Reviewer 1

General comments:

Talmy et al. Biogeosci

I thank the authors for their careful consideration of reviewers' comments and their thorough revision. All of my specific comments have been satisfactorily addressed, except for comment "4b" about plankton sizes. The microzooplankton predators are smaller than their large phytoplankton prey, which is unrealistic in size-structured marine food webs. Otherwise, the paper addresses relevant scientific questions within the scope of BG. Though the concepts, ideas, and tools are not necessarily novel, their implementation and the comparison with recent observational datasets are. Overall, I think is an elegant study that would be valuable to the BG readership.

We have changed our plankton sizes to make them more ecologically realistic. Please see specific comments below for more detail. We greatly appreciate this reviewer's attention to detail.

(Original) Specific comments:
4. Missing information on experiment design and parameters.

4b. L114: What is the sensitivity of the results to these assumed sizes? I would argue that when ESMs use only one zooplankton type, it is supposed to represent both micro and mesozoo. Similarly, when there are two zoo types, one is micro and one is meso, and the meso preys on the micro, which is missing from the parallel food web here. Also, the "large phytoplankton" here is barely the size of the diatoms in ESMs (10-100 um, "microplankton"), while both the small and large microzooplankton are also at the low end of the microzooplankton (10-200 um in ESMs, 2- 200 um in Sieburth et al. 1978), and when there is only one zooplankton group in ESMs it tends to encompass everything 10-2,000 um. I do not mean to suggest that this study is without value for that reason, but the comparison to global ESMs used for climate change studies is less direct.

Interestingly, there seems to be a great deal of variation regarding what is being described in ESMs. From Rohr et al., 2023: "*it is concerning that some models imply something statistically similar to an ocean filled entirely with very slow-grazing meroplankton larvae (MEDUSA2.1, OECOv2) and others an ocean filled entirely with very rapidly-grazing ciliates (MARBL and CMOC).*" Therefore, our modeled rates of grazing are likely to fall within the envelope of values simulated in ESMs. Nevertheless, we conducted sensitivity simulations modifying phytoplankton and zooplankton size (described in lines 174-179 and lines 282-283) and found that our primary conclusions regarding scaling relationships are insensitive to assumptions about size. These results are shown in Figure S6.

I appreciate the size sensitivity test. However, I still find the microzooplankton sizes to be unreasonable. How could a 3.2 um or 4.7 um ESR ciliate feed on a 7 um ESR large phytoplankton? Could you change your results presented in the main paper to those with the larger microzooplankton from the sensitivity test?

We have revised our plankton sizes as follows (see Lines 116-121):

"In both formulations, small and large phytoplankton represent cells with ~0.5 and 5µm equivalent spherical radius, and are representative of picocyanobacteria and eukaryotic algae, respectively. In the parallel model, small and large microzooplankton represent protists with ~7 and 50µm equivalent spherical radius and are representative of microzooplankton in the ciliate size range. The generalist predator in the diamond food-web model has 15µm equivalent cell radius."

Using the allometric scaling for maximal grazing rates in Table 3, the large microzooplankton had unrealistically low grazing rates with these new sizes. We revisited our allometric coefficients and realized that we had compensated for unrealistically small microzooplankton with unrealistically small values for 'a' (where grazing rate is a function of cell volume with aV^b). Similarly, our grazing half saturation rate (which is size independent) was too high (see Table 2). We have modified these values to more closely reflect the published literature (Hansen et al. 1997; Ward et al. 2012; Rohr et al. 2022). The resulting grazing rates are very close to those use in our previous submission, but we have rerun all simulations and we do see some modest changes, for example with slightly greater contributions of the large phytoplankton in the parallel food web (deeper blue colors in Figure 4). However, none of our findings are modified by the changes.

4e. Figure 2: Are the arrows meant to line up with (phyto→PON) and (zoop→DOP) or is that just a coincidence?

This is just a coincidence.

Could you move the arrows to prevent confusion?

The arrows now both point to the top of the detritus box

Other:

Table 3: I assume these size-dependent parameters take the form: parameter = a * size ^ b. But what is size? The ESR given in Section 2.1? Please specify.

Table 3 caption now says 'Coefficients a and b constrain allometric relations of the form aV^b where V represents cell volume (μm^3)'

Line 269-273. Is the Z:P ratio in terms of biomass? The *z-ratio* (as in Stock et al. 2014) is productivity. Please specify.

This paragraph (now lines 284-294) and Figure 7 caption now refer to the Z:P biomass ratio throughout

Technical corrections:
Figure S5 is missing the units.

The figure now has units

Hansen, P. J., P. K. Bjornsen, and B. W. Hansen. 1997. Zooplankton grazing and growth: Scaling within the 2-2,000-micrometer body size range. Limnol. Oceanogr. 42: 687–704.

Rohr, T., A. J. Richardson, A. Lenton, and E. Shadwick. 2022. Recommendations for the formulation of grazing in marine biogeochemical and ecosystem models. Prog. Oceanogr. 208: 102878.

Ward, B. A., S. Dutkiewicz, O. Jahn, and M. J. Follows. 2012. A size-structured food-web model for the global ocean. Limnol. Oceanogr. 57: 1877–1891.