Biogeosciences Discussions

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Comment on bg-2021-201

Anonymous Referee #1

Referee comment on "Bridging the gaps between particulate backscattering measurements and modeled particulate organic carbon in the ocean" by Martí Galí et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-201-RC1, 2021

This study compares POC concentrations simulated by a biogeochemical model (PISCES) to high resolution field estimations from autonomous platforms and satellites. The authors show large discrepancies between models and observations. However, model and observations both agree on the behaviour of slow and fast sinking particles. The authors conclude that uncertainties in the POC conversion factors, imperfection between available observations and model points and in the representation of the physics in the model are sources of mismatch. While I feel like some of processes invoked for explaining the discrepancies are not deeply discussed, I do not have any major issues with this work. I believe that some points should be clarified, better justified, and better documented before publication. These are listed below:

Minor remarks :

L24 : So all known factors driving sinking POC cycling in the mesopelagic basically….

L24-26: The abstract mentions that inconsistencies were identified. The rest of the sentence is somehow cryptic, and I feel like such inconsistencies should be detailed a bit more.

L46: None of these paper report actual measured flux attenuation, only (Marsay et al., 2015) does please revise.

L53: And wide variations in the attached microbial communities (Baumas et al., 2021)

L55: Rephrase to "large" instead of big, here and throughout

L56: This is not always true, please see work by (McDonnell M., P. & Buesseler, 2010)

L62: Please include results by (Alonso-Gonzalez J. et al., 2010; Riley et al., 2012).

L89: How was this represented in previous versions of the model?

L92: which ones? from what methods? You may want to state the pitfalls of such methods to connect with the subsequent part of the text.

L95. Please state the size range of particles observed with such devices.

L103 : surface POC flux or concentration ?

L106 : Which of the « drivers » are specifically being evaluated here?

L236: what is this based on? justify

L238: More strongly than what?

L239: (Briggs et al., 2020) recently found that fragmentation could be responsible for up to half what's observed in flux attenuation. How does the "small" fragmentation may compare to (Briggs et al., 2020) here.

L280: Any error associated with such climatologies (PISCES results excluded)?

L307: Please specify, what are the physical processes that are unrealistically represented

in this region?

L 369: what do mean by rare aggregates?

L450 See work by adam Maritny'group https://www.nature.com/articles/sdata201448 This presents of substantial amount of data including mesopelagic data that could be potentially used here.

L490: Add (Bianchi et al., 2018)

L530: does this translate into an increase in sinking speed (for a given size) in your model?

L569: Size vs sinking velocities relationships depends mostly on their composition (Laurenceau-Cornec et al., 2019), some large unballasted aggregates will not sink as fast as Stokes predicts.

L585: What about chemoautolithotrophy (CO_2 dark fixation by particles associated bacterias) (Herndl & Reinthaler, 2013)

LL595-608: Silly question, why are BACT not explicitly represented in such models?

L620: Down to what particle size?

L670: How are particles sinking velocities represented in PISCES? Do they increase with depth as observed in (Villa Alfageme et al., 2016)?

L676: Is fragmentation caused only by biological factors or could non-biological factors such as microturbulence play a role? Please discuss.

L704, please explicit

L717: cryptic sentence, please revise.

Figure 6: This clearly show that at high latitudes PISCES produces a pool of small slow sinking particles that doesn't seem to be remineralised quickly enough as they do not appear on the sPOC BGC-ARGO profile. The occurrence of sPOC seen from the BGC-ARGO profile could well be from b-POC fragmentating into s-POC rather than from the original s-POC fraction sinking out on its own.

Alonso-Gonzalez J., I., Aristegui, J., Lee, C., Sanchez-Vidal, A., Calafat, A., Fabres, J., et al. (2010). Role of slowly settling particles in the ocean carbon cycle. *Geophys. Res. Lett.*, *37*.

Baumas, C. M. J., Le Moigne, F. A. C., Garel, M., Bhairy, N., Guasco, S., Riou, V., et al. (2021). Mesopelagic microbial carbon production correlates with diversity across different marine particle fractions. *ISME Journal*. https://doi.org/10.1038/s41396-020-00880-z

Bianchi, D., Weber, T. S., Kiko, R., & Deutsch, C. (2018). Global niche of marine anaerobic metabolisms expanded by particle microenvironments. *Nature Geoscience*. https://doi.org/10.1038/s41561-018-0081-0

Briggs, N., Dall'Olmo, G., & Claustre, H. (2020). Major role of particle fragmentation in regulating biological sequestration of CO2 by the oceans. *Science*. https://doi.org/10.1126/science.aay1790

Herndl, G. J., & Reinthaler, T. (2013). Microbial control of the dark end of the biological pump. *Nature Geosciences*, *6*, 718–724.

Laurenceau-Cornec, E. C., Le Moigne, F. A. C., Gallinari, M., Moriceau, B., Toullec, J., Iversen, M. H., et al. (2019). New guidelines for the application of Stokes' models to the sinking velocity of marine aggregates. *Limnology and Oceanography*.

Marsay, C. M., Sanders, R. J., Henson, S. A., Pabortsava, K., Achterberg, E. P., & Lampitt,

R. S. (2015). Attenuation of sinking particulate organic carbon flux through the mesopelagic ocean. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(4), 1089–94. https://doi.org/10.1073/pnas.1415311112

McDonnell M., P., A., & Buesseler, K. (2010). Variability in the average sinking velocity of marine particles. *Limnology and Oceanography*, *55*(5), 2085–2096.

Riley, J., Sanders, R., Marsay, C., Le Moigne, F. A. C., Achterberg, E., & Poulton, A. (2012). The relative contribution of fast and slow sinking particles to ocean carbon export. *Global Biogeochemical Cycles*, *26*. https://doi.org/doi:10.1029/2011GB004085

Villa Alfageme, M., De Soto, F., Ceballos-Romero, E., Giering, S., Le Moigne, F. A. C., Mas, J. L., et al. (2016). Geographical, seasonal and depth variation in sinking particle speeds in the North Atlantic. *Geophys. Res. Lett.* https://doi.org/10.1002/2016GL069233