

Cornault et al. 2025 – Orbital-scale variability in the contribution of foraminifera and coccolithophores to pelagic carbonate production

Summary

This manuscript explores orbital-scale variation in the relative contribution of foraminifera and coccolithophores to the pelagic carbonate burial flux at a single site in the tropical Atlantic during the Miocene, Pliocene and Quaternary. The authors use two independent methods to identify the proportion of total carbonate composed of foraminifera tests vs coccoliths, weighing the biases of each approach. They apply spectral analysis to look for orbital patterns and longer term trends, and they check for covariation between carbonate accumulation rate and the relative contribution of foraminifera vs coccolithophores. Finally, they consider their results in terms of temperature thresholds, light requirements, evolution, and ecological optima.

The data presented here is new and the manuscript is likely to be interesting to a relatively broad audience, as it represents progress in understanding what can be gleaned from the relative contributions of forams vs coccoliths as well as understanding the response of carbonate production and burial to drivers on both million-year and orbital timescales. Further, as the data presented here coincides with previously collected data from the same site and time intervals, it also allows for better interpretation of what was happening at that particular site (and in the tropical Atlantic generally) during the last 15 My. The manuscript is clear in its focus and doesn't make excessive or overgeneralized claims, and the use of two different methods with very different biases alleviates challenges to interpretation and creates a more holistic picture (although these could be easily bolstered with a simple description of the actual sediment during measurement, rather than simply assuming its status – see details in the line-by-line).

As far as the data collection and overall presentation goes, I would recommend publication with minor edits. However, the discussion and interpretation of the data falls far short of its potential, and leaves much to be desired. In part this is due to confusingly worded sentences and poorly organized paragraphs in the discussion, which make it very challenging to follow. Additionally, pieces of the interpretation are left too vague for the reader to be able to properly consider the viability of the arguments made. It isn't clear, for instance, why a larger number of species should make nanoplankton more susceptible to eccentricity, or how more rapid coccolithophore evolution would 'drive carbon cycle changes'. There is oblique reference to how variation in the relative abundance of forams or coccolithophores would affect the ocean's carbon sink capacity, but these are never explained in any detail. I would also love to see more done (or done more clearly) with the overall results of Figure 2, concerning the relationship between relative calcifier abundances and total carbonate accumulation rate, as this seems to be ideal data for understanding how orbitally induced environmental changes affect carbonate burial. This is addressed in the discussion, but in such a confusing way that I wasn't able to get much out of it.

One other persistent issue is the dismissal of some pieces of the data to 'the susceptibility of foraminifera and coccolithophores to carbonate dissolution', without any explanation of why

this is believed to be the case, let alone the carefully constructed and well-evidenced argument that such an interpretation deserves (I have identified each instance of this problem in the line-by-line below). More generally, dissolution would be worth addressing with some thoroughness, as the *relationship* between carbonate production and burial is susceptible to the same environmental factors that govern carbonate production.

Overall, this paper has high potential and presents valuable data, and everything up to the discussion section looks more or less great, but its discussion needs rewriting. I recommend publication contingent on its discussion being overhauled and the above issues being addressed. Given the vast experience of the senior authors on this manuscript in precisely this field, I am honestly somewhat surprised that the manuscript was submitted in this state. The above issues are ones that should have been identified and attended to by the senior authors (who are more than capable of addressing them) prior to submission, rather than work done by reviewers. I hope to see this manuscript revised with more attention from the senior authors, who are in a better position to help develop the lead author's writing and will benefit more from authorship than any reviewer will from putting in this work.

Line-by-line

The below section identifies a few additional instances of confusion on the scientific points made as well as minor issues of grammar or suggestions for better readability. The English (outside of the discussion section) is superb, but a final read-through of the subsequent draft by someone even more versed in academic English could lend it extra polish.

L18...: neithers and nors should be eithers and ors; 'orbital parameter modulations'; last bit of abstract should be 'deposition on either geological or orbital time scales'.

