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

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The paper deals with the important question whether effects of ocean acidification on coccolithophore calcification can be detected in natural samples as opposed to samples from laboratory experiments. Looking at the sedimentary record is a reasonable approach to address that question. The authors present Coulter Counter measurements of the $< 10 \mu\text{m}$ size fraction of a sub-polar North Atlantic core. The data are interpreted in terms of a coccolithophore calcification response to rising atmospheric CO₂ concentrations. It is concluded that the coccolith mass of the heavier species increases in response to rising CO₂ concentrations. This conclusion, however, is not

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straightforward and needs considerable modification. There are two reasons for this: firstly, the methodology is suitable to only a limited extent, and secondly, a coccolith size change observed in sedimentary samples might have various causes.

1. Methodology Coulter Counter measurements provide only indirect evidence for coccolith size change. I perfectly agree with specific comment 1 by J. Young (Referee) and would like to re-emphasise that there is the need to test the Coulter Counter results by direct observations, i.e. biometrical analysis of SEM micrographs for instance.

2. The cause of a coccolith size change In the following I will assume that the data provided by the authors indeed show that some coccolithophore species have increased calcification in the last 30 years. It is well known that atmospheric CO₂ concentrations have risen for at least 50 years. Based on these two premises the authors conclude that calcification of coccolithophores has increased because of the increase in CO₂ concentrations. This is wrong because the equivalence of a correlation and a causal relationship can only be assumed for a controlled laboratory experiment, in which only one parameter was changed. Nevertheless, the sedimentary data provide an opportunity to test hypotheses derived from laboratory experiments. The studied core RAPID 21-12-B comprises approx. the last 230 years, i.e. CO₂ concentrations ranging between approx. 280 and 380 μ atm. For that CO₂ concentration range most experiments do not suggest a measurable change in coccolithophore calcification (Iglesias-Rodriguez et al. 2008, Langer et al. 2006a, Zondervan et al. 2001). However, a *C. leptoporus* experiment suggests that the number of incomplete (i.e. smaller compared to normal) coccoliths increases when CO₂ concentration is increased from 280 to 380 μ atm (Langer et al. 2006a). Whether this is valid for the natural environment can be tested using samples from the studied core RAPID 21-12-B. The Coulter Counter data presented here do not seem to support the notion of decreased calcification in *C. leptoporus*, i.e. are seemingly in contrast to the experimental data. The question whether they are actually in contrast to the experimental data, however, can only be answered on the basis of the necessary data, i.e. analyses of coccolith morphology and possibly

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size. These data would allow for another important comparison of experimental and geological data, complementing the comparison of experimental data with sedimentary data from the LGM (Langer et al. 2006a).

Technical comments: On page 2924, line 16, the reference to Langer et al (2006b) should be deleted. On page 2924, line 18 a wrong reference is given; the correct reference is Langer et al. (2006b). On page 2926, line 14 the reference is incomplete, i.e. only the year is given. The authors do not mention how the core they use was dated. The paper in which this was described (Boessenkool et al. 2007) should be cited.

To sum up, the paper by Halloran et al. addresses an important question. Direct measurements of coccolith size and morphology, however, would make the inferences much stronger. Moreover, the interpretation of the results needs to be modified. A revised version of the paper should be published in Biogeosciences.

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