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***Interactive comment on “Net community production and stoichiometry of nutrient consumption in a pelagic ecosystem of a northern high latitude fjord: mesocosm CO<sub>2</sub> perturbation study” by A. Silyakova et al.***

**Anonymous Referee #2**

Received and published: 22 October 2012

The Arctic marine ecosystem is expected to be particularly sensitive to ocean acidification. The authors have attempted to answer an important question: what will be the impact of CO<sub>2</sub> on net community production and carbon:nutrient consumption in a pelagic ecosystem of a northern high latitude fjord. Some of the presented findings are interesting. Yet, the authors fail in discussing these findings critically and thoroughly, which makes it hard to interpret the manuscript. Some of the data analysis is not clear, and the exact meaning of the results is thereby obscured. The discussion is a mere repetition of the results. Since the manuscript is part of a special issue, it may be

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reconsidered for publication, but only after a thorough revision.

General comments:

1. The manuscript contains a substantial number of inconsistencies and typos. Some I listed below but the manuscript should be carefully checked.
2. It would be very helpful if the authors could also include the relative changes in inorganic nitrogen and phosphorus.
3. How well do the changes in dissolved inorganic carbon and nutrients match with the changes in particulate carbon and nutrients? The authors should be cautious in their statements relating to particulate elemental ratios, since their own results are based on indirect measurements of the net uptake of inorganic carbon and nutrients. Also, any assumption on this aspect should be clearly indicated.
4. How well do the estimates of NCP match with primary productivity estimates from Engel et al. 2012?
5. The authors correctly state that the Arctic marine ecosystem may experience the greatest changes under ocean acidification. In this study, however, the authors did not test that particular hypothesis, as a detailed comparison with responses observed in other ecosystems is lacking. The authors should include such a comparison in more detail, and/or specify the aim of their study. Also, what did the authors expect to happen in the first place? This should be discussed more clearly in the introduction.
6. The termination of the first two blooms was included in the data analyses, whereas termination of the last bloom was not (i.e. day 28-31 is missing). Please discuss more clearly why this data was not included, and what the implications may be for the results.
7. Regression analyses should include the variation of data on both x- and y-axis, as one point per mesocosm is obviously not sufficient to describe the impact of CO<sub>2</sub> on NCP and C:N and C:P uptake.

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8. The manuscript lacks a thorough discussion on most of the findings. The discussion is rather a more detailed repetition of the results.

Specific comments:

Page 11708: Lines 19-21: Note that primary production was also shown to decrease upon elevated pCO<sub>2</sub> (e.g. Gao et al 2011, Nature Climate Change). Lines 25-26: Not a clear sentence, please specify what exactly is meant here with a dynamic ecosystem in terms of production and respiration of organic matter.

Page 11709: Line 6: NCP is estimated from the net changes in dissolved inorganic carbon. Only in closed systems (like the mesocosms), this may be used to estimate net biological uptake of inorganic carbon. Please state this more clearly.

Page 11710: Line 21-23: The total experiment lasted 31 days, yet the NCP and C:N and C:P uptake ratios were measured only until day 27. Why? Line 24: Which nutrients were added, and to what final concentrations?

Page 11712: Line 18-20: NCP is based on the cumulative change of dissolved inorganic carbon. Why should NCP be cumulated as well? Please clarify what exactly is meant with cumulative NCP. Should it therefore also not be the ratio between NCP (corrected cumulative difference in dissolved inorganic carbon) and the cumulative difference in nitrogen and phosphate?

Page 11713: Line 6-7: What is the difference between a 'cumulative difference in nitrogen and phosphate', and 'a cumulative difference in nitrogen and phosphate uptake'? Lines 8-11: To what extend are NCP and the C:N and C:P uptake ratios auto-correlated? So what part of the changes in C:N and C:P uptake ratios are caused by changes in NCP? Please clarify.

Page 11714: Line 7-10: Please be more specific here. Changes in CT and AT are a result of the CO<sub>2</sub> gas exchange with the atmosphere, and of the community production and respiration. As it concerns a closed system, these changes can be used to

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estimate NCP.

