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Biogeosciences Discussions



# *Interactive comment on* "Coccolithophore response to climate and surface hydrography in Santa Barbara Basin, California, AD 1917–2004" *by* M. Grelaud et al.

**M. Grelaud et al.**

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We thank J.P. Gattuso for his constructive criticism that helped to improve the manuscript substantially.

1-Most oceanographers use the "calcification" to describe a rate that is a mass of CaCO3 precipitated per unit of time. However, this paper reports data on the coccolith mass and size. It is important to note that mass and calcification may not be correlated as cells with a light coccoliths may exhibit a rate of calcification higher than cells with heavier coccoliths if the mass of CaCO3 was precipitated over a shorter time interval. In other words, the generation time is required to convert coccolith weights into calcification rates. Therefore, the authors cannot claim that calcification (or biomineral-

ization; see line 16 on page 4144) has increased in the past decades but, rather, that the mass of coccolith has increased.

Answer : we meant by calcification, the process of what is calcified and the result of this process. We agree with J.-P. Gattuso that this terms and/or "biomineralization"; could be used ambiguously here because it can be taken as a rate. To stop this confusion we replaced these words by mass, a less ambiguous term, in the revised manuscript. This does not change the signification of our finding in the SBB core.

2-The paper reports on experiments carried out by Beaufort et al. (2007) who showed that "during experimental acid attack the weight of cultured and fossil coccoliths did not change significantly in a range of pH going from 8.2 to 6.2". I suggest that the pH scale should be mentioned. Also, does this mean that there was no dissolution at lower pH? If there is dissolution at low pH, why is it that the weight of coccoliths did not decrease? This is critical because those data are used to dismiss a possible dissolution in the earlier part of the record, hence suggesting increased mass as a function of time.

Answer: in the experiment carried out by Beaufort et al. (2008), the authors used a total pH scale. During the experiment more than 80% of the coccoliths were dissolved, but the weight of remaining coccoliths had not changed significantly. To answer the question of J.-P. Gattuso, in that experiment the coccoliths have experienced acidification, but the coccoliths that remains were not changed. Coccoliths do not react progressively to dissolution but instead they break. Either they are broken and not recognized (the 80% that disappeared in the experiment) or they are not really touch (the 20% left). This paper did not express an absence of dissolution of coccoliths since most of them got dissolved. For the coccoliths which remained after the acid attacks, only small variations in the shape of E. huxleyi (etching) was observed on the SEM, but this had no significant effect on the weight of the coccoliths because the part which was dissolved represented less that 10% of the mass of the coccoliths. All this is described in depth in Beaufort et al. (2007) and we reworded slightly the manuscript to make it clearer but we did not expended to much because G3 is an online AGU journal which



**BGD**

5, S3219–S3223, 2009



is easily available. We tested as well the good preservation of coccoliths all along the core by the examination of samples taken at the top and the bottom of the core B with a SEM.

3-Section 4.1 mentions that the concentration of nutrients is also an important parameter controlling the abundance (and, presumably, the morphometric characteristics and weight) of coccolithophores. Section 4.3 would benefit from a paragraph mentioning how changes in the nutrient concentrations would impact the weight and size of coccoliths. The goal being to try disentangling the respective impacts of environmental changes on coccolith mass.

Answer: it is true that nutrients availability could have an effect on coccoliths morphometry, then we add a paragraph, in the revised manuscript, discussing the impact of nutrients on the weight of coccoliths in section 4.3 20th century warming and increasing mass of coccoliths: "Alternate explanations are based on long term changes in the availability of nutrients and/or SST. It has been suggested that coccolithophores secrete highly calcified coccoliths in environments with higher nutrient abundances such as in upwelling areas (Beaufort et al., 2008; Beaufort et al., 2007b) or fertilizing experiment in mesocosm (Engel et al., 2005). The 20th century increase in coccolithophores' carbonate mass would then reflect an increase in nutrient availability in the SBB. However, the California Current System (CCS) has experienced a spin-down since the beginning of the 20th century implying a deeper thermocline and upwelling of warm, nutrient-poor waters (Weinheimer and Cayan, 1997). This could be responsible for the observed marked decrease in zooplankton biomass in the California bight since the 1950s (Roemmich and McGowan, 1995) and would suggest reduced primary production. This scenario argues against a connection of increased carbonate mass of coccolithophores with nutrient availability in the SBB."

4-The two sentences in lines 16 to 19 of page 4144 are not very clear and should be reworded. Note that enhanced calcification generates CO2.



**BGD**

5, S3219–S3223, 2009



Answer: these two last sentences appear to be ambiguous, we prefer then to remove it and argue that the increase of coccolithophores calcite mass is linked to modern oceanic changes in SBB surface waters.

5-The paper may benefit from a discussion of data recently reported in another upwelling area off Portugal (Silva et al., 2008).

Answer: we added this reference to section 2.2 Coccolith census in the revised manuscript.

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5, S3219–S3223, 2009

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5, S3219–S3223, 2009

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