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Interactive comment on "Spring phytoplankton communities of the Labrador Sea (2005–2014): pigment signatures, photophysiology and elemental ratios" *by* Glaucia M. Fragoso et al.

Glaucia M. Fragoso et al.

glaucia.fragoso@noc.soton.ac.uk

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We thank the reviewer for his/her comments and suggestions, which we feel have greatly improved the manuscript. Below we respond to each comment in detail. RC refers to "Reviewer's Comments" and AC to "Author's comments". We have enumerated the reviewer's comments to organise better our responses.

Reviewer #3:

RC3.1 - The manuscript "Spring phytoplankton communities of the Labrador Sea (2005-2014): pigments signatures, photophysiology and elemental ratios" present a time series of pigments and nutrients data in the Labrador Sea from 2005 to 2014. The

authors use the CHEMTAX method to interpret the pigment dataset in term of phytoplankton groups and then to describe the distribution of these phytoplankton groups. Oceanographic provinces of the Labrador Sea are identified using on physical and biogeochemical parameters as well as phytoplankton diversity. Several statistical approaches based on clustering, ordination plot and regression were used to link the distribution in time and space of the phytoplankton with the environmental parameters. Finally, several physiological parameters related to the phytoplankton communities were measured (P curves, POC/PON, POC/POC Chla) or extract from the pigments distribution (AP/Chla, photoprotective pigments). The physiological information is used to go further in the explanation of the link between the phytoplankton community's distribution and the environmental conditions.

General comments: The introduction is not well structured and full of too heavy and unclear sentence.

AC3.1 - We have now rewritten and reduced the introduction to provide better focus. Please see the response to reviewer #2. We have attached the new version of the introduction as a pdf file.

RC3.2 - But, the manuscript goes better in the result and discussion section. The results section is clear with a good choice of graph. Sometimes, it was difficult to get the point of the use of methods and the information that sort from some data.

AC3.2 - We have now changed and improved the methods section for better clarification by adding further explanation of the use of the different methods to examine the data.

RC3.3 - Finally, the discussion put together in a clear way all the information in the results section and brings interesting information to parameters that were of unclear utility in the result section. The authors highlight the specificity of the species and explained their success in the different regions and use well the comparison with the literature. I recommend important change in the introduction to make it more fluent, to better extract the key information and topics of each sub-paragraph. The sentences are generally way too long and confusing. Most of them could be cut in two parts. There are several mistakes on the use of superlative in the results section. The discussion is well conducted and uses interestingly the results

AC3.3 – Thanks for the suggestions. The introduction has been shortened and sentences are now condensed.

RC3.4 - Specific comments by section Introduction L51: better to use “structure”

AC3.4 - Changed.

RC3.5 - L51: change the order to “functional role in the community”

AC3.5 - We have removed “in the community” to avoid redundancy.

RC3.6 - L 54 to 59: there is some redundancy with the lines 51-53

AC3.6 - We have now changed/reduced the introduction and shortened the sentences, so this redundancy does not exist anymore.

RC3.7 - L59 to 64: Unclear about the conservation or not of the stoichiometry. You said the “stoichiometry is consistent phylogenetically” and latter you mentioned, “they may vary (. . .) phenotypically within species”. Be more precise on when the ratios are conserved or not.

AC3.7 - Further clarification, these sentences have been rewritten. They would be rewritten as such:

Line 59 – “Patterns of phytoplankton stoichiometry may be consistent phylogenetically and within higher taxonomic levels (Ho et al., 2003; Quigg et al., 2003). However, phytoplankton stoichiometry has also been reported to vary according to nutrient supply ratios (Bertilsson et al., 2003; Rhee, 1978), as well as phenotypically within species from the same population (Finkel et al., 2006).” RC3.8 - L70 “shelves and the basin”

AC3.8 - This sentence has been removed.

RC3.9 - L75-76: I don’t think the interest to study the phytoplankton is to use it as an index of waters masses since simple parameters as temperature and salinity did a good job. It appears to me more important to highlight the possible importance of the biogeography on the biological pump, carbon export or the energy transfer to upper trophic level.