Page 11715: Lines 10-26: Why are the C:N and C:P uptake ratios of phase II and III added? What does this exactly tell us? How were the C:N and C:P uptake ratios of phase III obtained? According to the slopes in figures 6 and 7, and to the 'intercepts' in table 3 and 4, it seems that the values should be higher. If so, the difference in C:N and C:P uptake ratios between the two phases is substantial and deserves more attention.

Page 11717: Lines 1-4: What exactly did change in the phytoplankton community, and how may that explain the NCP, and the C:N and C:P uptake ratios? Lines 15-17: What may explain the observed effect of CO<sub>2</sub> on NCP in the first phase? Lines 26-27: This should be tested with particulate carbon and nutrient data.

Page 11718: Line 3: How do the results show that the net uptake stoichiometry of carbon and nutrients varies regionally? Isn't it anyhow rather obvious that this varies in time and regionally? Line 12-14: I would prefer 'the Redfield ratio' rather than 'Redfieldian'. What does this comparison of the 'post-nutrient period' with Redfield exactly mean? The C:N and C:P uptake ratios seem to deviate substantially from the Redfield ratio when the periods are analyzed separately. What causes this deviation?

Tables and Figures:

Table 1, 2, 3, 4: It would clarify the tables if the period t14-t27 could be written as: Phase II+III. Table 1: Should it not be 'The dissociation constant for carbonic acid is based on...'?

Table 1: Was pH not measured? What may be the implications of a potential offset between calculations based on CT and AT, pH and CT, or pH and AT? Please see recent work by Hoppe et al. 2012 (BG, 9, 2401-2405). In particular, this may have consequences for the regression analyses.

Table 3: Should the 'intercept' not read the 'slope', indicating the C:N and C:P uptake ratio (or actually, the N:C and P:C uptake ratios)? If so, it seems to be 1000-fold too

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high.

Figure 3: The difference between the treatments seems to have primarily been caused by a lag period in the high pCO<sub>2</sub> treatments between t23 and t25. Please indicate what may have happened there, and how this affects the interpretation of the data.

Figures 5 and 8: The figures should include the variability of the data, i.e. standard deviations on both x- and y-axes. Furthermore, it would be more appropriate here to use the dissolved CO<sub>2</sub> concentration on the x-axis instead of the partial pressure.

Figures 6 and 7: Graphs do not show the ratios between N or P and CT uptake, but the cumulative uptake. Any slope in the graph will indicate a ratio. This ratio does not indicate the C:N or C:P ratio, but the N:C and P:C ratio. Please correct, also in the text. What exactly has been plotted on the x-axis? Is this cumulative net CT-uptake or cumulative NCP?

Figure 8: To what extent is the decrease in C:N uptake and C:P uptake due to the decrease in NCP? What is the impact of CO<sub>2</sub> on the cumulative N and P uptake?

Technical corrections:

Page 11707: Line 5: 'bacterioplankton'. Line 5: Was the volume 50 or 45 m<sup>3</sup> (see material and methods)? Line 10: 'carbon and nutrients'. Line 21: The data on NCP, and on C:N and C:P uptake ratios was collected until day 27, not 31.

Page 11713: Line 7: 'uptake'.

Page 11714 Line 8: Also include '(AT)' after total alkalinity. Lines 12: As the values indicate a mean and standard deviation, what does the 'about' sign add? Line 18 and 23: Please include 'predominantly' or 'net' when referring to the autotrophic mesocosms. Line 29: Was the P value truly 0, or just a very small number?

Page 11715: Lines 6-7: Earlier, the C:N and C:P uptake ratios were referred to as 'utilization ratios', please make consistent.

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Page 11716: Lines 12 and 13: Correct sentence to, for instance, 'The mean cumulative NCP...with increasing CO<sub>2</sub>'.

Page 11717: Line 10: Remove 'a' before 'a phosphate'.

Line 17: 'low nutrients'.

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