L37 and throughout: 'calcareous nannoplankton' (nannoplankton pluralized without the s)

L48: what about their likelihood of being in faecal pellets, or the amount of cell material covering them? Seems like there could be more than three factors, and there's no citation to indicate why these three are even thought to be the most critical factors.

L53: 'long geological time scale' could be clarified here with a timeframe – thousands? Millions of years?

L53: 'less' should be 'fewer'

L54: 'explain it to be due to' might be better worded as 'attribute it to'

L52-54: This whole sentence is quite confusing, actually, and I'm not sure what it's saying. Is the decrease in weathering alkalinity? What direction is the CO₂ modulation?

L57: main (no s); estimated from **the** carbonate accumulation

L61: development of a tuned age model and quantification of the flux; also this sentence could do with being broken up into two sentences

L71: mbsl (for consistency with its use later)

L72: episodes **have** resulted

L76-77: I'm confused about 'show no relationship between carbonate content and carbonate flux'... wouldn't there be other reasons besides shoaling to have a relationship between % carbonate and the total carbonate mass accumulation? Changes in silicifier productivity, for instance?

L79: 'at different time scales' could be clarified

L80: Given its importance to the findings, it might be helpful to the reader to briefly summarize here by what method we know the carbonate content (so they don't have to track it down in Cornault et al 2023).

L88: 'In the first approach...' might be a less ambiguous way to word it than 'First' (which sounds like the first part of an approach)

L89: What else is there? What proportions? And would it make sense to have this sentence in the first section of the methods, with the rest of the site overview information?

L92-93: It might be helpful to your reader to elaborate on this, given how relevant it is to the method.

L94: 'in tap water in 15 ml centrifuge tubes in a rotating carousel'

L95: 'dry bulk sediment (DBS) weight'

L95: washed... and dried, presumably? How?

L90-103: Did you check (visually) to see if the DBS was carbonate only (ie not much contribution from silicifiers, clay mostly removed), and that the <63 fraction was almost entirely foram? You say you assumed it, but it seems like an easy thing to check, at least roughly, and it would support your use of the method.

L110-111: 'centrifuge tube'

L~120: It might be useful to provide a rough estimate of coccolith and foram size ranges during this time/at this site, for your readers who are less familiar with the subject.

L126: 'these changes' haven't been introduced yet – need to be introduced before they can be referred to like this.

L128:...’not for the Quaternary, as these two time intervals are...’ – maybe it’s just me but I found this confusing.

L129: ‘the change’ should be ‘changes’

L131: E+T-P should be defined for your readers who are less familiar with the subject.

L135: black **solid** line

L135-140: I’m confused... the vertical blue lines don’t seem to correspond to the highest solid line values in the third and fourth plots (MIS KM5 and MCO)?

L143-144: ‘which is related to the susceptibility of foraminifera and coccolithophores to carbonate dissolution’ – this is interpretation! Doesn’t seem like it belongs in the Results section, and also there’s no evidence given to back the claim. Why do you think that’s the case?

L146: Is there a reason to keep Fig S3 in the Supplement? It seems like it would be helpful in the Main Text. It would also be good to state somewhere in the Main Text how many samples were analyzed.

L147: peak values... are these the average? I was confused by the way this was worded

L149: ‘consistent with the effect of dissolution’... based on what?? This keeps getting stated without any citation or explanation. The wording here is also a bit odd – maybe these could be broken into separate observations? Or I’m confused about what it’s trying to say.

L155: ‘is showing’ should be ‘shows’

L156-... ‘During the Quaternary...’ – this is interpretation!! It should be moved to the Discussion section.

L159: ‘taking in account maxima values average’ should be (if I’m understanding correctly) ‘using the averages of the maximum values’

Fig. 2b: I’m curious if the slopes vary by site. Also, maybe instead of the three modeled regression lines, you could provide just the slope and y-intercept of the actual line? Just a thought, not necessary.