AC3.9 - We agree with the reviewer and have rewritten these lines to focus on ocean biogeochemistry and marine ecosystems. See below. Line 73. “Fragoso et al. (2016) showed that the biogeography of phytoplankton communities in the Labrador Sea during spring and early summer is shaped by distinct species found in Atlantic or Arctic waters, which may have a distinct impact on the biogeochemical cycles and transfer of energy to higher trophic levels. However, these authors focused on species taxonomy and investigated only the larger phytoplankton (> 4 μm). The photo-physiological and biogeochemical signatures, such as elemental stoichiometry (C:N ratio), of these spring phytoplankton communities occurring in distinct sectors of the Labrador Sea has not been previously investigated.” RC3.10 - L78-84: The same idea is repeated. Please reduce the size of the sentence, too much utilization of the conjunction “and”.

AC3.10 - This paragraph has been removed to shorten the introduction overall.

RC3.11 -L82: could simplify “high-latitude Arctic/Atlantic waters” by “polar waters”.

AC3.11 - This paragraph has been removed.

RC3.12 -L100: redundancy with the line 88-90

AC3.12 - Line 88-90 refers to analysis of pigments using the HPLC while line 100 refers to CHEMTAX analysis of pigment data; hence we do not see them as redundant.

RC3.13 -L93: Please precise the concept of “functional cell size”

AC3.13 - This sentence has been removed from the introduction.

RC3.14 -L94-95: “assemblage dominance”: wrong, it’s the dominance of phytoplankton groups and not assemblages

AC3.14 - This sentence has been removed from the introduction.

RC3.15 -L95: remove “however”

AC3.15 - Changed.

RC3.16 -L99: remove the comma.

AC3.16 - Changed.

RC3.17 -L107: “comprehensively understand” is a pleonasm.

AC3.17 - The word “comprehensively” was removed.

RC3.18 -L108-L111: you repeat the same information than the line 106-108.

AC3.18 - his paragraph has been reduced.

RC3.19 -Methods

There is some confusion on the water composition of the Labrador Sea. Moreover the authors depicted as well deep and shallow currents and water masses. The authors should focus on the surface and sub-surface water-masses and circulation since the pigment dataset presented here concerned only the upper 10m.

AC3.19 - We believe that the reviewer is referring to the Irminger Current (IC). The IC is described as a surface current (see Hauser et al., 2015; Yashayaev and Seidov, 2015), however the WGC may occasionally “slide” over the IC in the central-eastern part of the Labrador Sea and form a “tongue” of fresh, cold and less dense water. The lateral advection of this tongue (i.e. how offshore it goes) varies inter-annually during spring. We have used a T-S diagram to discern these water masses (IC, LC and WGC, see Figure 5a). As the reviewer has noted there were some relatively warm (> 3°C) and salty (> 34) water found at the surface. We refer to this as part of the IC, although it might have been slightly modified due to the highly dynamic features of surface wa-

ters, which includes influence of precipitation/evaporation, meltwater, riverine input and mesoscale eddies. Although the IC is “conserved” at mid-depth waters (200-600 m), it does reach the surface, however it becomes “modified” due to the factors already mentioned.

RC3.20 - L115: “transition zone between the Arctic and . . .”

AC3.20 - Changed.

RC3.21 - L115: Newfoundland is not really the southern boundary. The North Atlantic is the southern boundary.

AC3.21 - We have now defined the limits of the Labrador Sea according to the International Hydrography Organisation. See below.

Line 115 – “It is bounded by Davis Strait to the north, a line from Cape St. Francis in Newfoundland (47°45' N, 52°27'W) to Cape Farewell (southern tip of Greenland) to the southeast and the coast of Labrador and Newfoundland to the west (Fig. 1) (International Hydrographic Organization, 1953).”

RC3.22 - L119: The lower limit of the Greenland Shelf (ie 2500m) sounds very deep to characterize a shelf! I think you characterize the extension of the Greenland Current here.

AC3.22 - We apologise for the confusion. We were referring to the Greenland shelf and slope and not just the shelf. We have corrected this now. See the sentence rewritten below.

