

## ***Interactive comment on “ESD Reviews: Evidence of multiple inconsistencies between representations of terrestrial and marine ecosystems in Earth System Models” by Félix Pellerin et al.***

**Félix Pellerin et al.**

felix.pellerin@uni-hamburg.de

Received and published: 27 October 2020

First of all, we would like to thank the reviewers for their time to read the manuscript and to send us thought-provoking comments.

Both reviewers question our approach for a common framework to describe marine and terrestrial ecosystems in a consistent way. They argue that both ecosystems are different and thus there is no value in treating them in an integrative way. Of course, we agree that there are important differences between terrestrial and marine systems, and

C1

we will make this more clear in the revised version of the manuscript. However, many biological processes occurring in these systems are identical, and these processes have an important effect on climate through their role in biogeochemical cycles and biogeophysics. Why should we represent identical biological processes in a different way? We argue that there is no convincing reason why the same processes should be treated differently for marine and terrestrial systems.

We do believe that the unjustified difference in the representation of important biological processes between ecosystem models is an issue. For instance, photosynthesis and respiration do have a different thermal reaction norm. While this is taken into account in terrestrial, marine ecosystem models ignore this fact as illustrated in numerous experiments (see e.g. Wohlers et al. 2009, Padfield et al. 2016, Schaum et al. 2017). Thus any warming scenario will at its best simulate the consequences for carbon storage correctly for terrestrial ecosystems and inaccurately for marine systems. In coupled model runs this error will propagate in the system but we have currently no idea about the size of the error. Only with a unified model framework we will be able to address this question. Similarly, terrestrial models represent various biogeophysical mechanisms (i.e. albedo, light absorption, roughness length), while marine ecosystem models poorly represent them. In the case of light absorption, it has been demonstrated by coupled ocean ecosystem models that this feedback has major impact on climate predictions (see Patara et al. 2012 for a review). Again, in ESM runs, this error will propagate and might impact model predictions, in particular regarding the relative role of terrestrial vs marine ecosystems in the climate system.

In conclusion, the present study assesses the current inconsistencies in the representation of the same processes and mechanisms between marine and terrestrial ecosystem models. Such an assessment is a prerequisite to generate a common framework and a more quantitative analysis on the current inconsistencies in marine and terrestrial ecosystem models in ESMs.

Please note that all the other specific points identified by the reviewers are not dis-

C2

cussed here but will be addressed in the revised version of the current manuscript.

References:

Wohlers, Julia, Anja Engel, Eckart Zöllner, Petra Breithaupt, Klaus Jürgens, Hans Georg Hoppe, Ulrich Sommer, and Ulf Riebesell. 2009. "Changes in Biogenic Carbon Flow in Response to Sea Surface Warming." *Proceedings of the National Academy of Sciences of the United States of America* 106 (17): 7067–72. <https://doi.org/10.1073/pnas.0812743106>.

Padfield, Daniel, Genevieve Yvon-Durocher, Angus Buckling, Simon Jennings, and Gabriel Yvon-Durocher. 2016. "Rapid Evolution of Metabolic Traits Explains Thermal Adaptation in Phytoplankton." *Ecology Letters* 19 (2): 133–42. <https://doi.org/10.1111/ele.12545>.

Schaum, C. Elisa, Samuel Barton, Elvire Bestion, Angus Buckling, Bernardo Garcia-Carreras, Paula Lopez, Chris Lowe, et al. 2017. "Adaptation of Phytoplankton to a Decade of Experimental Warming Linked to Increased Photosynthesis." *Nature Ecology and Evolution* 1 (4): 1–7. <https://doi.org/10.1038/s41559-017-0094>.

Patara, Lavinia, Marcello Vichi, Simona Masina, Pier Giuseppe Fogli, and Elisa Manzini. 2012. "Global Response to Solar Radiation Absorbed by Phytoplankton in a Coupled Climate Model." *Climate Dynamics* 39 (7–8): 1951–68. <https://doi.org/10.1007/s00382-012-1300-9>.

---

Interactive comment on *Earth Syst. Dynam. Discuss.*, <https://doi.org/10.5194/esd-2020-55>, 2020.