We thank the reviewers for their constructive comments and suggestions. We have addressed all the points raised and implemented the suggested changes, including clarifying the model description, moving the model evaluation to the result section and correcting a few typos. We hope that the manuscript is now ready for publication in Ocean Science.

Our *detailed* response *to the* reviewers' questions and comments can be found below. All page/line/reference/figure numbers refer to the tracked manuscript. Reviewers' comments are in regular text, our responses are in blue and *new text from the manuscript is in blue italics.*

Review 1

Specific comments:

A key review study in the field that I think deserves mention is Nandara et al 2021, as it reviews sampling, observation and tracking simulation methods, while also emphasizing the importance of integrative approaches.

Kanchana, et al. "Two hundred years of zooplankton vertical migration research." *Biological Reviews* 96.4 (2021): 1547-1589.

Answer: Indeed this work by Bandara et al. (2021) is relevant. We cite this article in the context of mechanisms controlling zooplankton migration on lines 40 and 481. We have added a mention of this article in the discussion to emphasize integrative approaches (line 507).

The model considers two zooplankton sizes, both of which fall within the mesozooplankton size fraction, with copepods being key representatives. However, could the model be applied to or used with microzooplankton ? I imagine the complexity of including both groups lies in the differences in egestion and assimilation of various elements, as well as other factors.

Answer: Yes, the model could technically be used to represent the vertical migration of microzooplankton, after adjusting the parameters controlling their physiology and migration patterns. For example, in our model, we already represent two sizes of mesozooplankton, which differ in their light preferences, to reflect the fact that the smaller the zooplankton, the shallower their depth and the smaller their migration amplitude (Ohman and Romagnan, 2016). Similar adjustments could be made to represent the notable differences between mesozooplankton already included in the model and newly added microzooplankton. However, it is important to note that microzooplankton exhibit markedly different migration dynamics compared to mesozooplankton. When contrasting copepod migration depths (Ohman and Romagnan 2016) with that of ciliates (e.g., Wang et al. 2023), microzooplankton vertical

movement is often more subtle and constrained in scale compared to that of mesozooplankton partly because they do not have the same swimming ability as mesozooplankton.

Ohman, Mark D., and Jean-Baptiste Romagnan. "Nonlinear effects of body size and optical attenuation on diel vertical migration by zooplankton." Limnology and Oceanography 61.2 (2016): 765-770.

Wang, Chaofeng, et al. "Diel variations in planktonic ciliate community structure in the northern South China Sea and tropical Western Pacific." Scientific Reports 13.1 (2023): 3843.

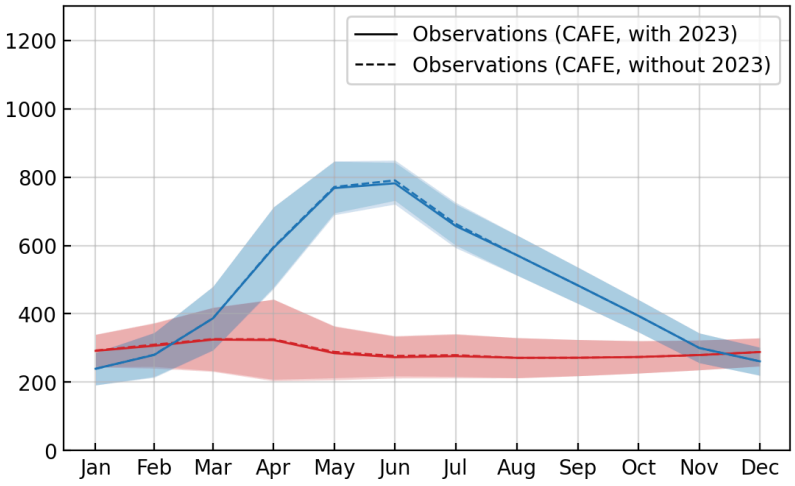
N:P=1:16 did you try varying this across different biomes?

Answer: The COBALTv2 model, on which COBALTv2-DVM is based, incorporates a static N:P ratio of 16:1 for mesozooplankton (note, however, that for phytoplankton and microzooplankton, the N:P is still static but differs from 16:1). This code cannot yet model a variable N:P ratio for zooplankton, however a dynamic stoichiometry has recently been implemented for phytoplankton (Hagstrom et al. 2024), which could be the basis for future developments applied to zooplankton. We would expect to observe higher N:P ratios in oligotrophic zones such as the subtropical biome than in eutrophic zones such as the subpolar biome, which could modulate the regional nutrient cycling.

Hagstrom, George I., et al. "Impact of dynamic phytoplankton stoichiometry on global scale patterns of nutrient limitation, nitrogen fixation, and carbon export." Global Biogeochemical Cycles 38.5 (2024): e2023GB007991.

I am curious about the difference in the dates for the datasets: migrating zooplankton data were collected between 2007 and 2019, while MODIS data span from 2002 to 2023. Given that 2023 was a particularly warm year, did including or excluding this year make a difference? Or was it clearly not affecting the seasonal variations?

Answer: We have tested the sensitivity to this particularly warm year as suggested by the reviewer. As shown in the figure below, the productivity estimates from MODIS measurements for 2023 are slightly lower than seasonal climatology, however the differences between climatologies calculated with and without 2023 are very small (subtropical: -0.55%, subpolar: -0.37%) and does not clearly affect seasonal variations.



Line 161: Nitrate and phosphate values?

Answer: We have clarified the values as follows:

L301-303*: "In both the observations and model, the subtropical anticyclonic gyre (elevated sea surface height, Fig. 1a) is oligotrophic at the surface, with nitrogen concentrations averaging* **0.29 and 0.28** ***umolN kg^{-1}*** *respectively, and phosphorus concentrations averaging* ***0.03 and 0.06 umolP kg^{-1}*** *in the first 100 meters."*

There is some inconsistent formatting in the reference section.
Answer: We have not found these inconsistencies but will be happy to modify the reference section as needed.