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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 anonimous Referee #1 for his constructive criticism that helped to improve the manuscript substantially. We have followed the suggestions in most cases. All relevant parts of the manuscript have been revised in order to clarify issues raised by the referee.

Grelaud et al., present an intriguing new dataset with unrivalled resolution of changes in coccolithophore assemblages and weights during the last 90 years from the varved record of the Santa Barbara Basin. Specifically, they are able to reconstruct a history of ENSO but also to chart changes in the weight of the coccolithophores over the timescale of anthropogenic change.

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Interactive Discussion
Discussion Paper

I am not so qualified to comment on the spectral analysis and application of the assemblages as a measure of PDO and ENSO through time but this appears to be a valid and interesting new methodology. However, the annual and decadal changes in weight are much larger then those of the trends over the last 90 years. The authors do not really comment on what could be driving the changes in interannual variability and yet this is the larger component of the signal which is worthy of grater discussion and detail.

1- I am also interested by the degree of preservation of the coccolithophores through time. Could there be any preservation biases down the core?

Answer: the preservation of coccoliths down core is very good as we checked it by inspecting samples with a SEM.

2- One of my main concerns is the state of the waters at the site with regard to equilibration of CO2 with the atmosphere. If we want to invoke a change in the coccolithophores with the changing chemistry of the atmosphere, it is essential to know whether the surface is at equilibrium. At the very least, it appears that the cold CC brings nutrients and waters from upwelling and so likely has a greater charge of CO2 from remineralisation and is actively effluxing carbon dioxide to the atmosphere. Are the waters at this site a source or sink of CO2 to the atmosphere or are they at equilibrium? If there is a change in the relative proportion of upwelling waters to subtropical waters then that could affect the carbonate chemistry independent of the change in the atmosphere associated with anthropogenic change.

Answer: even if during summer, the continental shelf of western North America (i.e. from Vancouver Island, Canada, to Southern Baja California, Mexico) is characterized by upwelled CO2-rich waters, this region continues to accumulate more anthropogenic CO2 (Feely et al., 2008). This phenomenon affects CC waters as well as subtropical waters. This area is clearly a source of CO2. We added few sentences in the manuscript about that in section 4.3.

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3- How much can the changes in size and weight be attributed to any trend in the ENSO or PDO indices?

Answer: we prefer discuss of long term variability of coccoliths mass rather than high frequency variability such as El Niño or PDO, but, we added a paragraph in section 4.3 stipulating that : "between the 1940's and the 1970's, weights of E. huxleyi and G. oceanica decreased (Figure 5a). This period corresponds to the cool phase of the PDO, which implies cooler SST along the North American Pacific margin. This aspect reinforces our supposition that warm SST are able to enhance Isochrysidales mass. In this context it is possible to suppose that high frequency variability in weight of E. huxleyi and G. oceanica during the 20th century could be linked to El Niño variability, with an increase of mass during warm episodes." In addition an increased upwelling injects more CO2 in SBB. At the contrary weak upwelling during El Niño should results in less CO2 concentration, which could lead to a changing calcification: But there is no real long term tendency in ENSO dynamics, and if we observed such a long term tendency in the coccoliths mass, this cannot be explained by ENSO.

4- Also, we know that the calcification can be affected by changes in the carbonate chemistry, but perhaps most starkly by changes in phosphate availability with limiting phosphate inducing large increases in calcification. Is there any evidence to suggest that the trend could be a result of changing phosphate limitation through time?

Answer: We added few sentences on that matter in 4.3. The CCS experienced a spin-down during the last century, which implies a deeper thermocline and upwelling of warm, nutrient-poor waters (Weinheimer and Cayan, 1997). One could then suppose that the spin-down could lead to depletion of nutrients and by inference of phosphate in surface waters. However, it has been shown that coccolithophores secrete more calcified coccoliths in higher fertility environment (Beaufort et al., 2008; Beaufort et al., 2007; Engel et al., 2005). As we observed an increase in the mean weight of Isochrysidales species through the 20th century, we supposed then that nutrient availability is not responsible for this increase.

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5- Are there any other features of the core which could be interpreted as changing nutrient availability?

Answer: analyses on core A and B are limited to TEX86 (Huguet et al., 2007) and coccoliths assemblages, we don't have any other proxies which could be interpreted as changing nutrient availability.

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