Line 116 – “The bathymetry of the Labrador Sea can be subdivided into the wide continental shelf and relatively gentle continental slope on its western side (the Labrador Shelf, > 500 km and < 250 m deep) and narrow shelf and very steep continental slope on the eastern side (the Greenland Shelf and Slope, < 100 km and < 2500 m deep).”

RC3.23 - L122: remove “mostly”

AC3.23 - Changed.

RC3.24 - L122: The Irminger current is not the main water masses of the Labrador Basin since this current it is confined on the east and west borders of Labrador Basin at a mid-depth (200-600m). The Labrador Sea Water composes the water of the basin and their characteristics are mainly influenced by the winder convection with the deeper water masses (see the work of Yashayaev et al.).

AC3.24 - We apologise for the confusion in this section. We were referring to surface hydrography only. As discussed above (AC 3.19), the WGC often "slides" over the IC, creating a broad and thin layer of fresh and cold water, usually observed in the central-eastern section of the AR7W transects. On the western part of the section the IC intrudes into upper waters. This is observed in the T-S diagrams when salty (> 34) and warm (> 3°C) waters of Atlantic origin are found at the surface. We have rewritten this paragraph for clarification. See below.

Line 121. "The upper Labrador Sea (< 200 m) is comprised of waters originating from the North Atlantic and the Arctic (Yashayaev, 2009). Atlantic-influenced waters occur mostly in the central Labrador Sea, where waters are relatively warm, salty and mainly identified as the Irminger Current (IC). Cold, low salinity waters originate from the Arctic via the surrounding shelves and are mainly identified as the Labrador Current (LC) and the West Greenland Current (WGC) (Fig 1). Circulation in the central basin of the Labrador Sea is complex, often showing a gyre-like flow system that alternates in direction (Palter et al. 2016, Wang et al, 2016). The inshore branch of the LC overlies the Labrador Shelf and includes Arctic waters originating from Baffin Bay and the Canadian Arctic Archipelago via Davis Strait and from Hudson Bay via Hudson Strait, together with inputs of melting sea ice, which originate locally or from farther north. The main branch of the LC flows along the Labrador slope from north to south and is centered around the 1000 m depth contour. It is composed of a mixture of Arctic water from Baffin Bay via Davis Strait and the branch of the WGC that flows west across the mouth of Davis Strait. The WGC, which flows from south to north over the

Greenland shelf and along the adjacent slope, is a mixture of cold, low salinity Arctic water exiting the Nordic Seas with the East Greenland Current (EGC) (Yashayaev, 2007), together with sea ice and glacial melt water (Fig 1). The WGC often spreads westwards, forming a "tongue" of buoyant fresher water, with the accumulation of low salinity waters, driven by high eddy kinetic activity in the central eastern Labrador Sea during spring (Frajka-Williams and Rhines, 2010). The WGC often floats over the IC in the central-eastern part of the Labrador Sea, however, the IC is usually observed in surface waters of the central-western Labrador Sea during spring. More detailed descriptions of the hydrography of the Labrador Sea can be found elsewhere (Fragoso et al., Head et al. 2013, Yashayaev and Seidov, Yashayaev 2007)."

RC3.25 - L123: There is no evidence than the cold fresh after originated from Arctic contribute substantially to the deep basin since the front between the basin and the shelf is very strong. Part of the VITALS program using gliders is actually studying the exchange between the basin and the Labrador Shelf (B. De young, J. Palter et al.).

AC3.25 - We have changed this paragraph for clarification. We now refer to the upper Labrador Sea layers (< 200 m) that are comprised of waters originating from the North Atlantic (IC) and the Arctic (LC and WGC). See the response above (AC3.23).

RC3.26 - L134: "Data used in this study"

AC3.26 - Changed.

RC3.27 - L134: remove "from stations" and "repeat".

AC3.27 - Changed.

RC3.28 - L146: Choose between "surface" or "near-surface" and stick to it all along the manuscript.

AC3.28 - We have chosen to refer to surface waters throughout the entire manuscript.

RC3.29 - L155: Maybe add the underline word "Back in the laboratory, POC/PON samples. . .”

AC3.29 - Changed.

