Response to Anonymous Referee #3

We thank the Referee for stating that this is a valuable study providing rare information at the community level of a high latitude ecosystem in response to CO_2 increases, and that the Referee finds the manuscript as well organized and written.

Specific comments:

Referee comment: It is better to mention in the title that the study was performed in mesocosms and not in in situ waters of a northern high latitude fjord. Something like " CO2 perturbation and NCP and stoichiometry of nutrient consumption in pelagic mesocosms in a northern high latitude fjord".

Authors' response: We changed the title of the reworked manuscript to "Effect of ocean acidification on net community production and stoichiometry of nutrient consumption during a mesocosm experiment in an Arctic fjord".

Referee comment: It is necessary to provide the information about the water temperature and natural irradiance during the experiment as biological activities are also affected by these variables.

Authors' response: We added the following sentences to the reworked manuscript: "The water temperature increased gradually during the experiment from ~2 to ~5°C in all mesocosms (Schulz et al., 2012). The levels of photosynthetic active radiation (PAR) at ground level in air varied between 700 and 1500 μmol m^{-2} s^{-1} (Schulz et al., 2012). Levels of PAR in all mesocosms were reduced up to 85-98% from the surface values at depth 14.5 m and up to 70-90% from the surface values at depth 4.2 m (Schulz et al., 2012)."

Referee comment: Page 11710, lines 6-7 and 10. Please mention irradiance transmission characteristics of TPU as well as of PVC for PAR, UVA and UVB.

Authors' response: We referred to the results of the variability of light attenuation in the mesocosms and that shading by TPU was lower than could be expected (Schulz et al., 2012).

Referee comment: As there is a technical note to calculate the exact volume of each mesocosm, please specify if the mesocosms enclosed 45 m3 (P. 11710, line 7) or 50 m3 (P. 11707, line5).

Authors' response: In the methods sections of the reworked manuscript we provide a range between 43.9 m^3 and 47.6 m^3 with reference to Schulz et al., 2012. In the abstract of the reworked manuscript we provide the approximate number of 50 m^3 volume according to technical note of Riebesell et al., 2012.

Referee comment: Page 11710, lines 16-17. Please explain clearly the characteristics of "dead" volume in the bottom of the mesocosms. Why did this dead volume cause an initial decline in pCO2 level, and why until t8 but not earlier nor later?

Authors' response: To clarify the use of term "dead" volume we added the following sentences to the Methods section: "Above the bottom plate inside each mesocosm there was a cone of a sediment trap (Czerny et al., 2012a, Fig. 1A), which separated the main water column and water below the cone. The water below the cone was not directly manipulated, and had a slow exchange with the main water column, which was manipulated. This space below the cone was approximately 8% of the total enclosures' volume (Riebesell et al., 2012). ... Exchange of CO_2-enriched water with unperturbed water in the "dead volume" caused an initial abrupt decline in pCO_2 levels from day t4 until day t8 (Bellerby et al., 2012). On day t8 abrupt changes in pCO_2 related to exchange with the "dead volume" after day t4 were no longer observed."

Referee comment: Page 11710, lines 21-23. Please explain how the experiment was divided into phases I, II and III. Is this in relation to the peaks of biomass?

Authors' response: We added the following sentence in the reworked manuscript: "Different periods of the experiment followed peaks of biomass growth (Riebesell et al., 2012): phase I, end of CO_2 manipulation until nutrient addition (t5-t12), phase II, nutrient addition until 2nd chlorophyll minimum (t13-t21), phase III, 2nd chlorophyll minimum until end of the experiment (t22-t30)."

Referee comment: Page 11710, lines 24. Please add the information about nutrient addition, concentrations, type of nutrients and the basis for adding such quantities in t13.

