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Interactive comment on "First in situ estimations of small phytoplankton carbon and nitrogen uptake rates in the Kara, Laptev, and East Siberian seas" *by* Bhavya P. Sadanandan et al.

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We thank the reviewers and the associate editor for their constructive comments. We have addressed the comments by reviewer #1 (as detailed below) and have revised the manuscript accordingly. Please note that page and line numbers in the reviewer's comments refer to the original manuscript while our references to page and line numbers refer to the revised manuscript. 1. Specific comments: Page 3, Lines 49-52: Hill et al., 2005 → Hill and Cota, 2005, Arrigo et al., 2015 → Arrigo and van Dijkend, 2015, Bélanger et al., 2013 → Bélanger et al., 2008?, Wassmann and Slagstad, 2011 → Wassmann et al., 2011. Please check references throughout the text!!

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We thank the reviewer for pointing out the mistakes in reference list. We have thoroughly checked and revised. 2. Page 3, Line 60: McLaughlin and Carmack, 2010 → McLaughlin et al., 2010 Corrected 3. Page 4, Line 70: Bélanger et al., 2013 → check the reference! This reference is added in the reference list of the revised manuscript. 4. Page 4, Line 74: Vancoppenolle et al., 2013 → this citation is no in reference list! This reference is added in the reference list of the revised manuscript. 5. Page 5, Line 94: Does your measured carbon uptake correspond to NPP or primary production? You need consistency for that throughout the text. Otherwise, you need to define NPP. The present study addressed only small phytoplankton uptake rates measured on the basis of a 4hrs in situ incubation experiments. Hence, the data do not represent net primary production. To make sure the consistency we removed the term net primary production from the manuscript. 6. Page 6, Line 132: "The chlorophyll (chl) samples" → Does it mean the chlorophyll a? Or does it contain chlorophyll a, b, and c? Kind of confused in the text! We used Chl a for the present study. We have replaced "Chl" with "Chl a" in the revised manuscript. 7. Pages 6-7: In materials and methods section, there is no description for how to measure water temperature and salinity, although water temperature and salinity data are used in Table 1 and described in the text. Please describe a detail method for the water temperature and salinity measurement! The temperature and salinity were measured using a Seabird SBE9plus CTD (conductivity-temperature-depth tool) equipped with dual temperature (SBE3) and conductivity (SBE4) sensors. The information regarding temperature and salinity measurements has been added to the revised manuscript. 8. Page 7, Line 134: Lee et al.,2005 → Lee and Whitledge, 2005 Corrected 9. Page 7, Line 149: "Niskin bottles attached to CTD" → CTD spell out! CTD stands for Conductance Temperature Depth device. We have added the full term in the revised manuscript. 10. Page 8, Line 165: Slawyk et al. 1977 → Slawyk et al. (1977) Corrected 11. Page 9, Lines 180-184: No unit for the salinity! Salinity is measured in Practical Salinity Unit (PSU). Usually it is not mentioned particularly. However, we added the unit of salinity in the revised manuscript as per the reviewer's suggestion. 12. Page 9, Line 182: When I read this sentence, I thought that you inves-

tigated for a late summer in 2013. We agree with the reviewer and changed it in the revised manuscript.

13. Page 9, Lines 189-191: I think authors may need to redraw figure 2 because I don't know whether the subsurface chlorophyll maximum actually exists in this figure. I think it is only the results of some stations.

