We gratefully thank referee #2 for the constructive comments on the manuscript. To improve the final version, we amended the manuscript as suggested by the referee to our best.

General comments:

1. When errors in primary production estimation were investigated, authors used modeled chl.a. The chl.a modeling uses parameters of each category, but large deviation around clear SCM was shown. Is this affect estimation error in post-bloom PP? Could you show the error in modeled chl.a profile and impact on PP estimation?

Response: We calculated the impact of the deviation in modeling the vertical chl a profiles on PP estimates. We focused specifically on the post-bloom period (Fig. 6), when the largest deviations reached ± 20% in depth-integrated PP estimates, as you mentioned. However, these deviations remain negligible in annual PP estimations. This paper already contains a lot of results on uncertainties in PP estimates (due to the SCM omission; see Table 6 and Section 3.3) or validation of the PP algorithm (see Appendix A1). We did not want to add these uncertainties in the Table 6. However, we added this additional information on the uncertainties due to the errors on the shape of the vertical chl a profiles in the revised version of the manuscript (see section 3.3). Otherwise, the errors in modeled chl a profiles are already presented in the Figures 4, 6 & 7 by the green reds (i.e. standard deviation).

2. Sensitivity analysis of PP models (3.3) is confusing. I guess that authors should compare modeled PP with in situ PP (as Fig. A1) between homogeneous chl.a profile and presence of SCM. Percent change in Table 6 is probably difference between modeled values with SCM and those without SCM.

Response: The percent changes in Table 6 show the difference between modeled values with SCM and those without SCM, as indicated in the reviewer's comments. Some improvements have been made to the legend of Table 6 and the manuscript (section 3.3, first paragraph) to clarify the text.

3. As shown in Fig. A1, most of the derived PP is within a factor of two. It means that errors in PP estimation is +100% and -50%. Is it possible to reduce this error if SCM is considered in PP model?

Response: The determination of derived-PP still remains challenging in marine waters (Friedrichs et al., 2009; Saba et al., 2011), and more particularly in Arctic waters (IOCCG report, in prep.). Appendix A1 is dedicated to the validation of the depth-integrated PP algorithm. Several parameterizations of the absorption coefficient were tested to estimate light propagation and to highlight the importance of using adequate photosynthetic parameters specific to Arctic phytoplankton communities (see lines 20 p. 1370 – lines 12 p.1371). Furthermore, an evaluation of the model was performed using several statistical indices (see lines 3-16 p. 1372), commonly used to validate PP models (Campbell et al., 2002; Friedrichs et al., 2009; Saba et al., 2011). In this validation, we used measured vertical profiles of chorophyll a and primary production. The aim of the Appendix A1 was not to estimate errors associated with the presence or absence of SCM. This aspect has been treated specifically in the Section 3.3, which has been improved based on the comments of the reviewer (see Section 3.3).

4. Please discuss about estimation errors in chl.a concentration due to CDOM and NAP

Response: In Appendix A1, we briefly discussed the role of CDOM or NAP on light propagation *and the choice of the parameterization of the absorption coefficient. We showed the difficulty to generate correct light propagation and to estimate the CDOM based on chlorophyll concentration. As a result, we used the surface salinity as a predictor of CDOM absorption. We are aware of the bias in estimating chlorophyll a concentration when CDOM is present, particularly using current algorithms for Arctic remote sensing studies (Arrigo et al., 2011; Ben Mustapha et al., 2012; Antoine et al., 2013; IOCCG, in prep.). The scope of this paper was mainly focused on the vertical chlorophyll a distribution based on in situ chlorophyll measurements and the potential errors in PP estimations. Unfortunately, we did not have access to a similar database of in situ CDOM and NAP absorption coefficients. The difficulties to estimate errors in chlorophyll a concentration associated with CDOM and NAP contaminations were not discussed in this manuscript due to the lack of in situ data.*

5. If possible, please write results and discussion separately.
Response: We decided to merge the results and discussion sections to keep the manuscript short with concise sentences.

