

## ***Interactive comment on “Small phytoplankton contribution to the total primary production in the Amundsen Sea” by Sang H. Lee et al.***

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General Comments: The manuscript “Small phytoplankton contribution to the total primary production in the Amundsen Sea” by Lee et al. presents size-fractionated chlorophyll, particulate organic carbon/nitrogen, and carbon/nitrogen uptake rates in the Amundsen Sea to characterize the contribution of small phytoplankton. As the authors state, this type of data is lacking in the Amundsen Sea, yet is invaluable for understanding how the region might be altered by climate change. I commend the authors on the collection of a unique dataset, and given the importance of the data, would be excited to see this manuscript published in Biogeosciences. However, it is my opinion that it should be reconsidered after major revisions for the following reasons: - There are strong statements re. the future importance and driving mechanism of small phytoplankton in the Amundsen Sea based on limited evidence from that region, and rather

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extrapolated from other regions (more northern Western Antarctic Peninsula and Arctic Ocean). Ultimately I feel that the focus should primarily be on establishing a baseline dataset for the region on small phytoplankton, rather than predictions that cannot be supported by the data presented (i.e. data from one year) and instead are based on data from other regions. ⇒ We agree with the reviewer's opinion. So, we modified our manuscript to delete the prediction parts in line 36-38, page 2 and line 309-314, page 13 (please see our revised manuscript).

- There is seemingly an inconsistency (or at best, a lack of explanation) between the demonstrated importance of small phytoplankton outside the polynya region and the claim that small phytoplankton will grow in importance with climate change (won't the non-polynya region decrease in size with increased warming?). ⇒ Polynya and non-polynya regions are different systems with different environmental conditions so that we can not simply say that. That is a main reason for why we separated them in this study. Actually, the data in Figure 7 included all stations from polynya and non-polynya regions. Anyway, we modified our manuscript to delete the prediction parts.

- There is a large focus on the comparison of data inside and outside of the polynya region, but with limited justification for this comparison, or discussion of how the polynya may be altered by climate change. Ultimately I agree that this comparison is valuable, but primarily in the context of establishing a baseline dataset for the region. ⇒ We agree with the reviewer's opinion. So, we modified our manuscript to delete the prediction parts in line 36-38, page 2 and line 309-314, page 13.

- The Results section needs to be reorganized (see suggestions below). ⇒ We reorganized as reviewer suggested throughout the result section.

- There are numerous grammatical errors, some of which I have identified in the "Technical Corrections" section. ⇒ We checked and revised the grammatical errors throughout the text.

Specific Comments: - Lines 54-62: I think it is important to indicate that Ducklow et al.

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(2007) and Montes-Hugo et al. (2009) detail the western Antarctic Peninsula (WAP) that is a focus of the LTER (north of  $\sim 68^{\circ}\text{S}$ ), and do not include the Amundsen Sea region.  $\Rightarrow$ We indicated that in line 56-57, page 3.

- Line 71: “in response to a regional warming trend” - I think this wording is too strong. Moline et al. (2004) note the association between cryptophytes and low salinity water (likely glacial meltwater), and hypothesize that cryptophytes will increase in importance given the predicted regional warming trend. Regarding the association between cryptophytes and glacial meltwater, Moline et al. (2004) suggest that this is salinity driven (they cite studies demonstrating cryptophytes tolerate/prefer lower salinity water), a point that Moline made nearly a decade earlier (Moline and Prezelin 1996, MEPS).  $\Rightarrow$ We deleted the sentence.

- Lines 71-73: re. an example of food web alteration due to a shift in phytoplankton community composition to smaller cells at least provide the example that krill do not feed efficiently on cryptophytes (see Moline et al. 2004 for references).  $\Rightarrow$ We further discussed on that in line 321-325, page 13.

- Line 79: “environmental conditions” - could this not simply be referred to as climate change?  $\Rightarrow$ Yes, it could. We revised it in line 81-82, page 4.

