

Answers to the reviewers

Dear Editor and reviewers, we first want to thank you for carefully evaluating the manuscript and giving us the opportunity to revise it accordingly. We carefully addressed each comment made by both reviewers. You will find below our point-by-point responses to each of these comments. Please find attached a clean and also a tracking changes versions of the manuscript. We hope that this version will be satisfactory and thank you for your time in this matter.

Yours sincerely,

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Reviewer #1

This manuscript explores in depth the effects of different sampling strategies for the under ice irradiance and transmittance used to calculate primary productivity using photosynthetic parameters. The use of profiling platforms provide a clear advantage to irradiance point measurements and should be further used for upscaling primary productivity estimates. The manuscript in general reads well, the figures are clear and the authors did a good job analysing a large dataset.

Comment C1

Why short incubations under two hours? The literature does not agree on this, so I wouldn't state it as "the better option". It depends if you want to measure gross or net PP among other things.

Answer A1

This part of the sentence has been removed.

Comment C2

This is confusing because photosynthetic parameters are also derived from ¹⁴C ¹³C in situ inoculated samples, the only difference is that they are incubated under a range of different irradiances and not just under one light intensity. This needs to be clarified because as it is it reads as if the ¹³C or ¹⁴C incubation method is not appropriate to measure PP.

Answer A2

This sentence in the last paragraph of the introduction has been re-worked so the reader to not have the impression that incubation method are not appropriate.

Comment C3

As you mention in your reply, this data was not used in the statistical analysis and therefore the lack of data on these two stations has no influence on the manuscript. I would add this information here.

Answer A3

This sentence has been removed. However, we still mention it in the figure caption, so the reader understand why some data is missing in the figure.

Comment C4

Specify the different irradiance levels used for the PE curve incubations.

Answer A4

The irradiance values were different for each experiment. We have added a few sentences in the method section and we are now giving the range of the maximum irradiance values used.

Comment C5

Add here the information that you provided in the answers to the reviewers, stating that this depth roughly coincides with the depth of the euphotic zone.

Answer A5

This was done.

Comment C6

The maximum depth of winter mixing determines the amount of nutrients available for that years PP which happens in spring-summer. So here you are talking about annual primary production and not about individual daily rates of carbon uptake which is what you are talking about before. The comparison is therefore not valid for your argument about the variability of daily PP.

Answer A6

The confusing sentence has been removed from the text.

Comment C7

Correct, but to constrain the variability in PP estimates and improve their accuracy, which is the aim of this paper, you need to take into account the variability in photosynthetic parameters due to all these factors. I know that in this paper you are just focusing on light, but you need to state somewhere that to improve the accuracy of PP estimates it is not only necessary, as you very nicely show, to improve our under-ice light field measurements, but also to have a seasonally and regionally extensive set of PE curves to constrain the variability due to nutrient availability.

Answer A7

We have added one sentence at the end of the discussion to emphasis on the importance of measuring a sufficient number of P vs. E curves under different nutrient conditions.

Comment C8

I am glad that you added this paragraph. What do you mean here by "dynamic? " Please specify.

Answer A8

We agree it was not clear. We reworked the sentence accordingly.

Comment C9

And a similar study to capture the variability of photosynthetic parameters should be conducted in the future to test if a handful of PE curves is enough to estimate PP

correctly or we need as many as we can get seasonally and spatially resolved to improve Arctic PP estimates.

Answer A9

A sentence has been added that acknowledge that more studies are needed to better understand the influence of P vs. E curve of the calculated estimates.

Comment C10

In your guideline to obtain the best possible estimates of primary production, you should remember the reader that the number of in situ PE curves measured is also very important to constrain the photosynthetic parameters under different nutrient conditions. If you only have one PE curve to calculate PP for the entire Arctic, the estimates will not be very accurate even if you have a super high resolution light transmission dataset.

Answer A10

We have added one more recommendation to acknowledge that one should acquire a sufficient number of P vs. E curves under different nutrient conditions that are representative for the region under investigation.