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

This study presents an impressive high-resolution record of 6 coccolithophore species counts along a core from the Santa Barbara Basin that covers almost the entire 20th century. Changes in relative abundances of these species are proposed as proxies of ENSO and PDO oscillations. This paper also speculates that the long-term trend of the weight and size of three coccolithophore species could reflect changes in calcification

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Interactive Discussion
Discussion Paper

either as a result of SST or CO2 increase. This is an interesting paper but some part of the discussion need to be better argued. In its present form, the manuscript needs major revisions prior decision for its publication to Biogeosciences.

1- Page 3: paragraph 3: This study uses relative abundances of sedimentary coccoliths to constrain.... "reconstruct" would be more appropriated.

Answer: the term has been changed.

2- Page 3 2.1 age model line 5: should use "higher"; rather than "superior".

Answer: the term has been changed.

3- How was the core sampled every millimeter? Could the author provide a description of the sampling technic used. When working at this sample step resolution, the question that immediately arises is "what can be the effect of post-deposition processes like bioturbation?"

Answer: a short description of the sampling technique has been added in section 2.1 Sampling. Concerning the preservation of the lamination, an X-radiograph of core A (Huguet et al., 2007) shows that laminae are well preserved and not affected by bioturbation.

4- The water depth of the core site is missing.

Answer: water depth and core coordinates have been added in section 2.1 Sampling and in Figure 1 caption.

5- Page 4 G. oceanica was selected for matching the two cores records to derive core B age model. Why this species? Do the authors get the same fit when using the other species?

Answer: we explain our approach in section 2.3 Age model. We used relative abundance of G. oceanica because (i) this species is the best recognized by SYRACO, (ii) this species could be used as a proxy of paleo El Niño in the SBB (De Bernardi et al.,

BGD

5, S3247–S3253, 2009

Interactive Comment

2005) and (iii) the curves of % G. oceanica are very similar between the two cores, while the others species present slight differences between the two cores.

6- Line 4: what is meant by "satisfactory" correlation? The author must provide determination coefficients for the 1934-2004 and 1914-1934 time-series.

Answer: we improve the correlation and add few sentences about it in section 2.3 Age model. We used 72 tie-points between the two cores to perform the correlation. The correlation is good between 2004 and 1938 AD (59 tie-points, R2=0.595) and less satisfactory between 1938 and 1917 AD (13 tie-points, R2=0.195). This difference in the oldest part of the cores is probably due to the peak of relative abundance of G. oceanica around 1930 AD that we found in core A and which does not exist in core B.

7-Line 8: should refer to figure 2C instead of 2B.

Answer: it has been changed.

8- Line 9: in the sediment trap study of De Bernardi et al. 2005, high abundances of G. oceanica were found for El Niño event one single event: the 1997/1998 El Niño event. This should be precisely stated in the manuscript.

Answer: this has been stated in the manuscript. Moreover we explain that "it has been shown that during El Niño years, the tropical convection center move to the central and eastern equatorial Pacific, leading to a weakening of the North Pacific High inducing the warming up of the California borderlands through the intensification of the southern California Countercurrent (Bograd and Lynn, 2001). Since G. oceanica is a tropical species, it seems realistic that this species is brought in the SBB by the California Countercurrent during an El Niño event."

9- Further adjustment of F. profunda to instrumental summer SSTs should also be plotted as a separated figure to show the final correlation.

Answer: this figure is not clear and the final relation is very close to that presented in Figure 2C (the tuning of F. profunda to SST shifts the previous age model of less than

BGD

5, S3247–S3253, 2009

Interactive Comment

6 months, what is not evident to highlight on a figure). This is why we do not present this figure.

10- How does the depth/age graph look like after these two fits?

Answer: the depth/age graph is meaningless since core B has been stored vertically and sediments settled during this period. Core A measured 32 cm when it was extruded, while core B measured 25.6 cm when it was sampled.

11-Figure 3 is called after figure 4, in the text.

Answer: now figure 4 is called after figure 3

12-Page 6: second paragraph should rather start by "Counts of E. huxleyi..."

Answer: the sentence has been changed.

13-Page 7: did Beaufort (2005) evaluate the effect of dissolution on the weight? If so, the authors should briefly describe its effect in the morphometry section.

Answer: few sentences have been added in section 4.3 20th century warming and increasing mass of coccoliths: During the experiment carried out by Beaufort et al. (Beaufort et al., 2008) more than 80% of the coccoliths were dissolved, but the weight of the remaining coccoliths did not changed significantly.

14-Page 8 Point Arguello should be indicated in figure 1

Answer: location of Point Arguello has been added to Figure 1.

