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Interactive comment on "Changes in coccolith calcification under stable atmospheric CO_2" *by* C. Bauke et al.

Anonymous Referee #1

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The manuscript 'Changes in coccolith calcification under stable atmospheric CO_2' presents data on Noelaerhabdaceae coccolith weight measurements from three different North Atlantic cores during the pre-Industrial Holocene. This is at times with minimal changes in atmospheric CO_2.

Previous studies have attributed changes in coccolith weight in sediment cores to changes in seawater carbonate chemistry, namely carbonate ion concentrations. Thus, this study can be considered ground truthing this hypothesis. Very interestingly, in two cores changes in coccolith weight are opposite to what would be expected from the estimated (small) changes in seawater carbonate chemistry. But most importantly, they are on the same order of magnitude as variations observed on the comparatively large glacial/interglacial CO_2 variability.

These findings are very important for future studies as highlighting that other factors, such as temperature, nutrient availability, and/or species and strain composition (also shown in controlled laboratory experiments) have probably much higher influence on coccolith weight than changes in seawater carbonate chemistry speciation. In this respect, previous studies trying to relate changes in coccolith weight to the latter alone, seem questionable. Thus, this manuscript represents a timely and important contribution to an ongoing discussion.

General comments:

1) Throughout the entire manuscript the term 'calcification' is used without clear distinction between calcification rates, the process itself, cellular calcium carbonate quotas and so on. As for instance calcification rate can change without affecting cellular quotas, the authors should be more specific.

2) Physiological studies on the effects of changing carbonate chemistry (on the scales of glacial/interglacial variability) suggest that it is rather pH than CO_2 or carbonate ion concentration affecting calcification rates in coccolithophores. The authors and other paleoceanographic studies, however, focus on carbonate ion. This should be discussed in more detail.

3) This and previous studies rely on reconstructions of ancient seawater carbonate chemistry speciation. One of the assumptions (not to mention uncertainties in temperature estimates and reconstructions of alkalinity from proxy-derived salinity) is air/sea gas equilibrium. This is, however, not the case in large parts of the ocean where seasonal seawater CO_2 variability, exceeds atmospheric variability on glacial/interglacial time scales. An exception are the super-oligotrophic regions of the central subtropical gyres, but many sediment cores are outside these areas. This issue should be discussed.

4) At the end of the discussion a paragraph on the most likely explanations, derived from direct measurements (e.g. species composition or morphotypes) as opposed to

speculation, for changes in mean coccolith weight at each site could be presented.

Specific comments:

1) P9416, L8: 'increasing pCO_2 and carbonate ion concentration', changes actually go in opposite directions.

2) P9416, L11: What is meant with 'realistic analysis'?

3) P9416, L15: Here and throughout the manuscript, what is meant with 'calcification'? See also general comment #1.

4) P9416, L17-18: Looking at the figures, it is rather 7 to 6pg at the Azores and 7 to 10pg at the Vøring Plateau.

5) P9416, L28: Higher productivity would potentially lead to higher CO_2 disequilibrium between seawater and air, i.e. lower seawater pCO_2. See also general comment #3.

6) P9417, L19-20: A direct connection between sinking speed of marine aggregates and size/weight of coccoliths is not shown in Rickaby et al. (2007).

7) P9418, L1: Beaufort et al. (2011) doesn't really confirm the observation that ocean acidification can influence coccolith size and weight as glacial/interglacial changes in carbonate chemistry speciation are much smaller than those expected for future ocean acidification. Furthermore, the current study challenges the conclusions drawn in Beaufort et al. 2011.

8) P9418, L3: The term 'driven' is not justified, as it was a correlation, not a cause-effect relationship.

9) P9418, L10: What do the authors mean with 'pH calcification optimum'?

10) P9418, L17: Nutrient utilization changes have direct influence on seawater carbonate chemistry speciation. See also general comment #3.

11) P9418, L24: I would re-phrase to 'The probably relatively minor changes in..', but

see also general comment #3.

12) P9419, L4: 'Allowing to assess' is a statement a bit too strong.

13) P9420, L26: The potential bias of counting 100 coccoliths in some and 3500 in others cases should be discussed in more detail. Adding detailed information to the graphs (or in a table) on the actual amount of coccoliths counted in each sample could be beneficial.

14) P9422, L15-20: Reconstructed changes in sea surface temperature are opposite to what I would have expected. If the Azores Front with warmer waters in the South shifted northwards during the Late Holocene, I would have thought sea surface temperatures to increase at ODP Site 980.

15) P9424, L14: Change to 'reported'.

16) P9425, L25: Change to '... the reconstructed carbonate ion ...'. See also general comment #2 and 3.

17) P9427, L3: Why should the, probably more obvious, explanation that changes in coccolith weight are the combined result of changes in temperature, nutrient availability, and species and strain composition, rather than relatively small changes in carbonate ion concentrations alone, be restricted to the North Atlantic?

18) P9430, L9: Change to '... the CO_2 solubility in the ocean depends on parameters such as SST and alkalinity.'

19) P9430, L11: 'strong decrease' in what?

20) P9430, L11: change to '... within rather stable atmospheric CO_2...'

21) P9432, L15: In my understanding, the study of Lohbeck et al. (2012) detected changes in strain abundance as the most important adaptation, over new genetic mutations.

22) P9433, L8: This study not only did not detect changes in coccolith weight, previously ascribed to changes in carbonate ion concentrations, it even found the opposite in two sediment cores.

Interactive comment on Biogeosciences Discuss., 10, 9415, 2013.