L170: Seems like this should come before L150?

L171-172: Again with the unsupported assertion about carbonate dissolution!! This needs to be solidly explained the first time with evidence, citations, and spelled-out logic if it’s going to be regularly referenced and relied upon for later argument.

L176: using **the** SYRACO device

L178: expect **them to be correlated with** the SYRACO **values systematically lower and no** differences...

L177-179: This isn't highlighted by the figure, but it would be good if it were.

L190: 'Compared to...' – I found this sentence confusing, and I'm not sure how best to reword it to make it less ambiguous.

L193: would **not** allow; contribution of the >63 μm **fraction** to the bulk

L204: Fig. 2b doesn't show this super well... maybe it would be helpful to have a figure more akin to Figure 1 (or a 2nd panel) showing it?

L206: increase **in** the contribution of foraminifera (**or decrease in the coccolithophore contribution**) **from the Miocene to the Quaternary** coherent with

L207: say what Si and Rosenthal found, so your reader doesn't have to track down the paper

L 207-210: The sentence beginning 'Furthermore' is very confusing. Different between the Pliocene and the Miocene? Or different within the Quaternary? Also the 'so' would perhaps be better written as 'indicating that'

L210: it **changes** between; For **these two** time intervals we do not; -- this is actually confusing because then you're talking about Quaternary cold events... so are we still talking about the Pliocene and Miocene? I'm lost.

L214: '...proof of the preferential dissolution...' you're arguing it constitutes 'proof' based on not a single scrap of evidence or explanation! The rest of the manuscript seems carefully constructed to build arguments based on observation, so I'm not sure what the blind spot is about this one thing. But it needs fixing.

L217: carbonate calcifiers, **while remaining** similar on a geologic time scale

L218: 'it isn't' should be **it is not** (don't usually use contractions in formal writing)

L219: CaCO₃ production **that** is driving the

L218-219: How does this work with the absence of a correlation?

L221: remove the comma after (2019)

L223-224: time scale, **producing changes in their** relative contribution to the CaCO₃ AR bulk.

L227: covary **nor are they** linked

L227-228: Point 1 seems a bit repetitive? They're not linked, meaning they're not linked...

L231: AR bulk **increases, both groups increase but not necessarily to the same degree** (e.g.

L233: increase **in** eccentricity corresponds to an increase **in** the mean

L235: due to **their** dependence

L236: Why would a larger number of species cause them to be more eccentricity affected? This could do with elaboration, as could the evolutionary forcing of coccolithophores by eccentricity (L239) and how this affects the carbonate accumulation rate and drives carbon cycle changes. This is the part of the meat of the discussion, and these are not self-evident claims that the broad readership of this journal will necessarily be familiar with. In addition to citing the relevant papers it would greatly help the discussion if these interpretations were explained or pieced together in the main text. These could have their own paragraphs even; there's plenty of space.

L239: as the **result** of; **coccolithophore** evolution (or **coccolith**, but not coccoliths)

L240: I would find it easier to read this section if there was a paragraph break after (Beaufort et al., 2022).

L241: As the two **main** pelagic

L244: biomineralization process... This could be more specific, and elaborated on.

L246: so if **both foraminifera and coccolith** productivity (or **coccolithophore** might be more accurate?)

L245-246: Are we talking about the PWP? Otherwise I'm lost again, since there's purportedly no correlation...

L248-250: Way more is needed here to flesh this out (and it could be interesting to explore!) and the English needs some work as well, and the organization (why does the last sentence happen there?).

L253-260: Same with this paragraph.

L275: trace elements, and **they sink** through the water column

L277: a large change **in** the

L277: 'by these two calcifiers' ... by one rather than the other, you mean, presumably?

L282: of **>32 μm** sediment

L289-293: Surely you're not thinking of redacting it already? 😊