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Biogeosciences
Discussions

Interactive comment on "Effects of CO_2 perturbation on phosphorus pool sizes and uptake in a mesocosm experiment during a low productive summer season in the northern Baltic Sea" *by* M. Nausch et al.

Anonymous Referee #1

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General comments

As the authors mention, more studies have to be conducted to understand how P cycle can be impacted by ocean acidification. This paper potentially provides many valuable information on this research field. However I consider that the results can be more effectively demonstrated to show the effect of CO2 increase on P cycle. Results on P pools and P uptake dynamics in the fjord waters are interesting but do not play a role to understand CO2 impacts on P cycle that is the purpose of this paper. The following comments may be useful to improve the present manuscript. After making revisions to

the comments, the paper may be considered to be published in this journal.

Major comments

1. Mesocosms vs. Fjord. This is a paper to show CO2 impact on P cycle, but large part of this paper is devoted to describing in situ observations and incubation experiments in the fjord waters. Environmental conditions including chemical and biological are quite different between the fjord and the mesocosms. Figs. 2 and 3 show that in the fjord upwellings often occurred. The upwellings transport low temperature, high salinity, high CO2, and high nutrient waters from the depths to the surface. The event alter nutrients and biological conditions in the surface fjord but not in the mesocosms. The fjord ecosystem changes significantly with time. After the start of mesocosm deployment, the systems in the fjord are essentially different from those in the mesocosms. I do not consider that the comparisons between the fjord and the mesocosms do not help to better understand CO2 impacts on P cycle. Temporal changes in P pool and uptake dynamics in the fjord is very interesting but may be able to report elsewhere.

2. Mesocosm fCO2. Figure 2a clearly shows that fCO2 was dramatically changed during the experiment. fCO2 in high CO2 treatment decreased from over 1600 ppm in phase I to less than 1000 ppm in phase III which is lower than the fCO2 of 821 ppm mesocosm in phase I. fCO2 variations are similar between the untreated and 497 ppm mesocosms. Some analyses are conducted for the whole experimental period between the untreated, intermediate, and high CO2 mesocosms. Is this really appropriate analyses? The fCO2 conditions in Fig. 2a simply look two CO2 treatment, lower (365, 368, and 497 ppm) and higher (821, 1007, 1231 ppm).

3. Abstract. Although most of this part is devoted to describing P pool sizes and P uptake dynamics, readers would like to know whether the pool size and uptake dynamics are altered under elevated CO2 conditions. Please show what is the conclusion of this study. The abstract can be written in a single paragraph.
 4. Introduction. P17546L25-27. TP pool has been recognized to be composed of PO4, DOP,

particulate organic P (POP), and particulate inorganic P (PIP) (Loh and Bauer, 2000; Yoshimura et al., 2007). Since PIP composes significant part of particulate P pool, ignoring PIP is not correct to describe P cycle in the ocean. In this study PIP did not measured, so the term particulate P (PP) or total particulate P (TPP) have to be used instead of the POP.

Loh, A.N., Bauer, J.E. (2000) Distribution, partitioning and fluxes of dissolved and particulate organic C, N and P in the eastern North Pacific and Southern Oceans. Deep Sea Research I 47:2287–2316.

Yoshimura, T. et al. (2007) Distributions of particulate and dissolved organic and inorganic phosphorus in North Pacific surface waters. Marine Chemistry 103:112–121.

5. Introduction. P17547L6-8. I agree with the author's view. Since many centric and pennate diatom species showed an increase in C:P ratio in response to increases in pCO2 (e.g., Sun et al., 2011; Sugie and Yoshimura, 2013), P metabolism in phytoplankton may be easily affected by an increase in CO2. Yoshimura et al. (2013, 2014) may report some changes in DOP dynamics in natural plankton communities under elevated CO2 conditions. These also can become a motivation to study impacts of CO2 increase on P cycle.

Sugie, K., and Yoshimura, T. 2013. Effects of pCO2 and iron on the elemental composition and cell geometry of the marine diatom Pseudo-nitzschia pseudodelicatissima. Journal of Phycology, 49: 475–488.

Sun, J. et al. 2011. Effects of changing pCO2 and phosphate availability on domoic acid production and physiology of the marine harmful bloom diatom Pseudo-nitzschia multiseries. Limnology and Oceanography, 56: 829–840.

6. Sampling strategy. P17548L25-27. Seawater samples were collected for integrated entire 17 m depth, but I imagine that the depth of thermocline (i.e., surface mixed layer) varied day by day. Is this method appropriate to observe temporal variations in P pool

and P uptake dynamics in the mesocosms?

7. P uptake experiments. While PO4 uptake was measured under light conditions, ATP uptake was measured under dark conditions. ATP uptake by phytoplankton can be altered under light and dark conditions. Please explain whether the balance between phytoplankton and bacterial ATP uptake is altered under light vs. dark conditions.

8. Discussion. This paper discusses temporal changes in P pools and uptakes in the mesocosms to show the impacts of CO2. In addition to this, to reveal CO2 impacts on P cycle, I would like to know whether temporal changes in e.g. PP/Chl-a and PC/PP differ among the mesocosms in each phase. Changes in these ratios under elevated CO2 can alter biogeochemical cycles of bioactive elements dramatically in the future.

Specific comments

9. P17549L24. Is this a colorimetric method?

10. P17550L4. A method for silicate analysis is not described in this paper.

11. L24. at 20 °C ==> at –20 °C?

12. L24-26. I like to see the reference for the microwave method for DOP analysis.

13. P17551L7. Why the subsamples need to be filtered through 0.2 μm filter in addition to through GF/F?

14. L13. Bjorkman ==> Björkman

15. P17552L2. 2.5 pmol mL$-$1 = 2.5 nmol L$-$1?

16. P17553L21-22. I like to see the reference for the pressure cooker method for PP analysis. Is there any reason why you use Oxisolv here, not potassium peroxydisulfate as in DOP analysis?

17. L26. Could you show the detection limit for PO4 analysis?

18. P17554Ll. Does the PC include particulate organic and inorganic carbon?

19. L9. Could you show the light intensity for the laboratory incubation, and the light condition correspond to which depth in the mesocosms?

20. P17555L6. Please use “Bq (SI unit)” not “Ci”.

21. L19. I like to see the reference for the “factor of 2”.

22. P17556L13-15. M1 and M5 etc. (probably mesocosm#1) are not defined in any part of this paper.

23. L17. Table 1 shows that minimum temperature was 7.82, not 7.81 here.

24. P17558L4. POC ==> PC

25. L4 and L6. Fig. 6b ==> Fig. 5b?

26. L6. Table 5 ==> Table 2?

27. P17559L28. PO4 uptake rates ==> PO4 turnover times?

28. P17560L1-4. I do not understand this. Does this agree with Fig. 9d?

29. L14. Table 2 ==> Table 5?

30. P17561L10. Fig. 6b ==> Fig. 5b?

31. P17563L5-7. Comparing Fig. 9a and b, I consider that the shortest turnover times in days 15-17 correspond to the highest uptake rates in days 15-17.

32. L13-14. I do not understand the two number “0.02 and 0.46 nmol (μg Chl a)$-$1 h$-$1”.

33. Table 5. In “Variable” pCO2 ==> fCO2?

34. Figure 2. fCO2 (umol L-1)? Put “b” on the bottom figure.

35. Figure 5c. Put a dotted line.

Interactive comment on Biogeosciences Discuss., 12, 17543, 2015.