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Biogeosciences Discussions

Interactive comment on "Build-up and decline of organic matter during PeECE III" *by* K. G. Schulz et al.

Anonymous Referee #2

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Major Comments

This manuscript presents results of a mesocosm nutrient enrichment experiment carried out under three different pCO2 levels (350, 700 and 1050 micro-atm), most of which have already been published (Riebesell et al., Nature, 450, 545-548, 2007). The paper in Nature focused on the much larger decrease in dissolved inorganic carbon (DIC) relative to the decreases in nitrate and phosphate than the Redfield ratios, which was interpreted to reflect higher carbon to nutrients uptake ratios by phytoplankton under elevated pCO2 levels. The organic matter thus photosynthesized was proposed to have been exported to the deeper layer. What is new in this paper, apart from a more detailed description/presentation of the data on salinity, temperature and on particulate and dissolved forms, is the inclusion of data on ammonia which show its build-up in the

mesocosm, especially in the lower, more saline layer. This accumulation occurred to progressively smaller extents in 2x and 3 x CO2 experiments (700 and 1050 micro-atm pCO2, respectively). The authors hypothesize that the greater carbon export and subsequent remineralization in these experiments promoted oxygen consumption in the deeper layer and suppressed ammonium regeneration.

As in the case of the Riebesell et al. (2007) article, the evidence presented here is also indirect. That is, there are no oxygen measurements from the lower layer to support the hypothesis. There are also some apparent inconsistencies in data and interpretation. For example, while turbulence led to vertical mixing resulting in up to 58% dilution of the deeper layer - the increase in ammonium levels in the upper mesocosm is attributed to this effect - a similar decrease in oxygen concentrations is also expected to have occurred in the upper mesocosm. On the contrary, Riebessel et al. found an increase by up to 20 micro-mol/kg in dissolved oxygen under elevated pCO2 conditions. More importantly, I am not aware of any work linking the decrease in oxygen concentration with lower ammonium regeneration in the water column. Rather than the effect on ammonium production, it is more likely that nitrification activity (i.e., ammonium consumption) was somehow affected by different treatments. In any case, the hypothesis offered is speculative and involves a conclusion (greater export of organic matter under high CO2 scenarios) that itself is based on circumstantial evidence. I find it hard to accept how the POC/PON ratio could remain relatively constant and close to the Redfield value both in the suspended matter in the upper mixed layer and in the sinking material collected by the traps in view of the proposed differences in the production and export of organic matter. The authors' explanation of preferential regeneration of carbon relative to nitrogen is speculative and not very convincing.

Specific Comments

Page 2, line 3: Change "currently change" to "are currently changing".

Page 2, lines 3-4: Change "subsequent" to "consequently".

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Page 2, line 5: Delete "natural".

Page 2, line 7: Change "mixed surface waters" to "the upper mixed layer of the mesocosm".

Page 2, lines 8-9: Change "deep waters" to "the deeper layer".

Page 3, line 6 (and elsewhere): Change "21." to "21st".

Page 3, line 7: Change "drives global climate change" to "is expected to drive global climate change".

Page 3, line 13: Change "do drop" to "to drop by".

Page 3, line 22: Change "carbonate saturation" to "the degree of carbonate saturation".

Page 4, line 3: Change "has" to "have".

Page 4, line 9: Change "effected" to "affected".

Page 4, line 11: Change "marine element cycling" to "cycling of important elements in the ocean".

Page 4, line 14: Change "solid" to "good".

Page 4, line 15: Change "are crucial" to "is crucial".

Page 5, lines 7-10: It will be better to describe briefly the nine experiments (i.e., 350 micro-atm: 1-3; 700 micro-atm: 4-6; 1050 micro-atm: 7-9). This information should also be included in the caption to Fig. 2.

Page 5, line 12: Is it 800 litres?

Page 5, line 18: Change "ensured the" to "ensured".

Page 6, line 11: Change "final concentration" to "final DIC concentration"?

Page 6, lines 16-19: How did you sample from a tube open at both ends? Also, the

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volume of the tube will be ˜14 litres, not 20 litres.

Page 6, line 20 (also the heading 3.2 on next page): "Measurements" also includes chemical measurements (analyses).

Page 7, line 1: Is "In principle" needed here?

Page 7, lines 4-5: What is the need to include information about parameters not presented in this paper?

Page 7, lines 6-8: Change the sentence to "Nutrient analyses were performed using an Autoanalyzer (AAII) on samples filtered through GF/F (for nitrate, nitrite and phosphate) and 3 um cellulose acetate (for silicate) according to Hansen and Koroleff (1999)."

Page 8, line 1: Change "and stored" to "and the filters stored".

Page 8, line 9-11: Change the sentence to "The dissolved compounds - DOC (dissolved organic carbon), DON (dissolved organic nitrogen) and DOP (dissolved organic phosphorus)- were determined in the GF/F filtered water samples".

Page 8, line 19: Change "into depth" to "to the deeper, more saline layer".

Page 9, line 2: Change "until" to "at".

Page 10, lines 8-11: The figure shows that ammonium accumulation decreased with increasing pCO2.

Page 10, lines 15-16: If the organic matter was indeed lost from the upper layer and remineralized in the lower layer (below the pycnocline), and given that appreciable mixing occurred across the pycnocline, why did the regenerated nutrients not sustain higher chlorophyll levels than the starting concentration?

Page 11, line 18: Change "lead" to "led".

Page 11, line 20: Change "Redfield" to "Redfield value of".

Page 12, line 2: Change "Redfield" to "the corresponding Redfield values".

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Page 12, line 5: Change "5x" to "6x".

Page 12, lines 8-9: Refer to Fig. 11 here.

Page 12, lines 16-17: Change the sentence to "The 2005 PeECE III mesocosm experiment differs from the earlier studies in several respects, the most important being the establishment of a halocline".

Page 12, line 18: Change "pelagic key" to "key pelagic".

Page 13, lines 1-2: Change to "into the upper surface occurred, probably caused by the wind force acting on the bags that was transmitted to depth".

Page 13, line 10 (also on page 14, line 18): Change "Bellerby and et al" to "Bellerby et al".

Page 14, lines 7-9: Why were the other nutrients not measured in these samples, and if they were, why are the data not presented? These could provide an idea of the extent of remineralization even in the absence of oxygen data.

Interactive comment on Biogeosciences Discuss., 4, 4539, 2007.