RC3.30 - L171: I think the good way to describe the CHEMTAX output is “relative abundance” instead of “ratios of abundance”

AC3.30 - Changed.

RC3.31 - L173: not clear if all the pigments ratios are from the literature.

AC3.31 - We have added a sentence to the Table legend mentioning that the pigment ratios were extracted from the literature. See the pdf attached in the response letter for reviewer #1, where we have added a new version of this table and legend.

RC3.32 - L174: Please indicate how the algal groups present in the study area are identified.

AC3.32 - The identification is described in full in Fragoso et al. (2016). We have now included this reference in this sentence of the manuscript. See below.

Line 174 – “. . .pigment concentrations of algal groups that are known to be present in the study area as reported in Fragoso et al (2016)”.

RC3.33 - L187: remove “that”

AC3.33 - Changed.

RC3.34 - L190: explain here the purpose of the fourth-root transforamation.

AC3.34 - An explanation has now been included. See line the sentence rewritten below. Line 189. – “. . .were standardized and fourth-root transformed before being analysed. Due to the high abundance of diatoms in the data, we have decided to apply a fourth-root transformation to increase the importance of less abundant groups, which would allow us to better discerning the spatial-temporal patterns of the phytoplankton communities in the Labrador Sea.”

RC3.35 - L195: “higher” than what? Be careful to compare with something when you use a superlative.

AC3.35 - This word was changed to “high”.

RC3.36 - Results L277: “less well stratified”. . .“at those stations where”

AC3.36 - Changed.

RC3.37 - L278: replace “during” by “in”

AC3.37 - Changed.

RC3.38 - L279: “more highly stratify”: pleonasm again. . .

AC3.38 - We have removed the word “more” from the sentence.

RC3.39 - L281: “higher”: then superlative to be compared with something.

AC3.39 - We have removed the parenthesis in this sentence so it is changed to: “. . .POC:PON ratios were also higher > 8. . .”

RC3.40 - L288: Not clear if the “pairwise analysis” you mentioned refer to the ANISOM one-way pairwise?

AC3.40 - We have changed the sentence to: “Pairwise one-way analysis of similarity (ANOSIM) between clusters. . .”

RC3.41 - L289: too long sentence, please reduce or cut in two parts. Parentheses are at the wrong place.

AC3.41 - We have now split the sentence into two. See below.

Line 287 - “Pairwise one-way analysis of similarity (ANOSIM) between clusters suggested that they were significantly different in terms of algal pigment composition ($p = 0.001$). However, pairwise analysis of clusters C3a and C3b showed that these groups were more similar in composition (R statistic = 0.33) than other clusters (R statistic values approached 1) (see Clarke and Warwick, 2001).”

RC3.42 - L298: “especially” is useless here. In general, there is an over utilisation of adverbs in the text (mostly/especially…).

AC3.42 - The word “especially” was removed from this sentence.

RC3.43 - L313: superlative!! No subject of comparison…

AC3.43 - We have rewritten this whole paragraph. See comment below (AC.3.44). RC3.44 - L315: superlative again. Wrong use.

AC3.44 - We have rewritten this paragraph. See lines the rewritten paragraph below.

Line 311. “In general, chlorophytes and diatoms (cluster C3a) were associated with the inshore branch of the Labrador Current (LC), on the Labrador Shelf. Surface waters from the LC were the coldest (temperature < 2°C) and least saline with the lowest density (σÆ§ of most stations approximately < 26.5 kg m-3) of all the surface water masses of the Labrador Sea (Fig. 5a). Mixed assemblages (cluster C3b), as well as blooms (chlorophyll average = 4 mg Chla m-3) of dinoflagellates and diatoms (cluster C2) were associated with the Atlantic water mass, and the Irminger Current (IC) (Fig. 5a). These were the warmest (temperature > 3°C), saltiest (salinity > 34) and densest (σÆ§ of most 315 stations < 27 kg m-3) surface waters of the Labrador Sea (Fig. 5a).”

RC3.45 - L321-324: Too long sentence make it confusing. Separate in two sentences?

AC3.45 - This sentence was split into two. See below.