Figure 2. does not contain any chlorophyll data. We have plotted the depth profiles of C, NO3-, and NH4+ uptake rates and explained about the subsurface maxima of uptake rates. We also revised the two sentences (190-192) as given to make the idea more clear. "Fig. 2 shows the depth profiles C, NO3ËĽ, and NH4+ uptake rates in the Laptev, Kara, and East Siberian seas. Only a few stations showed significant subsurface maxima for the C, NO3ËĽ, and NH4+ uptake rates during the present study where the rest of them exhibited no significant variation throughout euphotic zone". 14. Page 9, Line 193: "Fig. 3 & 4" → Figs. Corrected 15. Page 10, Line 211: Parkinson, 2002 → this citation is no in reference list! Reference is added in the revised manuscript. 16. Page 11, Line 227: "Table 2, Fig. 3 & 4" → Figs. Corrected 17. Page 11, Line 239: Kirk, 1983 → this citation is no in reference list! Added to the reference list. 18. Page 11, Line 240: Shiklomanov, 2000 → Shiklomano et al., 2000 We have checked the reference, however, we found that Shiklomanov, 2000 is the correct version. 19. Page 12, Lines 252-258: "The depth-integrated NO2-+NO3- concentrations varied between"→ ". . .concentrations in the euphotic zone varied. . ..." You do not show euphotic zone depth. Add euphotic zone depth in Table 1. If the difference in the depth of euphotic is large, the result may be influenced in nutrients budget. Also, I think that the meaning of "high concentrations of NO3+NO2 and phosphate" are ranked based on only nitrogen data and mentioned stations are not special compared to other stations. We agree to the reviewer's opinion regarding the influence of euphotic depth on depth integrated nutrient budget. We have added euphotic depth details in Table 1. The euphotic depths observed are different in almost all of the stations ranging from 33 to 76 m. However, the data from our present study did not show any dependency of depth integrated nutri-

ent budget with euphotic depth. For example, AF019, Af080, and AF095 stations have deeper euphotic zone, however; they are not having depth integrated NO2-+NO3- concentrations close to the highest values obtained at AF068, AF071, and AF005 which are having relatively shallower euphotic depths. The depth integrated P values also showed higher values at stations (AF019, AF068, AF100, AF080, AF095, and AF091) with both deeper and shallower euphotic depths. Based these information we could not derive any correlation between euphotic depths and nutrient budget. We have added one paragraph to explain these findings in the revised manuscripts (page 13-14: lines: 290-299). 20. Page 12, Line 262: this the stations → what stations? We have corrected the sentence in the revised manuscript as "In reference to the stations (AF005, AF068, and AF071 in the Laptev Sea and AF100 in the Kara Sea) nearby the river inlets were observed with relatively higher nutrient concentrations (Table 1)." 21. Page 12, Line 257: "Table 1, Fig. 3 & 4" → Figs. Corrected. 22. Page 13, Line 268: "higher than those of present study area" → You do not show daily data for carbon uptake rates! Add your data based on daily carbon uptake rates! The reference which we used was for total primary production. So we revised that sentence with small phytoplankton primary production data by Lee et al. (2017a). The revised sentence is as follows. "In agreement to this, the small C uptake rates reported from the Chukchi Sea (58.6–194 mg Cm-1 d-1; average = 127 ±55.2 mg Cm-1 d-1); Lee et al., 2017a) was relatively higher than those of present study (5.86-191mg C $m-2d-1$; average=37.7± 41.6)". 23. Page 13, Line 272: Glibert et al., 2011 → this citation is no in reference list! Reference is added in the revised manuscript. 24. Page 13, Line 288: It is necessary to investigate whether there is a relationship between SST and small phytoplankton uptake rate. You are dealing with an entirely different ecosystem as you mentioned. We appreciate the reviewer's opinion. The relationship of small phytoplankton DIN and C uptake rates with SST was checked already. However, a significant relationship was not observed. It can be possibly due to the narrow range of SST variation among the stations and also due to co-influence of multiple environmental factors. 25. Page 14, Lines 290-293: "However, Fig. 5 show a weak,...." → Authors just stated that possibility

of small phytoplankton efficiency to peak at nutrient stoichiometry close to Redfield's ratio. In my opinion, the DIN: P ratio of less than 16 means mainly nitrogen limitation in ocean. If DIN: P is the degree of nitrogen limitation, it can be interpreted that small phytoplankton is just advantageous to survive better than large. I wonder why the contribution of small phytoplankton is below 50% despite of the nitrogen limitation. Why did this happen? I guess that DIN:P ratios below 8 seem to affect the rate of phytoplankton uptake regardless of size based on limited data in this study.

