

The manuscript “Small phytoplankton contribution to the carbon and nitrogen uptake rates in the Laptev, Kara, and East Siberian Seas” written by Bhavya et al describes carbon and nitrogen uptake rates of small phytoplankton in the Laptev, Kara, and East Siberian Seas, Arctic Ocean, in which field-measured observation data are very scarce. This paper is very interesting to present small phytoplankton contribution to the total carbon and nitrogen uptake rates and especially some potential possibility of small phytoplankton thrive under sea ice retreat in the Arctic Ocean. The present study has scientific merits and originality in that: 1. the topic, “Small phytoplankton contribution to the carbon and nitrogen uptake rates in the Laptev, Kara, and East Siberian Seas”, is very intriguing enough to draw much attention for understanding Arctic marine ecosystem especially in the Laptev, Kara, and East Siberian Seas under ongoing environmental changes ; 2. the study is one of few studies for the contribution of small phytoplankton in the Arctic Ocean; 3. The result from the present study shows some possibility of small phytoplankton thrive under sea ice retreat. However, the current manuscript should be more polished for the final version.

We thank the reviewers and the associate editor for their constructive comments. We have addressed the comments by reviewer #2 (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. For example, some missing references and incorrect ones, e.g., Hill and Cota, 2005, Arrigo et al., 2015, McLaughlin and Carmack, 2010, and more. Authors need to check the references throughout the text.

We have checked the references thoroughly and edited as per the reviewer’s suggestions.

2. Line 97, The major rivers flows in to the Arctic.. Change with flow into the Arctic.  
Changed as per the reviewer’s suggestion.
3. Line 109, ..a first.. Change with the first..

Changed as per the reviewer's suggestion.

4. No detail description for the measurements for water temperature and salinity in materials and methods.

We have added the information regarding temperature and salinity measurement in the revised manuscript as follows. "The temperature and salinity were measured using a Seabird SBE9plus CTD (conductivity-temperature-depth tool) equipped with dual temperature (SBE3) and conductivity (SBE4) sensors".

5. Line 132, The chlorophyll (chl) samples... chlorophyll a? or chlorophyll a, b, and c?

We have used Chl *a* for the present study and the manuscript is revised by replacing Chl with Chl *a*?

6. Line 140, C and N uptake rates.. C and DIN uptake rates?

By "N" we meant "DIN". To avoid confusion we have replaced "N" with "DIN" in the revised manuscript.

7. Line 151, light filters.. What kind of light filters?

We have used neutral density light filters (LEE filters) to cover the polycarbonate sample bottles. The details have added in the revised manuscript.

8. Line 165, the methods Slawyk et al., 1977.. Check the sentence!

We have revised the sentence as per the reviewer's suggestion.

9. Line 191, a subsurface maxima like most of global ocean.. You need add some related references for that!

Since we did not get references for depth profiles of small phytoplankton uptake rates, we revised the sentence without reference. We reframed the sentence to avoid confusion as follows,

“Fig. 2 shows the depth profiles C,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  uptake rates per hour in the Laptev, Kara, and East Siberian seas. Only a few stations showed significant subsurface maxima for the C,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  uptake rates during the present study where the rest of them exhibited no significant variation throughout euphotic zone”.

10. -Line 194, The depth integrated.. Make a consistency with depth integrated inline 192

Replaced “depth integrated” with “depth-integrated” throughout the manuscript as per the reviewer’s suggestion.

11. Line 197, the maximum small plankton. . . small phytoplankton?

It is “small phytoplankton”. The correction has been done in the revised manuscript.

12. Line 197-198, How about any explanation for the maximum uptake rates at AF09?

The exceptionally high uptake rates for C,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  obtained at station AF019 is indeed very interesting. We observed very high particulate organic carbon as well as nitrogen concentration and specific small phytoplankton uptake rates compared to other stations. However, chlorophyll concentrations for the small phytoplankton community did not show such higher values when compared to other stations. Based on the background data obtained during the present study could not give a possible reason to the high uptake rates. We assume that the higher metabolic rates can be due to presence of different autotrophic communities which are different from other sampling locations. Unfortunately, we could not obtain species identification data during the present study.

13. Line 219-220, any related reference?

As per the reviewer’s suggestion we have added references for the contribution of ice algae to the primary production. Clasby et al., 1973 and Horner and Schrader, 1982

14. Line 227-228, higher C and DIN uptake rates of what? Small phytoplankton or total phytoplankton?

We meant small phytoplankton uptake rates here. We apologize for the confusion.

15. -Line 231, lower C and DIN uptake rates of what? Small phytoplankton or total phytoplankton? ⇒ very confused!!

