

Interactive comment on “Projected decreases in future marine export production: the role of the carbon flux through the upper ocean ecosystem” by C. Laufkötter et al.

C. Laufkötter et al.

c.laufkoetter@gmail.com

Received and published: 1 May 2016

We wish to thank reviewer #1 for the detailed analysis of our paper and his/her thoughtful comments, which have been very helpful and greatly improved the quality of this manuscript. A detailed reply to each point follows below:

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Response to Reviewer Comment #1

Reviewer Comment: This manuscript describes in detail the differences between 4 global biogeochemical models in the way that they represent the processes of POC production and sinking. Future projections are used to assess how the different model formulations lead to the wide range of projected changes in export production. The manuscript provides useful information for model users wishing to understand in greater detail how uncertainty in projections of future export arise and how individual models construct estimates of export. Although the manuscript doesn't really have a big, novel conclusion as such, as it is more about model exploration, it is nevertheless worthy of publication in Biogeosciences. I have only a few minor comments:

Reviewer Comment: Page 19943, Line 24: lower/higher this isnt clear and confused me. Please rephrase.

Author Response: Done.

Reviewer Comment: Page 19949, Line 10: Should refer to Figure 5

Author Response: Done.

Reviewer Comment:Page 19950, Line 10: Parameter values are listed in tables 5-8, not in appendix

Author Response: Done.

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Reviewer Comment: *Model descriptions section refer to the relevant tables with parameter values when discussing the different models. Also is the model output annual average? Or monthly?*

Author Response: Done. We use monthly mean model output, this is now mentioned in Section 2.3: Data processing

Reviewer Comment: *Page 19953, Line 20: Is this 35% a fixed value or an average?*

Author Response: This is a fixed value, the sentence reads now: “A constant fraction (35%) of the biomass losses due to microzooplankton mortality and the linear part of mesozooplankton mortality are routed to the small particle pool.”

Reviewer Comment: *Page 19954, Line 17: Lima et al. 2015 not in references list*

Author Response: This paper is in preparation, but the publication date has been postponed. We have removed the sentence from the manuscript.

Reviewer Comment: *Model evaluation: although all of the models have been validated in detail elsewhere, I think it would be useful to include a Taylor diagram (or some other quantitative information) on how model and satellite-derived export estimates compare, alongside Figure 2 which just gives a visual overview.*

Author Response: Done, we have added a panel with a Taylor Diagram comparing

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model and satellite-based export estimates, please find the figure at the end of this pdf. The caption of the figure is: "Taylor diagram comparing modeled export production averaged over the 2012-2031 period with satellite-based estimates by Dunne et al. 2007 and Henson et al. 2012. The angle describes the correlation between model and satellite-based estimate, the distance from the origin is the normalized standard deviation and the distance from the point REF is the root mean squared error".

Reviewer Comment:Page 19962, Line 21: I think this makes more sense if written as e.g. 12 to 14% of NPP as +2[%NPP]

Author Response: Done.

Reviewer Comment:Page 19962, Line 23: High latitudes, not just Southern Ocean as written here.

Author Response: Done.

Reviewer Comment:Page 19969, Line 21: "this process" - not entirely clear what the authors are referring to here. Do you mean the fraction of grazed material that becomes sinking/exported as faecal pellets?

Author Response: Yes! Done.

Reviewer Comment:Page 19970, Lines 7-10: reference to realistic e-ratio changes, the processes how particles are formed etc.: If only we knew what the important processes, their magnitude and variability were in the real world!

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Then we could really say whether one model was better than another. But just the huge range in satellite-based global e-ratio estimates (like the Dunne and Henson algorithms used here) emphasises that we dont know how the real world behaves either! Some discussion of how this uncertainty makes it difficult to judge whether a model is realistic or not would round out the discussion.

Author Response: We agree, and we have included the following sentence in that paragraph: “However, the most important processes, their magnitude and variability have not yet been identified, and observations to constrain parameters of potential candidate processes are sparse. “

Reviewer Comment:Page 19971, Line 5-10: But how would/should we choose/identify the most important processes? I am sure every observationalist you ask would give a different answer of what is most important! Can you make any suggestions about what the most important processes might be?