We agree with the reviewer's comment partially. It is possible that nutrient limitation can affect the small phytoplankton potential to assimilate C and N. However, from our study we could observe that the contributions were higher as 80% as well as lower as 25% at DIN:P below 8:1. However, the average small phytoplankton contributions are above the global average. And also, the results from the present study cannot claim that the lower DIN:P is the reason for lower contributions of small phytoplankton to the total primary production. We have explained it in the revised manuscript. Page: 20: lines 439-447 as follows, "The assessments by Tremblay et al. (2000) suggests that large phytoplankton can fix relatively more C per unit NO3- and thus export more C than small phytoplankton. However, the results from the present study show that the large phytoplankton communities in the Arctic Ocean could contribute only an average of 40%, 34%, and 35% towards the total C, NO3âĄż, and NH4+ uptake rates, respectively. And hence, small phytoplankton appears to be the major contributor of C, NO3-, and NH4+ uptake with percentage contributions of 60%, 66% and 65%, respectively, in the Laptev, Kara, and East Siberian seas. These values are much higher than the global average contribution (39%) of small phytoplankton production assessed by Agawin et al. (2000)".

Page 14, Lines 299-300: "between small phytoplankton uptake are DIN:P" → "and" instead of "are" Corrected as per the reviewer's suggestion. 26. Page 15, Line 316: "Fig. 6 & 7" → Figs. Corrected. 27. Page 15, Line 323: Glibert et al., 1982 → Glibert, 1982 Corrected. 28. Page 15, Line 314: " the bottom water. . .. . ..(1000-1700 hours)

turnover times compared to" → ". . . turnover times for NH4+ substrate. . ." And what does mean bottom depth? Is it correspond to 1% light depth? Define the bottom depth in euphotic zone! Checked and corrected as follows, Page 17: lines: 361-364 "Fig. 7 shows that turnover times for NH4+substrate (within 500 hours) in the surface waters is longer, however; relatively faster than NO3âĄż in upper layers of euphotic zone in almost all the stations in the Arctic Ocean. However, the bottom waters of euphotic zone showed relatively longer (1000-1700 hours) turnover times for NH4+ substrate compared to the surface waters." 29. Page 15, Line 316: "both NO3- and NH4+ substrates" → at surface water???? Or throughout the euphotic zone? Yes. Station AF044 showed consistently higher turnover times for both NH4+ and NO3- in the surface waters. We have revised the sentence as follows "The sampling location in East Siberian Sea (AF044) was observed with relatively longer turnover times for both NO3âĄż and NH4+ substrates at the surface layers (Figs. 6 & 7) possibly due to the lower uptakes rates over there". 30. Page 16, Line 339: "quantum efficiency/yield" → quantum efficiency (or quantum yield) By "/" we meant "or" here. To avoid the confusion we replaced "efficiency/yield" by only "yield" in the revised manuscript. We also modified the sentence as "The quantum yield for the present study is defined as the uptakes of DIN (NO3âĄż +NH4+ uptake rates) and C by unit small phytoplankton Chl a fraction which is obtained by dividing uptake rates by Chl a concentrations". 31. Page 16, Line 341: "in Fig. 8 and 9" → Figs. Corrected. 32. Page 16, Lines 355-356: Wassmann and Slagstad, 2011 → Wassmann et al., 2011, Tremblay et al., 2002 → this citation is no in reference list! Please check the reference! Corrected. 33. Page 17, Line 374: Legendre et al. (1993) →1992?, check the reference! Please, double check and correct them, if needed. Checked and corrected as per the reviewer's suggestion. It is Legendre et al., 1992. 34. Page 17, Line 375: "large phytoplankton cells (45μm)" → check the cell size. I think it probably means > 5 μm. We apologize for the typo mistake. We have corrected it to >5ïĄ■m in the revised manuscript. 35. Page 29, Fig. 2: Rephrase legend for Fig. 2 Corrected.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-76/bg-2018-76-AC1-supplement.pdf

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