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Biogeosciences Discussions

Interactive comment on "Effect of CO_2 on the properties and sinking velocity of aggregates of the coccolithophore *Emiliania huxleyi*" *by* A. Biermann and A. Engel

Anonymous Referee #2

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Many researchers are jumping on the bandwagon to investigate impacts of ocean acidification. However, most of the papers on the impacts to marine organisms and their consequences do not take into account adaptation of the organism through evolutionary time to more gradual increases in ocean acidification. Plopping unadapted organisms into a high CO2 environment, such as was essentially done in this paper, does not test their response to a high CO2 ocean of the future, but rather measures their response to stressful environmental conditions. Predictions from such experiments do not necessarily reflect what will actually happen in the future ocean. This paper, although quite carefully done, is just another example of this current and accelerating problem in the literature. This reviewer is not sure that the results have meaning or

predictive value in the real world where phytoplankton will never experience sudden extreme increases in ocean pH. In the case of marine algae, the problem of adaptation could have been circumvented in the methods of this paper since algae have short life spans and could have been raised through many many generations in a high CO2 environment before they were tested for aggregation. Acclimation for 13 days, as done in this paper, is not enough for adaptation.

Thus, I have major problems with this paper and the applicability and validity of the results to the real world. Some of the results suggest that the coccolithophorids were in fact stressed. For example, aggregates formed from those in ambient conditions were smaller and less fluffy. Phytoplankton under stress from many causes often produce more exudate material (polysaccharides) that would generate more mucousy, fluffy aggregates.

The authors might argue that the relevance to real ocean acidification does not matter because the paper demonstrates differences in the composition and characteristics of coccolithophorid aggregates with varying amounts of calcified and non-calcified E. huxleyi, regardless of the cause. However, that approach has already been published (Engel et al. 2009b).

If this paper is to be published the authors need to add an extensive section of the possible impacts of stress in causing their results, discuss the problem of lack of adaptation, and be much more conservative in their conclusions.

Specific comments:

No reference is given for line 10, page 9820 that lower pH results in lower calcification rates of coccolithophorids. Calcification rates may remain the same but dissolution rates may be higher, or both higher dissolution and decreased calcification may occur. This should be clarified. A similar assumption is made at line 16, page 9829 where naked cells are assumed to be that way because they don't calcify, whereas dissolution could also play a role.

Methods: The methods used are good, very thorough, and pretty much state of the art for handing and quantifying marine aggregates. However the authors began aggregation experiments 7 days after the start of stationary phase. This is very far along in the growth cycle. Aggregation of most phytoplankton in nature occurs soon after stationary phase begins. I understand that the authors needed enough material and gel exudates to achieve aggregate formation in these cultures and that that was probably only possible in late stationary phase. But again, this brings into questions the validity for predicting events in nature. Other conditions were also unnatural, especially the high concentrations of coccolithophorids considerably above expected concentrations in nature.

Discussion – A large section of the discussion is focused on impacts to particle flux in a high CO2 world. There needs to be considerable and strongly worded discussion added stressing that the cells in these experiments were not adapted and were thus stressed. We do not really know how these algae will adapt. Thus the results represent a worst case scenario that may not (and probably won't) happen. The authors need to be much more conservative in the implications of these results and discuss in detail the problem of stress.

A tremendous amount of work went into this paper and the authors are to be complemented on the care with which they made measurements and the technical expertise demonstrated regarding aggregation processes and theory.

Interactive comment on Biogeosciences Discuss., 6, 9817, 2009.