Line 321. “The ordination diagram revealed that stations from each distinct clusters are concentrated in different quadrants (Fig. 5b). The arrows in the ordination diagram represent the environmental variables. Positive or negative correlations indicate that the arrows are orientated parallel to the distribution of cluster stations with the strength of the correlation proportional to the arrow length.”

RC3.46 - L340: The table 4 is difficult to understand and could earn a better presenta-

tion.

AC3.46 - We have now reorganised Table 4, separating it into Table 4a and Table 4b. See the response to the reviewer #2 (AC2.48), where we add a new version of this table. Further explanation is given in new paragraph of the manuscript and in the revised legend of Table 4 (Line 963).

Line 339. “Table 4a indicates that the first axis (x-axis) of the redundancy analysis explained most of the variance (83.5 % of species-environment relationship; taxa-environmental correlation = 0.68). Summed, the canonical axes explained 99.8 % of the variance (axis 1, p = 0.002; all axes, p = 0.002) (Table 4a), which indicates that the environmental variables included in this analysis explained almost 100 % of the variability. Forward selection showed that five of the six environmental factors (silicate, temperature, salinity, nitrate and phosphate) included in the analysis best explained the variance in phytoplankton community composition when analysed together (p<0.05, Table 4b). When all variables were analysed together (conditional effects, referred to as λa in Table 4b), silicate was the most significant explanatory variable (λa = 0.2, p = 0.001), followed by temperature (λa = 0.05, p = 0.001), salinity (λa = 0.02, p = 0.002), nitrate concentration (λa = 0.01, p = 0.016) and phosphate concentration (λa = 0.02, p = 0.002) (Table 4). Stratification Index (SI) was the only explanatory variable that had no statistical significance in explaining the distribution of phytoplankton communities (Table 4b).” Line 963. “Table 4 – Results of the Redundancy Analyses (RDA) with the eigen-values, taxa-environmental correlations and percentages of variance explained used in the analysis (a). Automatic forward selection (a posteriori analysis) was used to determine the environmental variable(s) that best explain the variance of the data (b). The subset of environmental variable(s) that significantly explained phytoplankton distribution are referred to marginal effects (λ1) when analysed individually, or conditional effects (λa) when analysed additively in the model (b). Explanatory variables are temperature (°C), salinity, nitrate (NO3-; μmol L-1), phosphate (PO43-; μmol L-1), silicate (Si(OH)4; μmol L-1) and Stratification Index (SI) (kg m-4). Significant p-values

($p < 0.05$) represents the variables that explain the variation in the analyses." RC3.47 - L345: there is a problem, the title is the same than 3.3!!

AC3.47 - The title has now been updated to "Phytoplankton distributions and elemental stoichiometry".

RC3.48 - L344-352: Please present the POC-PON relationships somewhere.

AC3.48 - We are not sure what the reviewer means by this comment, but POC:PON relationships are shown in Figure 6a and has been referred to in line 351.

RC3.49 - L354: Please quickly explain the purpose of calculating the relationships between POCphyto and POC:PON.

AC3.49 - We have now added a short explanation of the purpose of studying the relationships between POCphyto and POC:PON. See the sentences rewritten below.

Line 354 - To investigate the influence of phytoplankton community structure on the stoichiometry of particulate organic material of surface Labrador Sea waters, the relationships between POCphyto (the estimated proportion of POC from phytoplankton) and the ratio of POC to PON were examined. In general, different phytoplankton communities had distinct relationships between POCphyto and POC:PON. Stations in the shelf regions . . ."

RC3.50 - L359: I would say, ". . .contribute for a high proportion. . ."

AC3.50 - Changed.

RC3.51 - L362: superlative lower (use low or compare to something).

AC3.51 - We have now included an object of comparison in this sentence. See the sentence rewritten below.

Line 362. "Stations influenced by Atlantic waters had generally lower contributions of POCphyto compared to Arctic-related waters, with most stations having POC:PON

ratios < 6.6 (Fig. 6c)."

RC3.52 - Discussion L392: as noted earlier in the manuscript, the surface phytoplankton didn't growth in the Irminger water since this water mass is observed only the slope and at great depth.