Authors' response: We added the following sentences in the reworked manuscript: "Nutrients (5 µM of nitrate (NO_3), 0.31 µM of phosphate (PO_4), and 2.5 µM of silicate (Si)) were added to mesocosms on day t13 to stimulate a phytoplankton growth. The reason for adding such quantity of nutrients was to simulate the upwelling of nutrient rich deep waters to the surface (Schulz et al., 2012)."

Referee comment: Page 11713, lines 6-8. Please explain why, to calculate C:N and C:P utilization ratios, you plotted the cumulative NCP against a cumulative difference in N and P uptakes for each period.

Authors' response: To clarify the method we used to calculate C:N and C:P uptake ratios we added the following sentences in the reworked manuscript: "A linear regression analysis was performed to define the relationship between NCP in each time period (phase) and corresponding cumulative change in inorganic nitrogen (ΔN) and phosphorous (ΔP). The cumulative change in inorganic nitrogen resulted from a sum of a cumulative change in nitrate, nitrite and ammonia. The relationships for each time period were defined with an equation type $Y = \alpha X + \beta$, where coefficient α corresponded to C:N or C:P uptake ratio. Tables 3 and 4 provide coefficients α averaged for low, intermediate and high pCO_2 levels (Slope), as well as standard deviations. Tables also provide regression coefficients (R^2) and p-values of F-test."

Referee comment: Page 11714, lines1-6. It is mentioned that the CO2 equilibrated with the water in the "dead" volume by t8 and, so, NCP of phase I was discussed only from t8 to t13. Please explain firstly how this CO2 equilibrium occurred in the "dead" volume (if it is completely dead).

Authors' response: To describe what we call the "dead volume" and explain the CO_2 equilibration with the water in the "dead" volume by t8 we added following sentences in Methods section of the reworked manuscript: "Above the bottom plate inside each mesocosm there was a cone of a sediment trap (see Czerny et al., 2012a, Fig 1A), which separated the main water column and water below the cone. The water below the cone was not directly manipulated, and had a slow exchange with the main water column, which was manipulated. This space below the cone was approximately 8% of the total enclosures' volume (Riebesell et al., 2012). ... Exchange of CO_2-enriched water with unperturbed water in the "dead volume" caused an initial abrupt decline in pCO_2 levels from day t4 until day t8 (Bellerby et al., 2012). On day t8 abrupt changes in pCO_2 related to exchange with the "dead volume" after day t4 were no longer observed."

Referee comment: Secondly, please describe the Chl a peak in Phase I in days 6 and 7 (Fig. 2) and characterize phytoplankton community before nutrient addition (this is missing because the authors start their explanation from t8).

Authors' response: As suggested by the Referee we added the following sentences: "Despite low nutrients concentrations chlorophyll *a* increased steadily from 0.2 µg l^{-1} at day t3 to 1.4 µg l^{-1} at days t6-t8 (Fig. 2; Schulz et al., 2012). … Phytoplankton community was composed predominantly of haptophytes in phase I...."

Referee comment: Moreover, it is open to question why the calculation of NPC did not start from t4, when Chl a started to accumulate (even if CO2 added was not yet in equilibrium with the "dead" water).

Authors' response: Our NCP calculations are based on a cumulative change in inorganic carbon. Due to manipulated water exchanged with non-manipulated water in the "dead volume" from t4 to t8, changes in CT concentrations caused by this water exchange were sometimes larger than changes in CT concentrations caused by biological production and respiration. On day t8 abrupt changes in CT concentrations related to exchange with the "dead volume" after day t4 were no longer observed, therefore we started NCP calculations on day t8.

Referee comment: If there is information about sediment trap data reflecting the amount of settled C, N and P at the bottom of the mesocosms, please add these data as they help interpret the fate of the three Chl a peaks during the three Phases of the experiment.

Authors' response: In the reworked discussion we referred to the study by Czerny et al., 2012 in the same issue, which discuss sediment trap data.

Referee comment: Page 11717, line 15. Please note that Brussaard et al. 2012 is not mentioned in the reference list.

Authors' response: Brussaard et al. 2012 was added to the reference list.