

Interactive comment on “Microstructure and composition of marine aggregates as co-determinants for vertical particulate organic carbon transfer in the global ocean” by Joeran Maerz et al.

Anonymous Referee #2

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Review of Maerz et al: Microstructure and composition of marine aggregates as co-determinants for vertical particulate organic carbon transfer in the global ocean

The authors present a new scheme for the calculation of the mean sinking velocity of marine aggregates as a function of the aggregate composition and the fractal dimension. This scheme is reported to be cost-efficient and hence useful in large-scale ocean models. The model is described in detail and carefully evaluated. The authors report a substantial improvement in the simulation of the latitudinal pattern of POC transfer efficiency.

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This is an impressive effort and worth of publication. I have some specific comments that should be addressed before publication.

Writing style: Sentences are very long and not always clear. This is particularly true for the introduction and model description.

General comments:

- I miss a comparison with the stochastic, Lagrangian model of sinking biogenic aggregates in the ocean (SLAMS) by Jokulsdottir and Archer. Jokulsdottir, T. and Archer, D.: A stochastic, Lagrangian model of sinking biogenic aggregates in the ocean (SLAMS 1.0): model formulation, validation and sensitivity, Geosci. Model Dev., 9, 1455–1476, <https://doi.org/10.5194/gmd-9-1455-2016>, 2016.

- Please make the model code publicly available. It is not in the repository that you mention.

- explain ALL abbreviations and symbols used in the figures in each and every figure caption.

- I am quite worried about the high buoyancy of diatom-dominated aggregates through the TEP formulation. This needs more justification. Do you here assume that all organic carbon has the same density as TEP? That would explain your low density of diatom-dominated aggregates. Is there sufficient evidence for such behavior?

Abstract:

Line 14: too much information given: delete rising CO₂ and without CO₂ climate feedback.

Introduction:

- P.2 Please give more references for your statements, especially in the first paragraph. No reference given between line 5 and 11.

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- P. 2, line 17: “The sinking velocity of aggregates is primarily determined by their size”. This needs a reference. I would argue it is density, e.g. Iversen and Robert, <http://dx.doi.org/10.1016/j.marchem.2015.04.009> . The next sentence also needs a reference (line 19).

- P. 2, line 32: primer → primary?

Model description

- It would be very helpful to have a table with all symbols used in the equations at the beginning of section 2.1

- P. 5, line 2, what is meant with “terminal sinking velocity”? I suggest to delete “terminal”

- Eq. 3: I can guess what is meant with dd , but it is easily misunderstandable.

- P. 5, line 28: What is meant by a “primary particle”. How does that differ from “a particle”?

- P. 7, line 1: What is meant by “the total number of one primary particle type” ? The total number of one should be one. Do you mean “of particles of one particle type”?

- P. 8, line 5: “mean primary particle size, (...) which we apply as a lower integration bound”. Please give a justification for this choice.

- P. 10, line 5: no reference to Engel et al 2004? Engel, A. , Thoms, S., Riebesell, U. , Rochelle-Newall, E. and Zondervan, I. (2004) Polysaccharide aggregation as a potential sink of marine dissolved organic carbon. Nature, 428 . pp. 929-932. DOI 10.1038/nature02453.

- Figure 2: explain abbreviations and symbols in each and every figure caption.

- P. 11, line 18: how is m_e and $m_{\text{potential}}$ calculated? I can't follow whether the masses of opal and of TEP are taken into account correctly to calculate the density

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of the diatom-aggregate. Do you here assume that all organic carbon has the same density as TEP? That would explain your low density of diatom-dominated aggregates. Please clarify.

- P. 13, line 1: mention that this forcing is based on ERA reanalysis (be specific) and avoid the abbreviation OMIP which you don't explain (or explain it)

- P. 13, line 3/4: are these global numbers? What are corresponding model parameters?

- Table 1: caption: "The value for the Martin curve..." . Why is this single parameter given in the caption, please add it to the list of parameters in the main body of the table.

- P. 16, line 4: "a minor role in biogenic fluxes". This statement needs a reference.

- P. 16, line 33/34: "adaptation .. within a few years." Is adaptation the right word here? Maybe "an equilibrium was established"? or its change after a few years was small..

Results

- P. 22, line 12-13: "diatom-dominated aggregates feature a high buoyancy through TEP." Is there any evidence for such behavior or is this a major model bug?

- P. 23, line 25: I assume z_0 is 100m, please clarify.

- Line 26: "to about 1000m" → at 1000 m.

- P. 28, line 29: this is not shown in Fig 7a, you only show mean density, not the effect of opal on density.

- Line 30: any indication in the literature and any scientific explanation why silicate frustule size affect the sinking speed if not by density?

- Fig 10: colorbar label: contribution → contribution(add 't')

- P. 35 and Figure 14a: what is the reason of showing cumulative CO₂ fluxes integrated

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over latitude? Please show just the zonal means, that's much easier to understand and compare to data. The units should not include per degree if it is cumulative.

- Figure 14c-k: cumulative fluxes make more sense here. I'd prefer actual fluxes/time and then the difference between the two could be cumulative. Then, one y-axis might also be enough.

- P. 37, line 24: suggested → hypothesize (careful which tense you use). Also, please please back up this hypothesis with literature.

- P. 38: you have not shown silicate distribution – is that reasonable? You refer to low transfer-efficiency in silicifier-dominate region, but this is not the case in the Southern Ocean, nor do you see much of an impact in Figs 15 a and d in the Southern Ocean, which is THE region dominated by silicifiers. This needs more explanation.

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