Author Response: We agree with the reviewer that it is a hard task to identify the most important processes. We contribute to the solution of this problem by pointing out which of the already modeled processes are a) particularly weak constrained and b) have the potential to contribute significantly to the total particle formation according to the models that implement them. We give a summary of these processes at the end of the paper: “In order to increase the reliability of e-ratio projections, a concerted effort including observations and targeted laboratory studies of plankton community structure, particle composition and sinking behaviour, particle aggregation rates, ballasting effects and grazing controls to support further model development and a rigorous model evaluation will be needed. ‘ Our results can unfortunately not be used to infer anything about the importance of processes that are not included in the analysed models. ‘

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Reviewer Comment:Appendix: add reference to the relevant parameter tables (tables 5-8) in the model descriptions.

Author Response: Done.

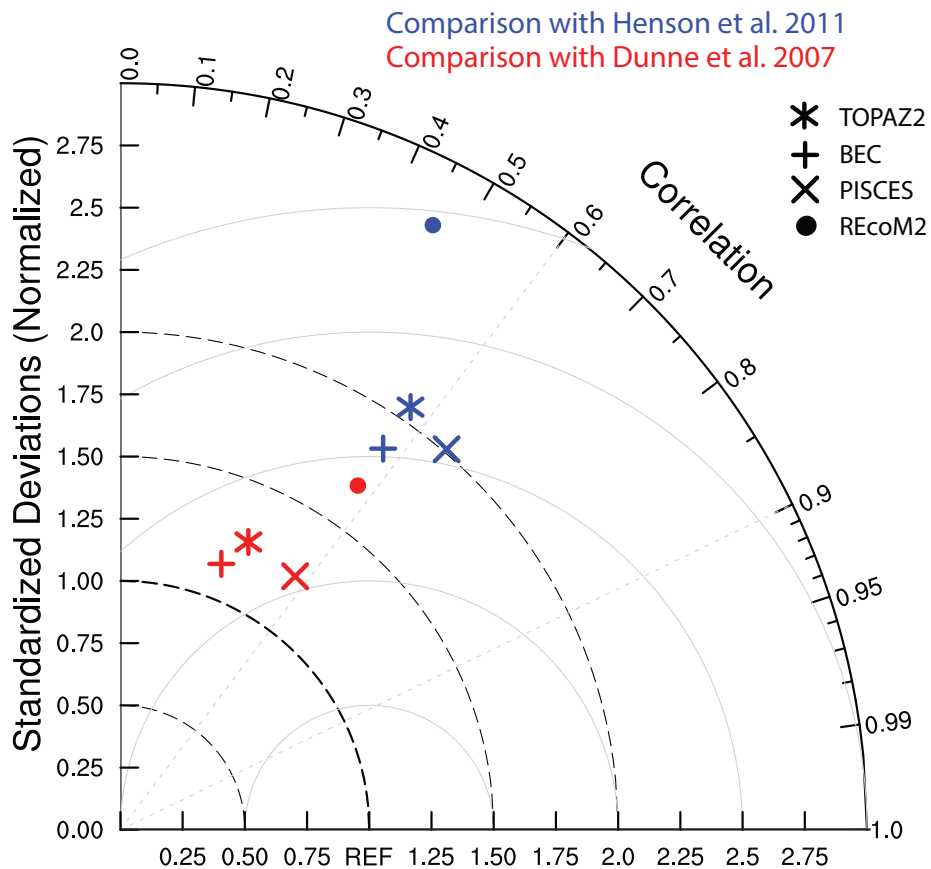
Reviewer Comment:Figure 7: The numbers on this figure were so tiny I really struggled to read them. Label the 2 columns low latitude and high latitude to make it easier for the reader. In TOPAZ, high latitude, the grazing and mortality arrows don't seem to go through the zooplankton box. Note in the caption that PISCES includes DOC aggregation; and that diatom and nanophytoplankton are denoted D and N respectively in the green boxes.

Author Response: Done.

Interactive comment on Biogeosciences Discuss., 12, 19941, 2015.

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Fig. 1.