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Biogeosciences Discussions

Interactive comment on "Southern Ocean BGC-Argo Detect Under Ice Phytoplankton Growth Before Sea Ice Retreat" *by* Mark Hague and Marcello Vichi

Anonymous Referee #1

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The manuscript examines the "melt-water hypothesis", which hypothesizes that the melting of sea ice in austral spring allows for an increase in photosynthetically available solar radiation (PAR) and triggers a rapid growth in phytoplankton, by using in-situ observations obtained by the biogeochemical (BGC) Argo floats. Although many studies have invoked this hypothesis in explaining the initiation of the spring bloom, they find that the growth initiation (GI) occurs roughly a month before the sea ice starts to melt. They compliment their results with a box model numerical experiment showing that the observed time series can be explained by a combination of physical mechanisms modulating the permeability of the sea ice to PAR and physiological state of the phytoplankton. The paradigm they find where phytoplankton growth is occurring prior

to the melt of sea ice in the seasonal sea-ice zone (SSIZ) is new. I recommend the manuscript for publication with minor revisions listed below.

1. Lines 147-149: Have you looked at whether examining Chl-a below the mixed layer changes the timing of GI? Does the timing of GI differ from the 'onset' proposed by Behrenfeld and Boss (2018)?

2. Lines 175-177: I would like to see how iron and silicate (presumably being the limiting nutrients for diatom) vary over the course of your simulation. Is the ecosystem always light replete or do nutrients also become a limiting factor for growth in your simulation?

3. Lines 178-180: Could you add a figure/time series of the input variables (solar radiation etc.) to the model?

4. Line 220: Thank you for also examining particulate organic matter (POC). Could you add in text how you calculated POC from the BGC-Argo floats? Also, considering the capacity for photoquenching/photoacclimation, do you think POC is a more robust variable in quantifying the temporal variability in phytoplankton/biomass? The weaker dependence on different rates of cooling, as you note, seems to indicate so.

5. Figure 7: Could you comment on the systematic offset between the float data and the ICE/LLA simulations you see in panels C and D?

6. Lines 294-296, 345: The PAR condition seems to be a key factor in interpreting the float and model results. Is it possible to estimate the PAR under sea ice either using satellite data (Morel et al., 2017) or Argo floats? (I am not sure whether the floats you have examined have the instrumental capacity but some BGC-Argo floats measure also PAR.)

7. Lines 324-326: Can you comment on the role/impact of zooplankton in your box model experiments? Does grazing by zooplankton affect the GI timing?

References:

Behrenfeld and Boss. (2018) Student's tutorial on bloom hypotheses in the context of phytoplankton annual cycles. Global change biology, 24(1), 55-77.

Morel et al. (2017). Examining the consistency of products derived from various ocean color sensors in open ocean (case 1) waters in the perspective of multi-sensor approach. Remote sensing of Environment, 111(1), 69-88

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