

Authors' Response

Dear Editor,

Thank you for your message regarding our manuscript. We have revised the manuscript accordingly and addressed all points raised by the reviewers, including the comments we overlooked before.

Response to the Editor

You are correct that we did not respond to one of the comments in the previous round regarding the model's derivation "from first principles", and the limits of this. We have now addressed the comment by Referee#2:

"Please add some explanations for your equations, and check them thoroughly. I still have the strong impression that they are mostly based on pragmatism and simplicity, rather than first principles. This would actually be fine, were it not for the authors' claims regarding first principles."

In the revised manuscript, we have addressed this in two ways. First, we have expanded the explanations of the relevant equations in the footnote to Table B1, particularly for those not fully described in the main text.

Regarding the comment on "first principles", we note that we had introduced a brief clarification (lines 70–76) already in the previous version, where we specified that this refers to the parameters. In the current revision, we have expanded the discussion (lines 537–550) to clarify the extent to which first principles are applied across different components of the model. The revised text now reads:

"Our ambition has been to parameterize all processes within the unicellular and multicellular groups from considerations based on first principles or, if those are not available, from cross-species analysis of laboratory observations. This ambition is only partially realized. For the unicellular groups, the parameters and processes related to uptakes are well characterized by first principles of diffusion, light encounter, and fluid mechanics of feeding (see Andersen and Visser (2023) for a thorough discussion), though cross-species analyses are used in some places. The parameters related to DOC losses are weakly defined due to our limited knowledge of the DOC dynamics. The parameters related to the metabolic costs of the uptakes (the β_X 's) are also loosely estimated to ensure an approximately even distribution between respiration and synthesis rates, and it

may be possible to obtain better estimates for those parameters. The two parameters for the diatoms are set via cross-species analysis (Fig. B1) and the vulnerability is calibrated to fit global patterns of diatom abundance. For the copepods, the general first principle is metabolic scaling (West et al., 1997) and the other parameters are mainly determined via cross-species analysis (Serra-Pompei et al., 2020). The only calibrated parameters (besides the diatom vulnerability) are those that form the closure of the model with respect to light absorption (light absorption coefficient), nutrient turnover rate (sinking speed of POM), and mortality on higher trophic levels.[...]"

In addition, we have addressed the review file validation notifications related to Figures D4 and 4.

We hope that these revisions adequately address the comment and we apologize for having overlooked it in the previous round.

Thank you again for your helpful suggestions.

Kind regards,
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