15-Line 6 to 13: CC is maximum between spring and fall resulting in cold and moderately high nutrient waters favorable to G. muellerae. Next sentence states: we observed high abundances in G. muellerae from November to April, i.e. fall to spring. There seems to be a contradiction here... I assume that "CC is maximum from fall to spring"; is the correct statement....

Answer: we slightly reformulated the paragraph to make it clearer. The intensity of

BGD

5, S3247–S3253, 2009

Interactive Comment

CC is maximum between spring and fall. This is due to the influence of the North Pacific High, which is well developed during this period. The CC brings nutrients from the upwelling cell off Point Conception and Point Arguello inside the SBB during this period. During winter, the intensity of CC is reduced as the upwelling cell (the North Pacific High being shifted southward). Colder and nutrients depleted waters are carried by the CC inside the SBB during this period. This is why we find G. muellerae during winter, since this species prefer cold and moderately productive waters.

16-Last sentence of this paragraph: "we observe highest abundances of G. ericsonii during summer when upwelling is active and the SST stays relatively warm"! Upwellings bring cold waters to the surface; this sentence does not make sense to me. The authors should rephrase it and provide T numbers rather than refer to cold and warm T?

Answer: upwelling does not occur inside the basin but outside, off Point Arguello and Conception. Nutrients are then brought inside the basin by the CC. Although the upwelling cell is active during summer, this is during this period that the warmest SST are recorded in SBB. For the last century, the mean SST for the summer is 16.25°C (June: 14.49°C, July: 15.99°C, August: 17.08°C and September: 17.42°C; data obtained from the IRI/LDEO Climate Data Library; http://iridl.ldeo.columbia.edu/). We added this in the text.

17-This section should discuss how ENSO is impacting on the hydrology (SSTs) at a seasonal time scale, and subsequently on the species distribution.

Answer: in this section we only interest to the seasonality of coccolithophores species. The impact of ENSO on the hydrology of SBB and on the assemblages is discussed in section 4.2 Influence of ENSO and PDO on SBB coccolithophores.

Section 4.3. 18-The paper discusses long-term trends i.e. SST increase with size and weight for three species. However, figure 5 also shows higher frequency variability that is not discussed in the manuscript.

BGD

5, S3247–S3253, 2009

Answer: 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."

19-What would be the effect of high OC fluxes on the dissolution of calcite in the sediment?

Answer: we did not investigate the impact of high organic carbon fluxes on calcite dissolution. However, investigation with a SEM of samples (core B) covering the last century show that coccoliths are well preserved and do not exhibit trace of dissolution.

20-Other parameters could influence the size/weight of the cell like Fe inputs (as observed for diatoms) which are higher during ENSO years, or the carbonate ion concentration (different in upwelled waters than non-upwelled surface waters). This section deserves a better assessment of the environmental variables that can potentially influence the morphometry of the cells.

Answer: at that point very little is known on what can change the morphometry of the cell. This high frequency variations observed in the mass records is difficult to compare with ENSO, PDO or short term variation in SST. We prefer to discuss the robust pattern of long term changes. In this we know that upwelling decreased, temperature increased and CO2 increase. From literature decrease in nutrient availability could turn on a decrease in mass which is the reverse of what we observed. We exclude therefore that type of argument, leaving with CO2 (and carbonate) and SST. We discuss both these parameters in the manuscript, and it was not possible to go further without making to many assumptions.

21-Figure 1: I suggest to split it into 2 figures showing SSTs for ENSO and non-ENSO

BGD

5, S3247–S3253, 2009

years to see how the surface hydrology is affected.

Answer: satellite data of SST do not present a sufficiently high resolution to highlight, inside the basin, the influence of El Niño. This is why we are not able to provide such figure. However, during an El Niño event the surface waters experienced a positive anomaly SST of about 3°C comparable to that observed in the tropics (De Bernardi et al., 2005).

References:

Beaufort, L., Couapel, M. J. J., Buchet, N., Claustre, H., and Goyet, C.: Calcite production by coccolithophores in the south east pacific ocean, Biogeosciences, 5, 1101-1117, 2008.

Bograd, S. J., and Lynn, R. J.: Physical-biological coupling in the California Current during the 1997-99 El Niño-La Niña cycle, Geophysical Research Letters, 28, 275-278, 2001.

De Bernardi, B., Ziveri, P., Erba, E., and Thunell, R. C.: Coccolithophore export production during the 1997-1998 El Niño event in Santa Barbara Basin (California), Marine Micropaleontology, 55, 107-125, 2005.

Huguet, C., Schimmelmann, A., Thunell, R., Lourens, L. J., Damste, J. S. S., and Schouten, S.: A study of the TEX86 paleothermometer in the water column and sediments of the Santa Barbara Basin, California, Paleoceanography, 22, PA3203, doi 10.1029/2006PA001310, 2007.

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