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Interactive comment on “Organic matter exudation by *Emiliana huxleyi* under simulated future ocean conditions” by C. Borchard and A. Engel

Anonymous Referee #1

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The paper entitled “Organic matter exudation by *Emiliana huxleyi* under simulated future ocean conditions” describes result of controlled laboratory experiments investigating the individual and combined impacts of temperature and the carbonate system on this well studied coccolithophore using a continuous culture approach. Primary production of particulate and extracellularly released material, concentration of transparent exopolymer particles (TEP) and concentrations and composition of combined carbohydrates (dissolved and particulate) were analyzed in eight treatments (300 μatm , 500 μatm and 900 μatm at 14°C and 900 μatm at 18°C each at two different phosphorous limited dilution/ growth rates).

Overall this is a good presentation of a carefully conducted study which will contribute towards understanding the impact of CO₂ on growth and carbon production of this

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coccolithophore. Below are some notes on a couple of issues that need attention.

Conceptual issues: In situ the carbonate system does not remain constant during growth of phytoplankton, as photosynthesis drastically changes the carbonate chemistry. Thus while these experiments are very useful to investigate certain behavior they certainly do not mimic in situ conditions (conclusion, P1203 line 17pp). Moreover, oligotrophic conditions are also not mimicked in this experimental design with fairly high nitrate concentrations (p1219 line 15).

Phosphor limited growth rates are implied. What were the actual nutrient concentrations during the experiment? Can nutrient limitation be inferred e.g. from phosphate concentrations or POP production? *E. huxleyi* are “low nutrient opportunists” and able to utilize organic phosphor.

TEP correlated with particulate combined carbohydrates – but it may be assumed that both also correlated well with cell concentration (not mentioned or shown). A large fraction of the particulate carbohydrates may be assumed to be cell associated (both internal and external) rather than representing TEP. A correlation between TEP and particulate carbohydrates thus gives very little reason to assume that the former represent the latter.

Low HMW-dCCHO: DO14C in combination with high TEP formation were interpreted to reflect fast partitioning (? transfer) from DOC to POC. This argument needs to be developed more carefully. Bacterial activity (uptake of HMW-dCCHO) may also convert dissolved carbon to particulate carbon, for example, but bacteria are not mentioned at all. Also the composition of released DOC varies with physiological stage of phytoplankton, thus a low HMW-dCCHO: DO14C ratio may reflect changes in phytoplankton exudation as well. When discussing TEP formation from precursors under different CO₂ scenarios, it may be worthwhile to look at a recently published paper on the topic by Passow in Marine Chemistry.

Growth rate is discussed as a parameter in itself, however, in this experiment growth

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rate reflected phosphorus limitation. If growth rate were limited by light climate for example the “impact of growth rate” on carbon partitioning may be very different. Discussing this explicitly would clarify this issue. The measured growth rate is a combined result of the environmental conditions, not a determining factor in it self.

Bacterial enzymatic reactions are not always and generally accelerated at elevated CO₂ (P 1216 line 13). Other papers show the opposite or no response to CO₂ or different responses for different enzyme activities. A more balanced approach might prove wise.

As small differences in experimental conditions impact results, these need to be described in more detail; e.g. especially data on the carbonate chemistry and nutrient concentrations are needed. These may be summarized from the Bochar et al paper. See also below for needed clarifications.

Technical Details: Throughout the MS the treatments are referred to as cultures, but as the same culture was used for all treatments, the word treatment may be more appropriate

P1200 line 26 pp: suggesting a stronger partitioning of PP from DOC to POC by coagulation of exudates. - Please clarify what exactly is meant (see below)

P1201 line 1: omit processes

P1201 line 17:..for light and temperature – does this mean the light intensity or the fluctuation or day length was varied?

Experimental set-up: Some details need to be expanded on: “Where nutrients and carbonate chemistry measured regularly – It states that pH was measured, how about other carbonate parameters and what was the pH range experienced in incubators? Refer to Bochar 2011 when necessary, but give some overall results of ranges. What were nutrient concentrations in the incubators during the measuring phases and before? Again the method is described but no data given. “How did the carbon-

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ate system parameters change during 14C incubations? This could be estimated if it was not measured. – Where treatments conducted as replicates or was there only 1 incubation per treatment? Do averages represent the 3 measuring dates of one incubation? – Was the bubbling of the incubators with adjusted air continued during the experiment (after incubation), or was only the media bubbled after the initial equilibration phase? If the latter, than information on the variability of the carbonate chemistry in incubators is even more essential. – After inoculation a 3 d batch growth was followed by 12 days at $D=0.3 \text{ d}^{-1}$, followed by 12 days $D=0.1 \text{ d}^{-1}$. (p 1205 line 5 pp) – How long after the different dilution rates were established did it take until cell concentrations in the incubator remained constant? page 1208 line 14: steady state between days 10 and 12 – how is that possible if each dilution regime was only enforced for 12 days? Also see line 10: lowering dilution rate ... day 17 – the counting of days seems inconsistent throughout the MS. The development of these cultures in each treatment must be described more accurately. – Sampling on day 10, 14 and 17 ($D=0.3 \text{ d}^{-1}$) as well as on day 22, 25 and 28 ($D=0.1 \text{ d}^{-1}$). – How is that possible, after three days batch and 12 days of $D=0.3 \text{ d}^{-1}$ the last sampling day at $D=0.3 \text{ d}^{-1}$ would be day 15! Later sampling is referred to as 1,2 and 3? Please clarify what that signifies. – To what conditions were cells acclimatized before inoculation?

P1208 line 17: cell yield. ... – yield usually does not describe a concentration but total production/ harvest

P1208 line 24: ..sampling 1,2 and 3 – what does this mean? Are the three sampling days meant? Both in text and in figure legends.

P1211 line 1: omit “now” P1211 line 14: While ... higher ... – Sentence needs grammatical adjustment and is too long, “higher than what?”

P1215 line 11: add “(diatom)” after *T. pseudonana*

Writing associated with figures is too small except for figure 4

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Fig 6: Do these values represent the ratio of rates (e.g. TEP production rate to POC production rate) or the ratio of standing stocks (TEP concentration vs POC concentration). Please clarify, in text and table also.

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