EGUsphere, author comment AC1
https://doi.org/10.5194/egusphere-2022-1282-AC1, 2023

Reply on RC1

Corentin Clerc et al.

Author comment on "Including filter-feeding gelatinous macrozooplankton in a global marine biogeochemical model: model–data comparison and impact on the ocean carbon cycle " by Corentin Clerc et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-1282-AC1, 2023

The authors would like to thank reviewer #1 for her valuable and useful comments. The authors considered all suggestions and addressed the raised issues, which we believed increased the clarity of the revised manuscript. Below are given point-by-point answers to the comments.

Reviewer comments are in bold, responses in normal font. Proposed changes to the manuscript are in italics.

I think the authors have offered an interesting, thorough, and generally well-presented manuscript. The manuscript adds a valuable contribution to the growing body of research around modelling gelatinous zooplankton, further supporting the importance of gelatinous zooplankton in global carbon export while also highlighting key areas for future research.

We would like to thank Reviewer #1 for her very supportive comments on our manuscript.

SPECIFIC COMMENTS

Consider using 'Crustacean Macrozooplankton (CM)', instead of 'Generic Macrozooplankton (GM)'. As the generic macrozooplankton group is based entirely on crustacean macrozooplankton I think this would aid in the clarity and precision of the manuscript. Generic implies that the group represents organisms across the macrozooplankton i.e. more than just crustaceans.

We agree with the reviewer that the definition of the generic macrozooplankton compartment (L136) was not precise enough, which may have lead to some confusion. Actually, our 'generic macrozooplankton group' intends to represent macrozooplankton that are not part of the Tunicata ("non-tunicate macrozooplankton"), which includes a lot of crustaceans but not only (e.g., pteropods). Since this compartment was parameterized using an allometric scaling relationship rather than group-specific parameterizations, we think that the group is generic enough to represent also non-crustacean types of macrozooplankton, such as pteropods. For this reason, the generic macrozooplankton notation is more appropriate, and the corresponding explanatory text in the Methods will be corrected as follows:

L136: *"GM, namely generic macrozooplankton, is intended to represent non-tunicate macrozooplankton, such as euphausids, pteropods or large copepods.»* instead of *"GM, namely generic macrozooplankton, is intended to represent crustacean macrozooplankton, such as euphausids or large copepods.»*

Also, L137, *"The parametrization is similar to that of mesozooplankton (Eq. 28 to 31 in Aumont et al. 2015)"* will be replaced by *"The parametrization is similar to that of mesozooplankton (Eq. 28 to 31 in Aumont et al. 2015) and parameter values have been derived using allometric scaling relationships (see section 2.2.1)."*

Line 151:
Include an explanation on why the decision was made to have 'feeding with identical preferences on both phytoplankton groups... as well as on microzooplankton'.

We assumed non-selective predation when modelling filtration in FFGM, meaning that the organisms are able to ingest all filtered prey. This lack of food selectivity is a known characteristic of filter-feeders (Pauli. et al., 2021b). Recent studies suggest that the efficiency of prey capture by filter-feeding gelatinous organisms could depend on the prey size but also on their taxonomy (Sutherland et al., 2022). Yet, while "future work should bring more quantitative studies of grazing rates and selectivity under in situ conditions, expand the number of pelagic tunicate species that have been studied" (Sutherland et al., 2022), quantitative estimates remain insufficient to properly assess this phenomenon, therefore we believe that non-selective predation remains the best option in the current state of knowledge.

To address the present comment, we propose to insert the following sentence at line 149 : *"Although there is some recent evidence for selective feeding behavior in pelagic tunicates (Sutherland et al. 2022), the lack of quantitative study led to the simpler representation of FFGM as non-selective feeders (Pakhomov et al. 2002, Vargas et al. 2004, von Harbou et al. 2011). Therefore, we assume […]"*

New references :

von Harbou, L., Dubischar, C. D., Pakhomov, E. A., Hunt, B. P., Hagen, W., and Bathmann, U. V.: Salps in the Lazarev Sea, Southern Ocean: I. Feeding dynamics, Marine Biology, 158, 2009–2026, 2011.

Vargas, C. A. and Madin, L. P.: Zooplankton feeding ecology: clearance and ingestion rates of the salps Thalia democratica, Cyclosalpa affinis and Salpa cylindrica on naturally occurring particles in the Mid-Atlantic Bight, Journal of plankton research, 26, 827–833, 2004.

Section 2.3: Sensitivity experiments
Adding an introductory sentence to this section would help the flow and to guide the reader, i.e. 'Five sensitivity experiments were carried out to...'.

In accordance with the reviewer's comment, the following introductory sentence will be added at line 190 : *'Five sensitivity experiments were carried out to evaluate the sensitivity of the model to the chosen parameterization."*

Rainbow colour palette for figures (fig. 3a, fig. 4, fig. 8, fig. A2e,f, fig. A3, fig. A4, fig. A5)
I strongly recommend changing from a rainbow colour palette for figures, to a "perceptually uniform" palette which provides the same perceived colour change over the

same change in value.

In accordance with the suggestion by the reviewer, colour palette will be changed to a "perceptually uniform" palette in fig. 3a, fig. 4, fig. 8, fig. A2 e,f, fig. A3, fig. A4 and fig. A5. We will use the "cividis" colour palette from the matplotlib python package.

