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Biogeosciences
Discussions

Interactive comment on "Synergistic effects of $p\mathbf{CO}_2$ and iron availability on nutrient consumption ratio of the Bering Sea phytoplankton community" *by* K. Sugie et al.

Anonymous Referee #1

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This study reports on the response of phytoplankton community to the changes in pCO2 and iron availability in the HNLC region of the Bering Sea. The effect of pCO2 was only observed in the iron-limited condition, with lower growth rate at higher pCO2, probably due to the lower iron availability. Si to N or C ratio, however, increased at higher pCO2 under iron limitation, even though there was no significant effect on silicification of the diatoms. In contrast, under iron-replete condition, phytoplankton did not show any different response to various pCO2. This manuscript could be publishable in Biogeosciences once the authors have addressed the comments below.

Although a number of studies have examined the combined effect of pCO2 and iron

limitation on marine microorganisms in the laboratory, there are only a few such reports from the field, probably due to the challenge to avoid iron contamination during manipulation of carbonate chemistry of seawater. In this study, the incubation experiment was carefully carried out under both iron-limited and replete conditions. Since the ambient water was only modestly limited by iron, as shown by the presence of 0.17 nM of dissolved iron, there was significant growth of phytoplankton during incubation without iron addition. Interestingly, the growth response to pCO2 indicates that iron availability is lower at high pCO2/low pH, which is consistent with the recent report by Shi et al. (Science, 2010). It also indicates that pCO2 may not have direct effect on phytoplankton ecophysiology even under iron limitation. However, since this study only showed results from one incubation experiment in this region, it may overlook the variability of the response of phytoplankton community to pCO2, as shown in Hopkinson et al. (Limnology & Oceanography, 2010). Besides, the specific growth rate and nutrient drawdown were only based on chlorophyll a, which is affected by iron status. The presentation of POC data is necessary here to aid our understanding of the results. The change in pCO2 usually causes changes in several parameters, including CO2 availability for photosynthesis, pH of seawater and iron availability due to the change in pH. Each parameter has different effects on phytoplankton physiology. The authors should try to tease apart these effects in the discussion.

Specific comments:

P4341, 2nd paragraph and Fig 3. As mentioned above, it would be helpful if the growth rate based on POC were presented here.

P4343, 2nd paragraph and Fig 7. Again, data on nutrient drawdown per unit of POC would be more informative and reflect the real phytoplankton biomass here.

Page 4343, 3rd paragraph and Fig 8. It is not clear how PDMPO fluorescence was quantified and normalized. If cells in iron-replete treatments have higher growth rate, shouldn't cells have higher fluorescence? Was there any change in cell size during

incubation? In some cases, cells become smaller under iron limitation. Is it possible that the higher fluorescence in Neodenticula seminae is due to the difference in cell size compared to other species?

Page 4344, 2nd paragraph and Fig 9. What about the actual values of POC, PON and Si? In Fig 9, Si:C and Si:N ratios were higher in control treatments than in iron added treatments. However, in Fig 8, there was no significant difference in PDMPO fluorescence between control and iron added treatments, which is not consistent with Fig 9. Why? Page 4345. 1st paragraph. Since in this particular incubation experiment, the coastal diatoms dominated the phytoplankton community, it may not reflect the response of the original phytoplankton community in HNLC region to pCO2 and iron, which is often dominated by oceanic species. The authors should keep this in mind in their discussion.

Page 4345, 2nd paragraph. The conclusion drawn at the end of this paragraph is not well supported by data presented in this study. First, the change in species composition was very subtle and only occurred in minor species. Second, the change was already seen between day 2 and day 4 when nutrients were not depleted yet.

Page 4348, 1st paragraph. Again, it would be clearer if POC and PON values were presented in results. If indeed the higher Si:N and Si:C ratios were caused by the decrease in PON and POC content under iron limitation, it seems surprising and puzzling that POC and PON in iron replete treatments were 3 to 4 folds lower that that in iron limited treatments.

Interactive comment on Biogeosciences Discuss., 10, 4331, 2013.