with size as the principle trait, and successfully uses a parameter optimisation routine to extract the trait characteristics (mean size and variance) at two contrasting study sites.

Major comments. =========== The lack of a size-dependent feeding preference is the single biggest limit to this model. Ideally any plankton web will have a size-range (or a size-trait continuum) for both phytoplankton and zooplankton, as size is such

a structuring component of the plankton across a broad range of sizes and trophic level. Positively, by excluding size-ranges in grazing the model presented does allow a simpler exploration of characteristics of phytoplankton size structuring.

[Response] We agree that adding a size-dependent feeding preference might be useful for investigating the grazing effects on phytoplankton size structure. Accordingly, we have added size-dependent feeding and another zooplankton compartment into the model as also suggested by another reviewer. Please see Section 2.3 Zooplankton size-dependent grazing.

Eq. 7b is missing the detrital remineralisation term, possibly where the two minus signs are.

[Response] Yes, it was a typo in the previous version. We have corrected the equation in the current version (Eq. 3).

P15, last paragraph. The use of trait derivatives sounds important, but it was introduced too quickly for me. Could you give a little bit further explanation?

[Response] Here we have modified the text to avoid too much interpretation in the Results section 3.4:

"The values of $(d^2 \mu(l))/(dl^2)$ were always negative in all times at both stations, suggesting that without "trait diffusion", size variance would decrease toward zero (Eq. 7c). This highlights the importance of trait diffusion (which can be interpreted as genetic mutation or transgenerational phenotypic plasticity) to sustain diversity."

We added some text in the Discussion section 4.1.1 to explain in more detail on the derivatives:

"In particular, the second derivative of the growth rate at mean size, $(d^2 \mu(l))/(dl^2)$, can be conveniently perceived as a proxy for the intensity of resource competition (The more concave is the curve of $\mu(l)$, the more intense is the competition, i.e., the fitness of suboptimal species decreases more steeply with distance from the optimal size)."

The first sentence is a turn-off. [Response] Sorry, we do not understand what exact sentence the reviewer meant.

Section 4.2.2. Transport of moments (instead of species) is the biggest issue of this type of trait-based approach. Or is it? This section quantifies through one example for a Gaussian distribution the size of the error. But the particular example chosen seems destined to show a small error, as one community is much smaller than the other. It would be better to show the example with the greatest possible error. Would that be a Gaussian with equal biomass but very different mean size?

[Response] The transport of moments is indeed an issue that bothered us. Fortunately, Jorn Brugemann in his thesis (Brugemann, 2009) has pointed out that the raw moments of the biomass distribution can behave as normal tracers in diffusion and advection. We have followed Jorn's suggestion to modify the transport of variance in our model (see Sect. 2.1 General description of the 1D ecosystem model). We have followed the reviewer's suggestion to test this approach in Fig. 14. It seems clear that when the differences between the two mean sizes or variances are large enough, the mixed community would not follow a Gaussian distribution. But when the two communities differ only moderately in mean size or variance, the approximate should be reasonable.

Minor comments. =========== P3, L2. Distinguishing between identity and diversity in the first sentence is confusing.

[Response] The "identity" is a term that theoretical ecologists often use (e.g. Tilman et al. PNAS 1997). It means the (dominant) functional traits themselves in contrast to the number of species present. We have added an annotation beside.

P3, L22. I think you mean in practice impossible, rather than almost impossible.

[Response] Yes, we have modified the wording to "which is however impossible in practice due to computational limits".

P4, L15 If trait number = N, trait resolution = D, then difference = N(D-2)-1. The derivative of the difference with trait resolution is N (independent of D). So it is not exponential, it is linear, with a slope N.

[Response] Yes, we have replaced the word "exponential" with "linear".

P6. L16 Do you mean Eq. (4a)?; bimodal? [Response] Yes. Sorry, it was a typo. We have corrected it to Eq. (10a). It should be unimodal because phytoplankton maximal growth rate usually peaks at nano size range.

P8. Z = depth. [water depth sounds like the bottom depth?] [Response] Z is the depth of the model grid. We have made it clearer in the revision.

P11, L8 "and both model" – sentence has gone astray? [Response] Sorry, it was a typo. We have deleted it.

P14, L10 "Large phytoplankton are susceptible to light limitation" I thought it was nutrients? [Response] Here we meant that because large phytoplankton are susceptible to light limitation, the effect of light limitation offsets the effect of replete nutrients on phytoplankton size at depth, which can explain why the proportion of size-fractionated Chl does not change with depth as predicted based on nutrient effects alone. However, based on the revised modeled results, we have deleted this sentence during revision.

Table 1. Unit of Kchl should be m-2 as written inside the -1 bracket. [Response] Sorry, it was a typo. We have corrected it.

Please also note the supplement to this comment:
https://www.geosci-model-dev-discuss.net/gmd-2017-104/gmd-2017-104-AC3-supplement.pdf

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