Climate of the Past Discussions

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Comment on cp-2021-76

Anonymous Referee #2

Referee comment on "Parallel between the isotopic composition of coccolith calcite and carbon levels across Termination II: developing a new paleo-CO_2 probe" by Camille Godbillot et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-76-RC2, 2021

The paper provides information about the use of isotopic composition of large and small coccoliths as a proxy for the estimation of past [CO_{2aq}] in the ocean. More specifically, it is proposed that the magnitude of carbon isotope "vital effects", measured as the difference between the $\delta^{13}C$ of coccoliths of small versus large cells can serve as a new probe for paleo-CO_2.

The main results of the paper are: -*1* comparison between accurate atmospheric pCO_2 measurements, oceanic [CO_{2aq}] estimations and coccolith $\delta^{13}C$ and $d^{18}O$ measured in different size fractions from a North Atlantic core, for Termination II; -2 the definition of absolute vital effect and differential vital effect (the former one depending only on the carbon isotopic difference between small versus large coccoliths); -3 provide data for the late Pleistocene since this interval is characterized by relatively low atmospheric pCO_2 concentration to be compared with previous results obtained for Pliocene period (when CO_2 levels were higher).

This study has the potential to provide interesting results about processes affecting coccoliths $d^{13}C$ vital effects from sediment samples. Indeed, a better knowledge is needed to assess the sensitivity of coccolith vital effects and calcification to the low range of pCO_2 variability over the late Pleistocene glacial-interglacial (G-I) cycles.

The paper is well written and well organized and the different proxies used in this study are clearly documented and described (estimation of oceanic [CO_{2aq}] , absolute and differential vital effects). The scientific context of the study as well as the thread of the discussion is also well documented. However, some results interpretation needs to be clarified and discussed with more caution since in some case they appear to be over-interpreted.

To resume, this study meets the standards for publication and **I suggest the paper is acceptable for publication after moderate revisions that may require**

reconsideration by referees/editors.

In the following, I develop several points that require more detailed explanation and several minor points

The first point concerns the discussion about the coccolith â□□d^{13}Csmall-large over the studied interval (Termination II) (mainly Section 3.3.2).

-the relatively acceptable statistical correlation between [CO_{2aq}] and â□□d^{13}Csmall-large (Fig. 4) relies on 2 points with low â□□d^{13}Csmall-large and relatively high [CO_{2aq}] values. When looking at the downcore records (Fig. 3), these 2 points corresponds to the H11 interval. This interval indicates noisy isotope values (Fig. 3). How robust is it? (if these 2 points were removed, the statistical correlation would probably be less significant): can you comment on this ?

-some information is needed about isotope measurements on the different size fraction : are they based on replicates ? (triplicates ?)

The second point concerns the downcore isotope records: -some information is missing why d^{13}C of large is more stable than d13C of small coccoliths; -another particular feature is the stability of the d^{13}C *bulloides* record; even if it is not the main topic of the study, reasons why this former record is stable over Termination II needs a comment (since it is not observed in other d^{13}C records from other planctonic species).

The third point is a general comment. The results of this study support findings that the isotopic composition of coccoliths (for different size ranges) is sensitive to CO_2 concentrations at the glacial/interglacial scale. However, even if in Sections 3.3.3 and 3.4, different factors that could imprint the coccolith vital effect are addressed, the conclusions about the use of this proxy as a paleo-CO_2 indicator are slightly too optimistic. It should be mentioned that there are still a number of issues to be clarified (effect of productivity, stratification). For example, it appears that core MD37 has a rather different productivity response than other cores located in the North Atlantic (see Villanueva et al., 2001). Also, the history of Termination II in the North Atlantic is punctuated by a sequence of events (deglaciation, Heinrich event 11) which have modified surface waters productivity and stratification of the water column on short timescales. All these features might have impacted the vital effects of the coccoliths separately or in a combined way. It would be interesting to compare these data either for another Termination or another more distant site of events affecting oceanic conditions.

The data reported in this study are necessary to improve the understanding of the proxy (coccolith isotopes) but the factors controlling the vital effects associated with hydrological conditions still need to be investigated in order to properly identify these factors.

Some minor points :

-[CO_{2aq}] calculation : mention the impact of salinity uncertainty on the estimation

-What is the temporal resolution difference between atmospheric pCO_2 record and SST reconstructions in core MD37 ?

-in relation with section 3.3.3 : do you have you access to the coccolith counts/assemblages over the studied interval ?