

Second Review of *Heterogeneous future of Arctic Ocean primary productivity changes projected in CMIP6* by Champiot-Bayard et al.

General Comments:

The authors have done a good job of addressing my questions and comments from the first round of review. Significant changes were made to the manuscript, and I am especially pleased to see the extra analysis considering changes over the upper mixed layer. I appreciate that this required a considerable amount of extra evaluation that went beyond simply justifying use of the 100m threshold for consistency with Vancoppenolle et al. (2013), but I believe it has strengthened the paper. The parts of the paper that do make use of surface values for direct comparison are now well-justified.

Additionally, considering seasonal analysis gives a more comprehensive view of the projected changes in Arctic productivity and I am pleased to see these additional analyses have added further detail to the original conclusions of whether/when oligotrophic conditions are reached in the CMIP6 ensemble.

I have a few minor comments on the updated manuscript that I would like to see addressed, but otherwise I am satisfied with the response to my comments and with the changes to the manuscript.

1. Most importantly, thank you for the figures showing the depth of CHL maxima in the CMIP6 ensemble! The projected changes in the depth at which the maximum occurs are interesting, but I think the key point here is assessing whether the deep CHL max (in the historical part of the run) is better simulated by CMIP6 than CMIP5, as this was a known limitation with some CMIP5 models.

The analysis done for the new Figure 3a should be sufficient to make a comment on this. I would like to see an addition to the discussion section where these results are compared to, for example, the Steiner et al. paper (<https://doi.org/10.1002/2015JC011232>) that I mentioned in my original comment. I would argue that an important question for understanding how Arctic NPP has changed between the current generation of models compared to the previous generation of models is understanding whether simulation of the observed deep CHL maxima has improved.

Given that the analysis of the depth CMIP6 CHL maxima is already in the results section now, a short paragraph in the discussion about how these results compare to papers that analyse the depth of CHL maxima in CMIP5 would tie this part of the story together well.

2. There are a few minor style corrections/typos to correct in some of the edits:

- The new Figure 2 is currently captioned as just “Fig 2” rather than “Figure 2”
- Typo on P2 line 25: (“region” should be changed to “regional”)

- P2 line 32: “Arctic Ocean NPP is projected to experience a continued increase in NPP” reads oddly. “The Arctic Ocean is projected to...”?
- P7 L2: “We did more individual model and regional analysis...” – consider rephrasing to make more formal.
- P7 L14: “Nitrate concentrations were extracted over the full water column, representing the upper 100m of the ocean” – it is unclear from this whether you used the full water column or just the upper 100m; please rephrase to clarify.
- P9 L3: check reference to “upper-100m NO₃”. I believe this now averaged over the MLD instead?
- P21 L19: “...CMIP6 projections point a reorganization...” should be “...CMIP6 projections point to a reorganization...”

(This is not intended as an exhaustive list, double check for minor typos.)

Technical Comments:

There are a few instances where changes to the manuscript have not appeared highlighted as edits in the track changes version. These are mostly on the first two pages of the document. The additions to the manuscript detailed in the Author Response are present in the new manuscript, just not highlighted as edits in the track changes version. I haven't found any problems with these edits other than that they're not flagged, but it may be worth double-checking that no intended extra changes have been missed.