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Interactive comment on "Not all calcite ballast is created equal: differing effects of foraminiferan and coccolith calcite on the formation and sinking of aggregates" *by* K. Schmidt et al.

Anonymous Referee #1

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GENERAL COMMENTS

The paper by Schmidt et al. presents results from an interesting experiment which set out to examine the affects of different types of calcite (small coccoliths versus large whole tests of foraminifera) on particle (marine snow) formation and sinking speeds. The issues addressed in this study go directly towards a greater understanding of the biological carbon pump and how ecosystem composition influences the export of organic carbon. It also examines some of the potential upper ocean mechanisms associated with the so-called 'ballast' effect, whereby sinking organic carbon becomes associated with biominerals (in this case calcite), which aid in the export of this material to depth.

The current study found two interesting results – that coccoliths did become incorporated into aggregates and increase the sinking speed relative to similar size aggregates with no coccoliths, and that whole tests of foraminifera broke large aggregates up and failed to incorporate any of the material. The manuscript is well written, with a logical structure and arguments and most of the conclusions are well supported by the results. Two issues come to mind, however, about the interpretation and experimental design.

The first concerns discrepancies between size of the final aggregates analysed (all >1 mm) and size of the foraminifera tests used (>0.25 mm, but maximum size not reported), and the potential for marine snow aggregates <1 mm (i.e., 0.5-1 mm) to have formed but not collected via the experimental design. The authors state that they made photographs of the tank bottom (pg 14865, ln 19) but do not state the resolution of such images and whether these would have seen small (0.5-1 mm) aggregates. They go on to state that after this all the visible >1 mm aggregates were collected – did this then exclude the smaller foraminifera tests (< 1mm) from the rest of the analysis? What proportion of the initial PIC added initially did this equate to? Did selection of the particles >1 mm exclude smaller particles which may have been of sufficient density to sink and skew the results towards larger ESD? Also, in the ocean what is the size spectra of marine snow aggregates – are the sizes of particles found in this study (2-9 mm ESD) common in the ocean? Some mention of these factors in the discussion would add significantly to the paper.

The second limitation/caveat of the study is in the choice of calcite: the authors use a 'clean' form of sedimentary material, which lack any of the associated organic matter (polysaccharides in the case of coccoliths and cellular material in the case of foraminifera) which would normally be found with these particles in the surface ocean. How do the authors think that this may influence their results? Could such substances be involved in aggregating material at lower ESDs? Although not to the detriment of the current study, it would be worth adding some mention to the discussion and suggesting that a repeat of the experiment with 'dirty' sources of calcite may also provide insights

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into the association between organic and inorganic particles in the upper ocean.

SPECIFIC COMMENTS

pg 14863, lns2-4 and lns 11-14: How many references are needed to make a point? Here, 8 and 11 different papers are cited to support two relatively simple points.

pg 14863, ln 18: The authors should be aware that two more recent studies by Le Moigne et al (2012) and Riley et al (2012) also support the notion that calcite incorporation with POC affects size and sinking velocity. For continuity in the paragraph "POC and minerals" would be better phrased as "POC and calcite".

pg 14863, ln 24: Do the authors have a reference to back-up the statement relating to shear and foraminifera associated carbon export?

pg 14863, ln 28: Do the results support the statement: "..the other significant portion of sinking calcite should have little influence over POC export"? The results show that the foraminifera tests do become associated with a small amount of POC, which with the fast sinking speeds of these particles would carry it to the deep ocean. Also, how do the authors interpret the observations of Riley et al. (2012) of aggregate-protist complexes (their Fig. 2) as part of the fast sinking marine snow particle pool seen in the North Atlantic?

pg 14864, ln 11: What is the cell size of Chaetoceros gracilis, relative to coccoliths and tests? The reference should be "Le Moigne" not "LeMoigne".

pg 14865, ln 22: Were any pictures taken of the aggregates picked for sinking speed determination? These would also be useful for the discussion of 'fluffy' aggregates (pg 14869, ln 18) in the Discussion.

pg 14865, ln 28: What is the justification for picking particles > 1mm?

pg 14866, ln 14: For PIC analysis, was the MilliQ used to rinse the filters of seawater salts pH adjusted? MilliQ tends to be acidic leading to the (small) potential for dissolu-

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tion/etching of material during exposure.

pg 14869, ln17: How does the calcium carbonate concentration used in the experiment compare to that found in the open ocean?

Please check through the manuscript to make sure that oC is used when referring to temperature instead of ‘C, particularly in the sampling and analysis section.

References

Alldredge, A. L. and Silver, M. W.: Characteristics, dynamics and significance of marine snow, Prog. Oceanogr., 20(1), 41–82, 1988.

Le Moigne, F. A. C., Sanders, R. J., Villa-Alfageme, M., Martin, A. P., Pabortsava, K., Planquette, H., Morris, P. J. and Thomalla, S. J.: On the proportion of ballast versus non-ballast associated carbon export in the surface ocean, Geophys. Res. Lett., 39(15), L15610, doi:10.1029/2012GL052980, 2012.

Riley, J. S., Sanders, R., Marsay, C., Moigne, F. A. C. Le, Achterberg, E. P. and Poulton, A. J.: The relative contribution of fast and slow sinking particles to ocean carbon export, Global Biogeochem. Cycles, 26, 1–10, doi:10.1029/2011GB004085, 2012.

Interactive comment on Biogeosciences Discuss., 10, 14861, 2013.