Response to RC1:

Dear Mr. Laurenceau-Cornec,

Thank you for your patience during this review process. We thoroughly revised the manuscript and believe its quality has improved substantially.

- We described the methods in more detail by means of a treatment table and an experimental setup overview plot.
- There is now additional data on the phytoplankton community in the Appendix.
- We restructured the discussion, rewrote large parts of it and added a new chapter on the limitations of our methodology.
- Finally, we revised the conclusions drawn from our analyses, keeping in mind the regionality of our data.

The only main concern we could not address is the information on the nature of sampled particles. After we processed the FlowCAM images and calculated sinking velocities and physical particle properties, the FlowCAM computer gave up on life and we lost the raw image data. Unfortunately, we had only saved picture collages on a backup file, which do not contain particle IDs. We thus cannot link particle images to their corresponding measurement. The particle collages are also not fit for a qualitative depiction of particle types. Since they do not contain one image per particle, but all captures that were taken of each particle, there can be hundreds of images for a slow sinking particle, but only a handful for a fast sinking one. An un-biased selection of particle types is therefore not possible. We address this shortcoming both in the Material and Methods and the Discussion sections.

You will find almost all of your in-text comments addressed in the revised manuscript. Due to the sheer amount, we will refrain from collecting all of them here. The only comment that has not been addressed in the text is the following:

- *How was the OMZ-influenced water added to the mesocosm? Could have it promoted any aggregation / fragmentation of the particles? Was the water velocity low enough to mimic a real upwelling event? (vertical velocity of upwelling event is generally low enough to consider a negligible influence on particle sinking velocities (see Bretagnon et al. (2018, doi:10.5194/bg-15-5093-2018).*
    - The OMZ-influenced water was added using a special distribution device, which we moved up and down the mesocosm during the addition in order to assure a representative injection. A picture of the apparatus can be found in the supplements of Goldenberg et al. 2022 (10.3389/fmars.2022.1015188), Figure S1C.
    - The water exchange velocities were probably much larger than during natural upwelling. We thus cannot exclude that this promoted aggregation/disaggregation of particles in the mesocosms. However, as it was a 1-time event, such effects should be visible immediately before/after the addition. When checking sinking velocities and particle properties in Figure B1, there seem to be no major disruptions around the OMZ water addition (day 11/12).

While working on the reviews, I personally appreciated your in-depth knowledge about particle types and the factors that govern sinking velocity. In fact, I learned a lot during this process, so thanks for the lecture!

I hope that our revisions satisfy your points of criticism sufficiently and lead to a “small but still important contribution” to the field, as you nicely put it. You will find an uploaded pdf-file with “tracked changes”.

Thank you very much for your time and consideration.

With kind regards,

Moritz Baumann

Response to RC2:

Dear Ms. Cavan,

Thank you for your patience during this review process. We thoroughly revised the manuscript and believe its quality has improved substantially.

- We described the methods in more detail by means of a treatment table and an experimental setup overview plot.
- There is now additional data on the phytoplankton community in the Appendix.
- We restructured the discussion, rewrote large parts of it and added a new chapter on the limitations of our methodology.
- Finally, we revised the conclusions drawn from our analyses, keeping in mind the regionality of our data.

The only main concern we could not address is the information on the nature of sampled particles. After we processed the FlowCAM images and calculated sinking velocities and physical particle properties, the FlowCAM computer gave up on life and we lost the raw image data. Unfortunately, we had only saved picture collages on a backup file, which do not contain particle IDs. We thus cannot link particle images to their corresponding measurement. The particle collages are also not fit for a qualitative depiction of particle types. Since they do not contain one image per particle, but all captures that were taken of each particle, there can be hundreds of images for a slow sinking particle, but only a handful for a fast sinking one. An un-biased selection of particle types is therefore not possible. We address this shortcoming both in the Material and Methods and the Discussion sections.

You will find an uploaded pdf-file with “tracked changes” showing the implemented revisions. In addition, we will address each of your comments in the following.

- *Please include a figure showing a map of mesocosms and a diagram of a mesocosm with the set up.*
    - Sure thing, both are now included.

- *A table with initial nox conditions in the mesocsms and how these changed after addition of OMZ waters. I can see these exist in Bach et al 2020 but without these the methods are not fully understandable if only reading this manuscript.*
    - Good point, we added this table.

- *There must be images of the particles, can you show these to show as example 1) particle type, and 2) a porous and non-porous particle. I was surprised there was not any mention of particle type and wonder if perhaps if this data is being saved for another manuscript, if not please include the data here. If it is, please summarise what the particles were and if composition changed over time.*

- We could unfortunately not give more information on particle types. I described the reasons for this up above.
  Nonetheless, the necessity of information on particle types is a major take-away of this review. In the future, we will make sure to be able to provide this data and use it for more meaningful sinking velocity analyses.

- *in line 234 you state seabirds stimulate new production, it's a bit pedantic but isnt this regeneration of nutrients and so they are stimulating production, but by definition (F- ratio) its regenerated nutrients (ammonium) not nitrate.*
  - You are very correct, we amended this. (And it is not pedantic.)

- *consider putting some of Fig.1 plots on same scale so can compare Sv.*
  - Since we were less interested in the quantitative numbers of sinking velocity and more in its temporal development, we decided to keep the scales separately. If you have arguments in favor of aligning the scales, please let us know and we will gladly reconsider.