AC3.52 - In the central-eastern part of the Labrador Sea, the IC is found below the WGC "tongue", as the reviewer mentioned. However, in the central-western region the IC is found at the surface so phytoplankton are growing in these different water masses (IC, LC, WGC). Phytoplankton species found in the IC are usually found in Atlantic waters, while polar species are found in the LC and WGC (see Fragoso et al 2016).

RC3.53 - L396-397: Here the concept of ecological succession should be better presented. Is the variation between a deep and shallow mixed layer associated to the season or the two conditions (shallow/deep mixed layer) can be observed at the same time of the year?

AC3.53 - Part of this paragraph has been rewritten to clarify the seasonal and temporal patterns of phytoplankton communities. See below.

Line 390 – "In this study, our assessment of phytoplankton pigments from surface waters of the Labrador Sea during spring/early summer are based on a decade of observations and show that the distribution of phytoplankton communities varied primarily with distinct waters masses (Labrador, Irminger and Greenland Currents). However, a temporal succession of phytoplankton communities from the central region of the Labrador Sea was observed as waters became thermally stratified from May to June. Major blooms (Chla concentrations > 3 mg Chla m-3) occurred on or near the shelves in shallower mixed layers (< 33 m, Table 5). Diatoms were abundant in these blooms, however they co-dominated with 1) chlorophytes in the west (mostly in the Labrador Current) and 2) Phaeocystis in the east in the West Greenland Current. A more diverse community with low chlorophyll values (average Chla concentrations ∼2 mg Chla m-3,

Table 5) was found earlier in the season (May) in deeper mixed layers (> 59 m, Table 5) of the central basin. Once these waters of the central basin became thermally-stratified (June), a third bloom co-dominated by diatoms and dinoflagellates occurred, revealing an ecological succession from mixed flagellate communities. These patterns are similar to those seen in other shelf and basin regions of Arctic/subarctic waters (Coupel et al., 2015; Fujiwara et al., 2014; Hill et al., 2005)."

RC3.54 - L401-403: A link is missing between this information and the above sentence.

AC3.54 - This sentence has been rewritten for clarification. See lines this paragraph rewritten below.

Line 398. "It is well known that diatoms tend to dominate in high-nutrient regions of the ocean due to their high growth rates, while their low surface area to volume ratios mean that they do not do as well as smaller nano- or picoplankton in low nutrient conditions (Gregg et al., 400 2003; Sarthou et al., 2005). The Labrador Sea is a high-nutrient region during early spring due to the deep winter mixing (200 – 2300 m) that provides nutrients to the surface layers. High nutrient concentration supports phytoplankton spring blooms, particularly those dominated by diatoms, once light becomes available (Fragoso et al., 2016; Harrison et al., 2013; Yashayaev and Loder, 2009)."

RC3.55 L406: "often" and "as well" mean the same here. Please remove one of the two.

AC3.55 -We have changed the word "often" to "occasionally" to clarify the sentence.

RC3.56 L470: I would prefer to use the mean POCphyto rather than POC>. . .The latter formu- lation is not really comparable since we don't know the dispersion of the data.

AC3.56 -The dispersion of the data of POCphyto/total POC and POC:PON ratios are shown in Figure 6c and 6b, respectively. We have now referred to the figure in the text. See line the sentence rewritten below.

Line 469. "In this study, highly productive surface waters of Arctic origin (near or over

the shelves) had higher phytoplankton-derived particulate organic carbon (POCphyto > 43 % of total POC, Fig. 6c), as well as higher and more variable POC:PON ratios (average > 6.9, Fig. 6b) compared with stations influenced by Atlantic water (average POC:PON < 6.3, POCphyto > 35 %, Fig. 6b)."

RC3.57 - L475: were also abundant

AC3.57 - We are not sure what the reviewer is referring to here.

RC3.58 - L512-519: It should be interesting to explain the meaning of the AP/TChla ratio in term of strategy for the adaptation to light regime.

AC3.58 - Few studies have examined this in any depth and hence we can conclude very little in the present study. AP/TChla ratio varied according to community composition and species adaptation to light environments, mixing regimes, competition for light with other dissolved substances (etc) could explain the observed trend. Further in depth physiological work is needed. We have extended the discussion a little bit in the paper in attempt to explain why such trend is observed.