We meant small phytoplankton uptake rates here. The manuscript is revised accordingly to remove the ambiguities regarding small and total uptake rates. We attempted to compare with the small phytoplankton uptake rates obtained from various regions in the revised manuscript.

16. Line 236, metabolic activities of phytoplankton. Small phytoplankton?

Yes. It is small phytoplankton. We have edited it in the revised manuscript.

17. -Line 237, Not much discussion for small phytoplankton primary production in 3.4 section!!

You need to focus more on small phytoplankton primary production.

We have attempted to explain more about the small phytoplankton uptake mechanism and influence of nutrient concentrations on the small cells. Since there are not many experiments conducted on small phytoplankton uptake rates, particularly from polar oceans, the comparative analysis is relatively difficult. However, we attempted to give a better explanations in the revised manuscript using the available resources.

18. -Line 253-254, make a same digit for concentrations.

We would like to keep 3 significant digits for the nutrients. In that case 22.3 and 189 are having same significant digits that is 3. We believe that this representation is statistically correct. With reviewer's permission we would like to keep the data same as it is.

19. -Line 258, check the sentence!

We have changed the sentence appropriately as per the reviewer's comment.

20. -Line 263, this the stations. which stations you mean?

We have revised the sentence with station details (AF005, AF068, and AF071 in the Laptev Sea and AF100 in the Kara Sea) as per the reviewer's suggestions.

21. -Line 271, lower C and DIN uptake rates of What? Small or total phytoplankton?

We meant small phytoplankton uptake rates here. Revised the manuscript as per the reviewer's suggestions.

22. -Line 279-282, Is this for only small phytoplankton contribution? You need to discuss more on small phytoplankton primary production.

N starving can abstain both large and small phytoplankton from achieving potential primary production. However, to an extent small phytoplankton are less severely affected by nutrient limitation than large phytoplankton. Since the small phytoplankton cell size is small nutrient requirement to gain potential primary production is relatively lower compared to the larger phytoplankton cells. However, under very poor nutrient conditions, small phytoplankton may also undergo nutrient starving.

We have explained it as follows in the revised manuscript: "In general, experimental and theoretical evidences suggest that smaller cells have higher rates of nutrient uptake per unit biomass and lower half-saturation constants due to their higher surface area to volume ratios (Eppley and Thomas, 1969; Aksnes and Egge, 1991; Hein et al., 1995). And hence, the lower minimum cellular metabolic requirement for small phytoplankton selectively allows them to survive under lower resource concentrations than larger cells (Shuter, 1978; Grover, 1991). And hence, small phytoplankton cells appear to have substantial leads over larger phytoplankton cells under nutrient-limited steady-state environmental conditions

(Grover, 1989; Grover, 1991). However, under very poor nutrient conditions, small phytoplankton may also undergo nutrient starving”.

23. -Line 308, plankton to facilitate.. phytoplankton or zooplankton?

It is phytoplankton. We edited the sentence in the revised manuscript.

24. -Line 327-329, Are the results for turnover time in India for small phytoplankton? Or total phytoplankton? If these results for total phytoplankton, then is it appropriate to compare turnover rates for small phytoplankton in this study?

We appreciate the reviewer’s concern. The turnover rates from India is of total phytoplankton community. We admit that it is not wise to compare the turnover times by total phytoplankton with those of small phytoplankton. However, as far as we know there are only few studies reported turnover rates of total phytoplankton. Moreover, there is no report so far regarding the small phytoplankton turnover rate measurements.

25. -Line 339, ..quantum efficiency/yield.. What “/” means?

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 ( $\text{NO}_3^- + \text{NH}_4^+$  uptake rates) and C by unit small phytoplankton Chl *a* fraction which is obtained by dividing uptake rates by Chl *a* concentrations”.

26. –Line 343, it should be like this, ..C and N were observed..

Corrected

27. -Line 345-346, N yield.. Is this term correct?

We have replaced “N yield” with quantum yield for DIN” and the same done for “C quantum yield”.

28. -Line 350-351, check the sentence!

We have revised the sentence as given, “It is a known fact that the impact of global warming on the Arctic Ocean has been introduced rapid changes in its physicochemical properties. Hence, the necessity to trace the changes in primary production pattern in the Arctic Ocean gained attention in the recent era”.

29. -Line 373, Should be “the total primary production (Hodal and Kristiansen, 2008).”

Corrected.

30. -Line 376, .large phytoplankton cells (45 $\mu$ m). Is this size correct? Check the cell size

We apologize for the typo error. It is actually >5 $\mu$ m. The correction has been done in the revised manuscript.