- Line 82: Consider renaming, e.g. “Water samples”.  $\Rightarrow$ We renamed it in line 85, page 4.

- Results section: this section is very tedious to read. Perhaps that is unavoidable given the results presented (essentially a long list of averages and standard deviations). However, I think it would benefit tremendously from some reorganization. All statistics should be reported in a consistent manner, e.g. range followed by mean  $\pm$  SD in parentheses. Additionally, each topic has the same info presented, e.g. total/small cells, % contribution, inside/outside polynya. I think it would help guide the reader if this info was presented in a consistent order for each topic.  $\Rightarrow$ We revised the result section as suggested.

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- Lines 273-275: The authors present strong evidence that small phytoplankton contribute more in the non-polynya region than the polynya region. How might we expect the polynya to be altered with climate change? It seems reasonable to expect that the non-polynya region will decrease in size, and thus reduce the contribution of small phytoplankton. This is inconsistent with the stated motivation and implications of the paper (i.e. an increase in the contribution of small phytoplankton, and resulting decrease in primary production), and needs to be addressed. ⇒Actually, polynya and non-polynya regions are different systems with different environmental conditions so that we can not simply expect that. Actually, our non-polynya stations were not an ice free open ocean in this study (see Figure 1). Increasing polynya region altered with climate change could cause different conditions from previous original conditions. That is a main reason for why we separated them in this study. The data in Figure 7 included all stations from polynya and non-polynya regions.

- Lines 299-304: the prediction of Moline et al. (2004) for an increase in the contribution of smaller phytoplankton with expanding meltwater is for the portion of the WAP that is a focus of the LTER (north of 68S), and did not explicitly include the Amundsen Sea region. Do the authors have any evidence specific to their region of interest for a potential shift to smaller phytoplankton, as well as a driving mechanism? If not, I do not think they can make strong statements re. the future of Amundsen Sea phytoplankton community composition, as well as its impact on primary production (using the relationship in Fig. 7). ⇒We deleted the sentence.

- Lines 305-315: this discussion should include the fact that krill do not efficiently feed on small phytoplankton (see Moline et al. 2004 for references). ⇒We further discussed on that in line 323-325, page 13.

Technical Corrections: - Lines 18-19: "Small-sized phytoplankton : : : ocean condition."  
- rephrase. ⇒We rephrased that in line 18-19, page 2.

- Line 45: refer to Fig. 1. ⇒We referred to Fig. 1 in line 45, page 3.

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- Line 65: “In an expecting : : :” - rephrase. ⇒We rephrased that in line 67, page 3.
- Line 67: “In consistent : : :” - rephrase. ⇒We rephrased that in line 69-71, page 3.
- Line 73: “higher trophic levels” and “subsequent food web” are redundant. ⇒We deleted subsequent food web in line 322, page 13.
- Line 76: “what extend” - rephrase. ⇒We rephrased that in line 79, page 4. - Line 78: “marine ecosystem : : : ongoing changes” - rephrase. ⇒We rephrased that in line 81-82, page 4.
- Lines 83-88: refer to Fig. 1 in here somewhere. ⇒We referred to Fig. 1 in line 87, page 4.
- Lines 91-22: “were belong” - rephrase. ⇒We rephrased that in line 95, page 5.
- Line 95: “biological and chemical property” - please be specific. ⇒Actually I tried to mention that other researchers collected water samples for their own biological and chemical research. We deleted that since it might be confused.
- Lines 109-113: the information re. the isotope tracer technique, light depths, and light sensor was already provided. ⇒We deleted the same information in line 113-117, page 5.
- Lines 137-138: “integrated from six different light depths” - change to “depth integrated”? ⇒We changed it to depth integrated in line 141, page 6, line 163, page 7, and line 183, page 8.
- Lines 141-143: “In the Amundsen Sea : : : 2014 : : :” – unnecessary info (the cruise location and date has already been specified). ⇒We deleted unnecessary info in line 146-147, page 7.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/bg-2016-453/bg-2016-453-AC2->

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