<u>Specific comments:</u>
p.1350 line 17: Did you carry out any quality check or validation on chl.a concentration itself between methods (acidification and non-acidification, HPLC, and so on)?
Response: This is a good question. Several studies are using the same database (Arrigo et al., 2011; Matrai et al., 2013; Hill et al., 2013). First, we followed the same criterion as in Hill et al. (2013) (i.e. only total chlorophyll a values were used). Secondly, we normalized the vertical chl a profile by the averaged chl a concentration of the vertical chl a profile (see Eq. 2). This step reduces uncertainty related to different methods and analytical protocols. However, we are aware that intrinsic and potential biases related to the dataset are unavoidable and caution is recommended in the interpretation (see lines 10-11, p.1350).

p.1351 line 3: Is data during the Arctic winter needed for analysis? Because the chl.a in winter is impossible to detect from satellite.
Response: We agree with the reviewer's comment that chl a in winter is impossible to detect from satellite. However, these results were useful: (1) to describe the general pattern in vertical chlorophyll a distribution during the winter period, which shows chlorophyll a maxima at the surface (see Fig. 5; formerly Fig. 4), and (2) to compare the vertical chlorophyll distribution and associated errors in PP estimations with the study of Arrigo et al. (2011) during the winter period (see Table 3). Unlike Arrigo et al. (2011), we found that the highest percent of underestimation in PP occurred uniquely during the post-bloom period (see Section 3.3 and Table 6).

p.1351 line 17: What is the chl *a* normalized with? If you put equation (2) just below equation (1), this is easy to understand.
Response: *We referred to the Equation (2), directly after the Equation (1) to help the understanding of the paragraph and the normalization of the chlorophyll a.*

p.1353 line 16: You separated time periods by month and called pre- and post-bloom. Is this meaning that phytoplankton bloom between April and May?

Response: This question was also raised by referee #1. See our response in our report to referee #1.

Line 149 to 159: I am a little confused about this paragraph. Are the data separated into pre-bloom, post-bloom and winter purely by the calendar month? Irrespective of the location or ice cover? I ask because a location with complete ice cover in April or May would not be characterized as in the post-bloom phase. Also is there no bloom phase? Later in the paragraph it is stated that the temporal threshold between pre- bloom and post-bloom was defined as the time period when surface Chl a is highest, so were the periods calculated individually for each station? I need a little more clarity in this section.
Response: For clarity, the section ii) of mentioned paragraph was rewritten. Here are the revised sentences: 'ii) The dataset was partitioned into the following three separate time periods: pre-bloom (February-April), post-bloom (May-September) and winter period (October-December). For the development of the empirical model, however, the partitioning of the time periods is based on the conceptual scheme illustrated in Figure 4, which depicts the annual cycle of the $\mathrm{chl}\,a_{\mathrm{surf}}$ *concentration throughout the growing season. The temporal threshold between the pre-bloom and the post-bloom periods was defined as the annual highest* $\mathrm{chl}\,a_{\mathrm{surf}}$ *value when the spring bloom reaches its paroxysm (Fig. 4). Hence, the empirical model does not contain a specific period of spring bloom. When the sea-ice free period is long enough, a fall bloom is expected, owing to nutrient replenishments at the surface layer by forcing events (i.e. convective mixing and upwelling) during the late season. The temporal threshold between the post-bloom and winter period was defined as the time when daylight becomes less than nine hours. This threshold corresponds to the approximate length of photoperiod below which the SCM is no more observed within any bin (data not shown). In addition, a flowchart showing the partition and the use of the database has been added to improve clarity (see new Fig. 3).*

Table 6: "The contribution of the different periods...." Is this "Contribution of SCM" (p.1364 line 24)?
Response: As written in the general comments (2.2), some modifications have been made to the legend of Table 6 and the manuscript (section 3.3, first paragraph) to facilitate the reader's comprehension.

Could you show a flow chart to derive vertical profile of chl *a*?
Response: A flow chart has been added (see new Fig. 3).

References cited in the Responses section:

Antoine, D., Hooker, S. B., Bélanger, S., Matsuoka, A., and Babin, M.: Apparent optical properties of the Canadian Beaufort Sea - Part 1: Observational overview and water column relationships, Biogeosciences Discuss., 10, 4025-4065, 2013.

Ben mustapha, S., Bélanger, S., and Larouche, P.: Evaluation of ocean color algorithms in the southeastern Beaufort Sea, Canadian Arctic: new parameterization using SeaWiFS, MODIS and

MERIS spectral bands, Can. J. Remote Sens. 54, 535–556, 2012.