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Biogeosciences Discussions

Interactive comment on "A zooplankton diel vertical migration parameterization for coastal marine ecosystem modeling" *by* Ariadna Celina Nocera et al.

Anonymous Referee #1

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General Evaluation

The authors present a 1-D NPZD model of coastal ecosystems with diel vertical migration (DVM) in zooplankton. DVM is parametrised by an optimal light level and allowed to occur only when food availability is below a certain threshold. A sensitivity analysis is presented showing the relation between DVM and several model parameters and boundary conditions. The authors conclude that DVM increases C export and that C export will be severely overestimated without DVM.

As may already be clear from the last sentence of the previous paragraph, my main impression from this work is that it has not been thought through very thoroughly. The

main model set-up and assumptions appear either rather half-baked or unfounded. Another problem I have with this study is that I expect from every model study at least some attempt to compare the model quantitatively with observations, and this has not been done here. Also, one of the central assumptions in this model is that DVM occurs only at low food concentrations, but this assumption is only mentioned but not really discussed in terms of how realistic it may be or whether it has been observed. In fact, no evidence is presented for it. While this assumption could make sense below the photic zone, where it could help determining the daytime depth of the zooplankton, I think it is introduced here too simplistically, in a way in which it could also keep the zooplankton very close to the surface. Because of these deficiencies, and I list some more below, I consider this work far below the current state of the art and do not recommend publication.

Specific points

Abstract, line 3: "... most zooplankton species." DVM occurs in many but probably not most species, e.g., it is not known for many microzooplankton species.

P. 2, line 5: "The efficiency 5 of the biological carbon pump is regulated by zooplankton and micronekton vertical migration ..." Surely, other processes and phenomena also affect the efficiency of the biological C pump. For example, sinking of phytoplankton and aggregates and their stoichiometry.

P. 7, line 30: "parameter space" It remains unclear how many parameters the model has, and why the ones examined here were selected.

P. 8, line 23: "rC:N = 7 mmolC mmolN−1" Further above the authors give two C:N ratios for phytoplankton and zooplankton, citing Redfiled (1958) (who did not distinguish between phytoplankton and zooplankton). So this is inconsistent with the model set-up and could lead to a mass-balance violation. It is not clear whether the model was checked for mass conservation.

P. 8, lines 26-27: "... a non-realistic benthic zooplankton community ..." A benthic community is not necessarily unrealistic, although it is of course not zooplankton, as long as it undergoes no (vertical) motions. This seems to be the case in the simulations without DVM.

P. 9, lines 25–26: "When turbulent diffusivity is low enough, zooplankton aggregate into narrow patches (Fig. 4c and f), while if it is strong enough, it will be mixed homogeneously (Fig. 4b and e)." It is not clear that this is what is going on between Fig. 4b and e. Both panels look very similar, with zooplankton being concentrated near the optimal isolume.

P. 11, line 3–4: "a more or less abrupt transition happening around a critical grazing rate that we call gmax, from no migratory behavior ($\Omega = 0$) towards a stronger, more clearly defined one ($\Omega > 0$)." I think this sentence highlights a major problem of this ms. The model makes a very strong assumption, namely that DVM stops once a certain amount of food is available, and no evidence is presented for this assumption. Then major conclusions are drawn based on this assumption. This is an example for such conclusions. The effect of the maximal grazing rate is solely due to this assumption because it determines whether the zooplankton can graze down their food below the critical level allowing for DVM.

P. 13, lines 7–8: "This indicator [export] is consistently larger when gmax < 1.0 d^{-1} in all experiments" These are the same conditions where DVM is suppressed, so this is the foundation for the conclusion that C export can be severely overestimated without DVM. But apparently this does not fit with the authors' view of DVM as a process favouring export, so they provide both, resulting in a self-contradictory conclusions section.

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