Line 286:
Include a brief mention of why 0-300m was chosen for analysis.

The 0-300 m depth range was chosen for our analyses to ensure that we were capturing most of the organisms present in the epipelagic zone, which can be as deep as 250-300 m in the tropical gyres. This choice was applied for both macro- and mesozooplankton but there was an error in the manuscript indicating a 0-100 m depth range for macrozooplankton (L280). This typo was corrected.

We justify this choice here with the AtlantECO dataset (see section 2.4.1) for FFGM species.

First, when looking at the distribution of the maximal depth of sampling (see figure A2 in the attached supplement page 3), there is a clear cut off in the distribution at around 300 m, samples being sporadically distributed for deeper maximal depths. Spatial resolution of data below 300m is hence very coarse. Also, the depth distribution displayed below shows that using 100 m as a maximal depth would exclude a significant portion of the dataset.

Second, the available data suggest that most of the biomass is present in the 300 m first meters. Indeed, when analyzing the raw AtlantECO dataset (i-e non gridded), the mean biomass for FFGM is 4.93 mg C m^{-3} and the median 0.31 mg C m^{-3} for the data with a maximum sampling depth shallower than 300 m. These metrics drop to 0.04 mg C m^{-3} for the mean and 0.0 mg C m^{-3} for the median when focusing at the data with a minimum sampling depth deeper than 300 m.

Last, when focusing on the median by maximum depth bins (red points in the attached supplement page 3), we show that the median is null from 300 m to about 1000 m. Deeper values (>1000m) are very uncertain due to the few data points available as shown on the depth histogram.

Thus, we propose to add the following at L286 and L280: "[*vertically integrated between 0 and 300 m] to ensure that most of the organisms present in the epipelagic zone are included*"

We also propose to replace L264 *"Then, we only retained observations from the upper 300 m to exclude deep water samples and focus on zooplankton communities that inhabit the euphotic layer"* by *"Then, we only retained observations from the upper 300 m to exclude deep water samples and focus on zooplankton communities that inhabit the euphotic layer because measured biomasses and sample numbers are low below 300 m (see. Fig. A2)"*

And to add figure A2 in the appendix (which would now contain 10 figures), with the following caption :

Figure A2. Depth-Biomass scatter plot and histogram of FFGM observed biomass and maximal depth of the samples AtlantECO dataset before excluding deep samples (Section 2.4.1). Blue points are samples. The red dots represent the median biomass per depth bin.

Line 324-325:
It is interesting that doubling the complexity of the zooplankton (from 2 to 4

compartments) has minimal effect on chlorophyll. It would be interesting to have a short discussion on why this is and how it compares to other biogeochemical models.

Chlorophyll is relatively little impacted by the addition of higher trophic levels (in PISCES-FFGM compared to PISCES-v2, the version published in Aumont et al. 2015). Indeed, macrozooplankton represent only 10% of the biomass of all organisms, and they consume less than 5% of the total primary production. Therefore, adding more macrozooplankton groups has a small effect on primary production in our model because grazing rates on phytoplankton are very low (< 10%), partly because GM eats little phytoplankton and then because metabolic rates are low. These low differences in chlorophyll fields also suggest that the mesozooplankton quadratic mortality used in PISCES-v2 is quite relevant to implicitly account for the effect of predation pressure by upper trophic levels on primary productivity.

Note that our study focuses on the role of FFGM, and thus our analysis is mostly based on comparing PISCES-GM with PISCES-FFGM. The modest role of adding FFGM on lower trophic levels (phytoplankton and microzooplankton) is by the way mentioned and explained in Section 4.1.2

Section 3.1.2:
What is the reasoning behind using 0.5 mg C m-3 as the cut off for high/low biomass (Table 4 etc).

The cut-off value corresponds to the rounded median value of macrozooplankton observations from MAREDAT (0.52 mg C m^{-3}), see Table 4). Regions where biomass (simulated or observed) is higher (resp. lower) than the cut-off are defined as high (resp. low) biomass regions.

The following sentence will be added at the end of the legend of Table 4 :

"The cut-off value of 0.5 mg C m-3, used for defining high and low biomass regions, corresponds to the rounded median value of the macrozooplankton observations from MAREDAT (see section 2.4.2)."

Figure 5:
Red/green is not a good choice for distinguishing between the two model runs, as red/green is the most common type of colour-blindness. This should be changed to a colour-blind friendly palette.

We will switch our previous color palette to a colour blind friendly one in figure 5.

Table 6:
Include a description of the difference between the two Luo et al. (2020) columns.

The following sentence will be included in the legend of Table 6 : *"There are two columns for (Luo et al. 2020) as the authors tested two parameterizations of carcass and fecal pellet sinking speeds : 1000 m/d for carcasses and 650 m/d for fecal pellets (third column) or 800 m/d for carcasses and 100 m/d for fecal pellets (fourth column). »*

TECHNICAL CORRECTIONS

All technical corrections will be applied to the revised version of the manuscript.

Please also note the supplement to this comment:

https://egusphere.copernicus.org/preprints/2022/egusphere-2022-1282/egusphere-2022-1282-AC1-supplement.pdf