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Interactive comment on "Biogeochemical implications of comparative growth rates of *Emiliania huxleyi* and *Coccolithus* species" *by* C. J. Daniels et al.

C. J. Daniels et al.

c.daniels@noc.soton.ac.uk

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Anonymous Referee #3

We thank the reviewer for their comment and address them below

The authors performed culture experiments to challenge the assumption that under identical culture conditions Emiliania grows "significantly" faster than either of two *Coccolithus* species. Though I agree that such a direct comparison under identical culture conditions is a useful approach, I cannot follow the conclusion derived from the results. The authors confirm that under various identical culture conditions Emiliania has indeed higher growth rates than *C. pelagicus*/ *C.*

***braarudii*. To me this confirms the assumption they set out to challenge. The authors claim that these differences are small and not significant. Please clarify for what reason. The term "significant" is obviously not used in a statistical context. Instead the authors define 2 times higher to be significant (p.10516, lines 15-18). This approach is difficult to understand and needs to be clarified. I suggest including statistics on your results and in addition evaluating the differences in growth rate in a biological context.**

We have now rephrased and clarified the manuscript to remove mention of the term "significant" except for when used in a statistical context. We agree that in most of the culture experiments, *E. huxleyi* grew faster than *Coccolithus*, and do not state otherwise in our manuscript. However, our main point regarding relative growth rates is that the difference is smaller than had been anticipated based on previous literary measurements and assumptions. We have reworded this paragraph to clarify this point, and now include statistics where appropriate.

As growth rate is an exponential measure, the biological significance of even small differences may be underestimated. For instance, translating 12 and 28% higher exponential growth rate (p.10519, lines 8-9) into abundance in a natural phytoplankton community will result in huge differences after only a few rounds of cell division. However, further following the discussion I have the impression that growth rates from culture experiments are not necessarily informative when determining the relative abundance/contribution to calcite production of the respective species in natural phytoplankton communities and wonder if such a model as used in this study should actually be based on growth rate data from culture experiments.

The reviewer is correct that gross growth rate, as determined from culture experiments, is an exponential measure. However, phytoplankton suffer loss (through grazing, advection or viral lysis) and therefore their net growth rates are likely to be significantly lower and potentially not exponential. Daily calcite production (the timescale at which

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we are considering) will be directly related to the gross growth rates of that day, rather than the net growth rates. Therefore we are able to apply our experimentally determined gross growth rates to estimate calcite production. There is a lack of in situ measurements of individual species or coccolithophore growth rates, thus our culture data is the best available data at present that we have for considering relative growth rates and calcite production. We have not used culture data to inform about relative abundance but instead have used field samples.

p. 10514, lines 5-7: I suggest to clarify what you consider to be a fast/slow growing coccolithophore species as this may confuse the readers.

We have rephrased this sentence.

p. 10519, lines 21-23: The light intensities used in this study do not appear to be a reasonable explanation for the lower growth rates compared to many other studies on Emiliania cultures that report growth rates >1 at similar temperature/light levels.

While the instantaneous irradiance alone cannot explain the differences in growth rates between our study and other studies, the day length and daily dose of irradiance will have a significant effect on growth rate. While coccolithophores will become light saturated at a given instantaneous irradiance, the length of time for which they are exposed to this irradiance will affect their growth rates, with a general increase in growth rate as day length increases (Paasche, 1967). It has been shown that day lengths shorter than 16 hours will reduce phytoplankton growth, however there is no consensus in the literature as to which day/night cycle is recommended (Probert and Houdan, 2004). As our study used a day length of 12 hours, we would expect our growth rates to be lower than studies that have used 16 hour day lengths (e.g., Bach et al., 2011; Hoppe et al., 2011; Langer et al., 2009). However, our maximum growth rates are similar to Iglesias-Rodriguez et al. (2008) who used a 12 hour day length. We have reworded and extended our discussion of daily dose irradiance to improve clarity.

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p. 10521, lines 20-25: I am not familiar with this method. However, I wonder if there is any inter-calibration of different methods available that you could refer to?

This method is a well-documented method that is prevalent in studies of natural communities (Gibbs et al., 2013; Poulton et al., 2011; Young and Ziveri, 2000). As far as we are aware, a direct inter-calibration between methods has not been performed, although the same culture strain has been examined both biometrically (Hoffman et al., 2014) and chemically (Langer et al., 2009). We have now added references for our method.

p. 10522, lines 17-20: This is not a "population" but a "community" as you refer to an assemblage of different species.

We have changed this text as suggested.

p. 10523, lines 2-3: Please clarify what you mean by "The relative abundance of *E. huxleyi* to *C. pelagicus* was generally low (0.7–85) . . ."

We have rephrased this sentence to clarify that the relative cellular abundance of *E. huxleyi* in most of the samples was well within our model range, with a low average.

p. 10525/10526: I suggest to include a brief discussion on the relative importance of the studied coccolithophore species for calcite production/the oceanic carbon cycle in areas where *Coccolithus* species are of high abundance vs. a global scale.

We have added a more in depth discussion of the potential importance of *Coccolithus* in a global context. However, our intention with this manuscript was not to explicitly define the (global) magnitude of calcite production of *Coccolithus*, but to highlight the potential importance of *Coccolithus* and perhaps other calcite-rich coccolithophore species in the global ocean.

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Interactive comment on Biogeosciences Discuss., 11, 10513, 2014.