Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2020-423-RC1, 2021

Comment on gmd-2020-423

Anonymous Referee #1

Referee comment on "A discrete interaction numerical model for coagulation and fragmentation of marine detritic particulate matter (Coagfrag v.1)" by Gwenaëlle Gremion et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2020-423-RC1, 2021

The present paper aims to include the process of particle coagulation and fragmentation into an OGCM. Particle coagulation is a challenging process to model as it requires the inclusion of many compartments, representing the spectrum of aggregated particle sizes. So far, no real attempt has been made to incorporate this process explicitly into the larger scale biogeochemical models. I believe this is an important step in biological oceanography due to its importance in carbon flux estimations.

Ideally, one would include a total of N tracer compartments, N representing the maximum amount of individual cells or particles a single aggregated floc can contain. However, due to computational restrictions, including N tracers in an OGCM is not feasible. This paper aims to address this problem by reducing the particle size resolution (i.e. reducing the amount of tracers). More importantly, the modelling approach is flexible to allow a nonlinear size distribution, which is more suited to the biological process.

It is encouraging that attempts are being made to incorporate this process into an OGCM and I believe this paper certainly has merit. I would recommend publication subject to addressing the minor concerns raised below.

- Firstly, I was surprised to see links to the cloud microphysics field had not been made. These spectral bin models are used frequently e.g. Khain et al 2004 and a discussion is warranted.

- Line 375 states “But, the sensitivity of our model outcomes to many arbitrary constant parameters needs to be profoundly investigated”. This is an extremely pertinent point and I think at least a basic sensitivity analysis should be conducted.

- Regarding the penalty function: while I appreciate the simplicity used to reconcile the errors arising from nonlinearity, more tests should be carried out to confirm the applicability of the parameter choices used in the function.

- The work aims to replace the simplified coagulation parameterizations currently used in OGCMs, which use several detritus compartments. While I completely agree that the approach used here is a positive step, it would be useful to demonstrate exactly why the model developed here is preferable beyond the current discussion given in the introduction. Is there evidence showing that carbon fluxes are estimated more accurately using this type of method? Can a simple experiment be carried out to show the shortfalls of the other approaches? There is going to be a computational penalty for including more tracers, so it should be shown that the sacrifice is worth it.

- Takeuchi et al. 2019 finds aggregates are bounded in size by the Kolmogorov length scale. Rather than using an arbitrary upper bound, this characteristic could be used to inform the choice of upper bound.

Khain, A., Pokrovsky, A., Pinsky, M., Seifert, A. and Phillips, V., 2004. Simulation of effects of atmospheric aerosols on deep turbulent convective clouds using a spectral microphysics mixed-phase cumulus cloud model. Part I: Model description and possible applications. *Journal of the atmospheric sciences*, *61*(24), pp.2963-2982.

Takeuchi, M., Doubell, M.J., Jackson, G.A., Yukawa, M., Sagara, Y. and Yamazaki, H., 2019. Turbulence mediates marine aggregate formation and destruction in the upper ocean. *Scientific reports*, *9*(1), pp.1-8.