- *Did you compare the means of your variables with time for the different OMZ water treatments? I can see from your statistics and figures there is no difference in magnitude, but there might be interesting (or not) subtle differences in the trends of some of your variables. For instance instead of just the solid black line you could have a blue and red one too. If there isnt any thing interesting to be seen with time then this can just be stated.*
  - At some point early in the analysis, we did have a red and blue average line per OMZ treatment. It made it really hard to distinguish between the different lines though, and there were no real insights gained. We thus decided that an overall trendline would be more beneficial for the reader, and that the information on the OMZ insignificance is better conveyed via the statistics.

- *in your discussion around size vs Sv you note that a low sample number (n) could be the reason. We also looked into this using the Cavan et al 2017 data from Guatemala, but published the size vs Sv in a seperate paper (Cavan et al 2018, JGR), https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2018JG004392. You can see in Fig.1 below 1250um theres a signal of size vs Sv, but above this there is not, which we hypothesised was due to a low sample size. This could be useful to further back up your discussion (~ line 387) and is from a similar location.*
  - Wonderful, thank you for the input! We included this reference in line 368.

- *As the main motivation for this study is to improve models it would be helpful to expand discussion on your coefficients for the size vs Sv relationship, ~ line 395. what was the range reported by Cael? Were your coefficients on the lower or higher end, how do they compare with global values, does this location have a lower or higher*

slope than others? What does this infer about biology? What else needs to be done to get this paramterisation in models and how would a modeller scale the coefficients with location/chl/temperature etc. to represent this location differently?

- You're absolutely right, thank you for this idea. We included a more thorough comparison of our Peruvian size-sinking relationship with the different relationships of Cael et al. (2021) in lines 378-384.

- *A large proportion of the discussion is given to the opal ballast, which the authors find is not a key driver here (would we expect that in the tropics?) and the wider community has already shown ballast is often not a driver. I would encourage the authors to bring out more novel aspects, particularly around porosity which has only more recently been quantified and could be really important in driving fluxes. For instance, pellets that are more porous (e.g. salps) are less efficient vectors of carbon to the deep. I think some interesting discussion could be had here at the authors discretion.*
    - We restructured the discussion, which removed some emphasis from the opal ballast part. In comparison, porosity receives more attention now than before. However, we find it difficult to draw much insight from the porosity data without treatment differences and to discuss porosity mechanisms without knowing about particle types. Nonetheless, we believe that the reworked Discussion section "Size, porosity and shape as drivers of sinking velocity" reads a lot better now.

Some discussion around particular limitations is needed, especially:

- *The use of mesocosms, what are the limitations of artificially manipulating the ecosystem in this way? are there wall effects for example?*
    - One limitation of our mesocosm setup is that the enclosed plankton community is truncated at a maximum organism size of ~3 mm during filling. This is done to exclude impactful predators and reduce artifacts. Although this might affect sinking fluxes, enclosed organisms do grow larger inside the mesocosms after filling, so the effects would be only temporary.
    - Due to the smaller surface to volume ratio in mesocosms compared to bottles, wall effects are in general less impactful. Yet, they are a problem, especially fouling organisms growing on the inside walls. They compete for nutrients with pelagic organisms and can sink to the sediment trap, thereby influencing vertical mass fluxes. We avoid this by cleaning the mesocosm walls and removing the growing biofilm regularly.

- *What is the mixed layer depth? and as the mesocsms are only 19 m deep, do you think the particles you sample would actually be exported out of the mixed layer? many would be recycled before reaching the mixed layer if its much deeper than 19 m.*

- This is a good point. In fact, the mixed layer is quite shallow in this region and was shallower than our mesocosms during the time of the experiment. We added information on it in lines 74-75.

- *I am really glad to see the seabird discussion, but did you count seabirds per mesocosm and compare to N or P? Can you absolutely prove that seabirds increased N and P in the mesocsoms? I think its still fine to mention the birds in the manuscript but need to acknowledge you hypothesise the affect the birds had rather than can prove it. This sets up a nice future experiment to be had.*
    - You are right, we cannot beyond doubt prove that the seabirds increased N and P in the mesocosms. However, we did count inca terns per mesocosm and often found more than 10 birds sitting on each unit. Additionally, feces on the inner mesocosm walls proved that they did defecate inside of the mesocosms, and hence most likely into the mesocosm waters. I therefore think we can with high confidence assume that the inca terns added N and P to the system. We included these arguments in lines 355-360 and rephrased our wording, hopefully to your content.

- *Are there limitations to your methods of measuring Sv? might the material have aggregated once settled and before you sample it? there are also limitations to the flow cam method which need to be ackowledge. Around line 391 would be a good space to introduce discussion on this.*
    - Yes, there absolutely are. We have dedicated this a whole section, which deals with the effects of sampling, sample handling, and FlowCAM limitations on sinking velocity measurements.

In my opinion, your review was very fair, professional and benevolent. I hope that our revisions satisfy your points of criticism sufficiently and that you enjoy the second read of our manuscript. You will find our “tracked changes” in the uploaded pdf-file.

Thank you very much for your time and consideration.

With kind regards,

Moritz Baumann