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Interactive comment on “CO₂ increases ¹⁴C-primary production in an Arctic plankton community” by A. Engel et al.

A. Engel et al.

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Point-by-point response to Anonymous Referee #1

Referee: The manuscript by Engel et al. aims at describing the responses of the plankton communities during a CO₂ enrichment experiment in Kongsfjorden, Svalbard. This is a very worthwhile study that is of high relevance considering the threat of Ocean Acidification. Unfortunately the manuscript is not easy to read as it contains several strange sentences and statements. Hence a thorough linguistic check is suggested. Furthermore the result section is full of primary production estimates referring to the mesocosms numbers. However, nowhere could I find a reference to what pCO₂ level the different mesocosms numbers were. For instance in the tables, why refer to these numbers instead of the pCO₂ levels. It can only be the participants that care about

C5785

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Interactive Discussion

Discussion Paper



these numbers.

Response: We fully agree with the referee that numbers of mesocosms are less informative than pCO₂ levels. We will replace mesocosm numbers with time-averaged pCO₂ levels in the text, tables and figures. Because pCO₂ was variable within each mesocosm, we will also add pCO₂ development of each mesocosm to figure 1.

Referee: Also I think the authors should look over how many significant digits they present. Having too many only makes it more difficult to keep track of the different values.

Response: We will check significant digits for each value given.

Referee: Finally I am concerned with an article that does not include a conclusion (or summary and conclusion). The abstract contain some of this, but I would have liked to see some more clear statements on how an enrichment experiment impact primary production. Consequently I cannot recommend publication of this manuscript without major revisions.

Response: As emphasized by referee 1 and 2 a clearer conclusion derived from main findings is lacking. This will be included in the revised version.

Detailed comments Referee: Line 9 on page 6. What is day 10 referring to? Line 12 same page.

Response: There was a mistake. The sentence should read: Briefly, nine mesocosms were deployed close to the coast of Spitsbergen near Ny-Ålesund on 28th May 2010 (day -10). All mesocosms enclosed nutrient-poor, post-bloom fjord water. The CO₂ manipulation was carried out between 6th and 11th of June (day -1 to day 4) by the addition. ...

Referee: This figure reference is not relevant here. After sentence ending on line 14 same page. Instead include: "the development of pCO₂ in the mesocosms is illustrated in Figure 1.

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9, C5785–C5789, 2012

Interactive
Comment

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Interactive Discussion

Discussion Paper



Response: We agree and will adopt the referee's suggestion.

Referee: Line 19 same page. How can one continuously collect 5 l of sample? Line 25 same page. I guess that the samples were not determined frozen as it now reads.

Response: The sentences will be modified to: The sampler is equipped with a motor and collects water (5L volume) while being lowered from surface to 12 m depth. Samples were collected in the morning (9am-11am). Concentration of Chlorophyll a (Chl a) in the mesocosms and in the fjord was determined from 500ml seawater filtered onto glass fibre filters (Whatman GF/F 25 mm, pre-combusted 450°C for 5h) by low vacuum filtration (<200mbar) and stored at -20°C.

Referee: Please state after how long the samples were analysed.

Response: Filters were kept frozen for 24h.

Referee: Line 3 page 7. This ref to fig 1 is also misleading. Nothing in this figure indicate any bloom or addition of nutrient, more than what is observed by changes in pCO₂ (that can have several causes).

Response: Figure 1 also shows the temporal development of Chl a. Here, one peak is observable before day 13 (day of nutrient addition) and two peaks after. We therefore think the referring to Fig 1 is meaningful.

Referee: Line 11 page 7. Strange sentence. "for the fjord every other day of the experiment of days 1, ..." . What is really meant? Are the incubations done for each mesocosm for all the days mentioned, and for the fjord water on every other day? Please rephrase so it is understandable.

Response: We will rephrase the sentence to: 'Triplicate light incubations, and one dark incubation were made for each of the 9 mesocosms and for the fjord on days -1, 2, 5, 7, 10, 12, 14, 16, 18, 20, 22, 24, 26, and 28.'

Referee: Line 18-20 page 7. If this rinsing was done after filtration of sub-samples

how do you secure that it does not affect the POC content?

Response: Since the rinsing with sterile filtered seawater ($<0.2\mu\text{m}$) would not affect POC content, we assume the referee is actually concerned about a contamination of the DOC which was determined from the filtrate. The filtrate (used for the determination of DOC) was removed from the filtration device before rinsing and acidification of the POC filter. Therefore, neither POC nor DOC were contaminated during the processing of the other. We agree that the methods description is not straight forward on this matter and for clarification we will change the paragraph to: "Particulate primary production (PPPOC) was determined from particulate material on the filter, while the filtrate was used to determine dissolved primary production (PPDOC also referred to as "exudation"). Incubations were stopped by filtration of a 50 or 100 ml sub-sample onto $0.4\mu\text{m}$ polycarbonate filters (Nuclepore). After removing the vials collecting the filtrate of the associated filter, all filters were rinsed with 10 ml sterile filtered ($<0.2\mu\text{m}$) seawater, and then acidified with $250\mu\text{l}$ 2N HCl in order to remove inorganic carbon. <...>"

Referee: Lines 11-13 page 9. I assume that this statement refers to PP measurements. If not please state what parameters it refers to.

Response: This calculation was done for PPPOC, PPDOC and DOC. We will specify the sentence to: 'For identifying differences in PPPOC, PPDOC and DOC between the pCO_2 treatments, absolute deviations ($\text{AD}(\text{xi})$) were calculated for each day of sampling by subtracting from each observation (Xi) the arithmetic mean of all observations ().'

Referee: Did all observations include all different pCO_2 levels? If so I do not see how this would be a valid approach. Please clarify Line 16 page 10.

Response: As stated in the text, the arithmetic mean was calculated from data of one variable (i.e. PPPOC) measured in all mesocosms at one timepoint (t_i ; i.e. day 1). The absolute deviation (anomaly) thus refers to the deviation of one mesocosm from

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Interactive Discussion

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the mean value of all mesocosms at that day. The mean deviation is the arithmetic mean of all absolute deviations (anomalies) and shows how one mesocosm deviates on average from the mean development. This is a straightforward approach to compare the development in the different mesocosms.

Referee: Giving this primary production average with 3 significant digits is not relevant with the given standard deviation(?). The same goes for all the result section as well as in the abstract.

Response: We will check significant digits for each value given.

Referee: Line 19 page 22. The reference to Arrigo et al, 2011, is not the most suitable for this purpose. There are several articles that address this aspect based on direct measurements of the C-system.

Response: There was a mistake in the reference. The publication that we wanted to cite here is: Arrigo et al, 2010; Arrigo, K. R., Pabi, S., van Dijken, G, and Maslowski, W. Air-sea flux of CO₂ in the Arctic Ocean, 1998–2003. *Journal of Geophysical Research-Biogeosciences*, 115, G04024, doi:10.1029/2009JG001224, 2010

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