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Interactive comment on "A multi-species coccolith volume response to an anthropogenically-modified ocean" *by* P. R. Halloran et al.

J. Young (Referee)

j.young@nhm.ac.uk

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Iglesias-Rodriguez et el. (2008) published a provocative paper suggesting that coccolithophores, one of the most important groups of biocalcifying plankton may respond to ocean acidification by increasing rather than decreasing their calcification. This question a key paradigm of ocean acidification research, that acidification will inhibit biocalcification. So, the paper has attracted considerable interest and comment both among academic researchers and the much broader community of citizens and decision makers interested in climate change science. Iglesias-Rodriguez et al (2008) presented results from two separate studies. The first of these was a series of incubation experi-

ments on the response of natural coccolithophore populations to elevated CO2 levels, which provided evidence for increased calcification by the key species Emiliania huxleyi. The second set of results came from well-dated, very rapidly deposited, sediments suggesting an increase in mean coccolith mass over the past century paralleling the rise in global CO2 levels. The current paper deals with the sediment study, providing important new details to allow assessment of the robustness of the results. Specifically, the data in Iglesias-Rodriguez et al. (2008) on mean carbonate particle mass in the <10μm fraction is supplemented here by coulter counter data on particle volume. This new data is used to analyse how the particle size spectrum has changed through this time interval. Given the great topical interest of the subject matter this is clearly an important paper and BioGeoscience Discussion is an ideal forum for publication of the work.

Specific comments

The data presented provide strong evidence of changes in particle size distribution and additional support for the hypothesis that coccolith size has changed significantly in the recent past and particularly in the past 25 years in the sediments of the studied core, RAPID 21-12-B. These results provide strong evidence of deep sea sediments responding to recent environmental change and unquestionably deserve to be investigated. However, interpretation of the results is not straightforward and three specific aspects deserve more comment in order to avoid over-extrapolation of the results.

1. The evidence for coccolith size change is indirect

The data is based on measurements of carbonate particle volumes without determination of whether these are coccoliths, far less what species they are. There is conventional count data from the unprocessed sediment that coccoliths dominate the fine carbonate fraction and that the coccolith species assemblage does not change significantly up-core (fig. 3 of Iglesias-Rodriguez et al. 2008). Based on this it is assumed that changes in particle volume spectrum are a result of changes in coccolith calci-

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fication rather than changes in species assemblage, or changes in the non-coccolith fraction. This is a possible explanation of the results, however, small changes in the contributions of different species or non-coccolith carbonate could easily account for the observed patterns. Also it should be noted that the nannofossil assemblage counts were carried out on the raw sediment not on the filtered sediment used for the size analysis. So, the interpretation that the particle size shift is caused by intraspecific changes in coccolith mass urgently needs to be tested by direct observations.

2. There is no evidence of size increase in Emiliania

The data presented here suggests that the increase in mean coccolith mass in the most recent samples is largely a product of decrease in particles of effective spherical diameters of 1-1.5 microns, which is the size fraction of Emiliania huxleyi and small Gephyrocapsa coccoliths, with concomitant increase in relative abundance of both smaller and larger particles. This results appears to be in conflict with the initial interpretation of Iglesias-Rodriguez et al. (2008) that increase in calcification across the size spectrum of coccoliths could explain the increase in mean particle mass. More specifically it means that there is no evidence that the mass of Emiliania huxleyi coccoliths has increased thus making comparison of the culture results on Emiliania huxleyi and these sediment results increasingly tenuous.

3. Possible influence of sedimentary processes

It must be noted that the sediments studied here are drift deposits, from the eastern flank of the Reykjanes Ridge in the sub-polar North Atlantic deposited by the Iceland-Scotland Overflow Water (Boessenkool et al. 2007). This is a logical choice of environment since the drift process produces the very high sedimentation rates which are necessary in order to study assemblages at high resolution. In normal pelagic sediments sedimentation rates are typical 10-30m/Ma, i.e. 10-30mm per thousand years, as opposed to 2300mm per thousand years in these drift deposits (Iglesias-Rodriguez et al. 2008).

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Clearly changes in sediment particle composition in this type of deposit could be a product of changes in flow velocities, or changes in the relative contribution of different source regions to the overflow water, rather than being exclusively a product of changes of particle flux into the source regions of the outflow water. There is probably no way that these two possible factors can be separated out from study of a single location. Hence results from a range of locations are needed before firm conclusions can be drawn from the results.

Summary The more detailed data presented here indicate that the inference of Iglesias-Rodriguez et al. (2008) that coccolith mass has increased in response to rising global CO2 levels is less robust than it appeared. This paper is an important correction and should certainly be published but fuller discussion of the problems in interpreting the data would be worthwhile.

References

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