RC3.59 - L522-523: Conufsing because you introduce "two parameters" and after you cite three parameters (Nitrate, Silicate and SI).

AC3.59 - The word "two" has been removed from this sentence.

RC3.60 - L540-552: You show interesting difference in the photophysiological characteristics of phytoplankton, especially between the west and east communities. Near Greenland, the communities is composed of species resistant to high light while on the Labrador Shelf, the species are less resistant to photo-inhibition. Is the light conditions are so different between east and west to explain these different adaptations to light? It could be interesting to describe these difference in the light regimes between the two side of the Labrador Sea. The latter melting of the ice cover on the Labrador Shelf could be an explanation?

AC3.60 - We have now improved the discussion about the influence of PAR in separating the polar phytoplankton communities observed. See the rewritten paragraphs below.

Line 540 – "Polar phytoplankton communities from shelf waters (east versus west) observed in this study had distinctive photo-physiological characteristics. Comparing these blooms, diatom/chlorophyte communities (west) had higher photosynthetic efficiency (αB = 9.2 $\times$ 10-2 μg C μg Chla h-1 W m-2), lower light-saturation irradiance (Es = 35 W m-2) and higher photo-inhibition (β = 16 $\times$ 10-4 μg C μg Chla h-1 W m-2) than communities from the east. This suggests that the community located in the Labrador Shelf waters (west) was more light-stressed compared to the community observed in the east (diatom/Phaeocystis). Haline-stratification due to the influence of Arctic waters occur in both regions during spring, contributing to the shallow mixed layer depth (<33 m) observed (Table 5). However, waters from the Labrador Shelf (west, Cluster C3a) were more stratified than the Greenland Shelf (cluster B, see stratification index (SI) values, Table 5) because of the local sea ice melt observed in this area, which contributes to increased stratification in this region. The diatom species observed on the Labrador Shelf were mostly sea-ice related (Fragilariopsis cylindrus, Fossula arctica, Nitzschia frigida) compared to pelagic species observed in the Greenland Shelf waters (Thalassiosira gravida, for example) (Fragoso et al., 2016). Sensitivity of sea-ice related diatoms to irradiance > 15 μmol photons m$-$2 s$-$1 has been reported (Alou-Font et al., 2016), which can help explaining why phytoplankton communities from the west were photo-inhibited. Phaeocystis/diatoms located near Greenland (east) had the inverse pattern: low photosynthetic efficiency (average αB = 6.8 $\times$ 10-2 μg C μg Chla h-1 W m-2) and high light-saturation irradiances (Es = 62 W m-2). This pattern in diatom/Phaeocystis dominated communities mean that photosynthetic rates were relatively low at high light intensities, although photo-inhibition was low (β = 4 $\times$ 10-4 μg C μg Chla h-1 W m-2). Phaeocystis antarctica, widespread in Antarctic waters, relies heavily on photo-damage recovery, such as D1 protein repair (Kropuenske et al., 2009), which could explain how these communities overcome photo-inhibition. Stuart et al. (2000), however, found a high photosynthetic efficiency (αB) for a population

dominated by Phaeocystis near Greenland and attributed this to the small cell size of Phaeocystis. However, in addition to the exposure of ice-related diatoms to high light levels due to increased stratification, the high concentration of chlorophytes and prasinophytes, which are also small in cell size, might also explain the higher αB observed in the Labrador Shelf waters (west, cluster C3a) when compared to values from diatom/Phaeocystis blooms (east, cluster B).

RC3.61 - L555 to 558: The sentence is confusing. It takes time for me to understand that dinoflagellates bloom in May to avoid higher light levels. Please rephrase or separate in two sentences to improve the clarity. AC3.61 - The beginning of this paragraph has been rewritten for better elucidation. See the sentence below.

Line 555 - "Days are longer and solar incidence is higher in June compared to May at these latitudes (Harrison et al., 2013). Dinoflagellates were found to bloom in the central Labrador Sea in June as a consequence of increased thermal stratification. To cope with high light levels and potential photo-damage, this phytoplankton community appeared. . ."

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