

R1

reviewer comment 1 (RC1)

COMMENT: This manuscript presents a carefully designed and well-documented experimental study on species-specific differential dissolution in three large, ecologically important coccolithophore species—*Coccolithus braarudii*, *Helicosphaera carteri*, and *Scyphosphaera apsteinii*—which, despite their biogeochemical relevance, have received less attention than the model taxon *Gephyrocapsa huxleyi*. By exposing live cultures of all three species simultaneously to strongly undersaturated seawater ($\Omega_{\text{calcite}} \approx 0.033$) in a controlled dark, low-temperature environment, the authors systematically document dissolution sequences at high temporal resolution (15 sequential time points). The side-by-side design, combined with high-quality SEM imaging, allows for direct interspecific and morphotype-specific comparisons, notably revealing that *C. braarudii* is the most dissolution-resistant, followed by *H. carteri* and *S. apsteinii*, and that within *S. apsteinii* lopadoliths, R-units dissolve faster than V-units.

The ability to match experimentally documented features with those observed in sediment trap and water-column samples provides strong evidence that the laboratory findings are applicable to natural assemblages and can help resolve long-standing challenges in distinguishing dissolution from malformation in field material. Particularly noteworthy is the identification of a nanostructure on the proximal side of the distal shield in *C. braarudii*, which is not only morphologically distinctive but also potentially significant for understanding coccolith biomineralization and the role of organic–mineral interactions.

REPLY: We appreciate both the reviewer’s concise summary and positive evaluation of our study.

COMMENT: Methodologically, the study is highly reproducible: strain origins, growth media, culture conditions, and carbonate chemistry manipulations are clearly described; measurements and calculations are transparent; and SEM preparation parameters are fully reported. The workflow is appropriate for the study’s aim of determining

dissolution sequences. The authors also acknowledge relevant limitations, such as the absence of biological replication and potential influences of the organic coating.

REPLY: Again, we appreciate the concise summary and positive evaluation.

COMMENT: Figures are generally of high quality and well-aligned with the text, but small adjustments in scale bar clarity, annotation, and caption detail would improve accessibility. Likewise, restructuring certain paragraphs for focus, redefining specialist terms at first use, and clarifying methodological points (e.g., morphological assessment approach, rationale for species choice) would further strengthen the manuscript. Overall, the study offers novel insights, a rigorous experimental basis, and clear potential to inform both modern carbonate cycling studies and palaeoceanographic interpretations.

REPLY: We have restructured the text for focus, redefined specialist terms, and clarified methodological points as detailed below.

Again, we appreciate the reviewer's positive assessment of our study.

Specific comments:

L50–56 – The transition from global carbon cycle context to coccolithophore dissolution is abrupt. Consider adding a bridging sentence to connect the large-scale biogeochemical role with the specific processes studied here.

REPLY: We added the sentence: NEW TEXT (inserted in line 56): “These calcifying organisms influence air-sea CO₂ exchange in several ways, e.g. through particulate inorganic- and organic carbon production in the surface ocean but also through export of calcium carbonate to the deep ocean (Morse and Mackenzie 1990).”

L64–81 – This paragraph contains redundancy. Please streamline by consolidating repeated points on the challenges of interpreting field samples, removing the “first

task/second task” phrasing, and integrating the sediment observations with the experimental confirmation of shield separation into a single, concise statement.

REPLY: We deleted lines 69-81... and replaced it with NEW TEXT: “For example, in surface sediments *Calcidiscus leptoporus* coccoliths (placoliths characterized by two shield-like plates connected by a central tube) lacking proximal shields have been taken as a sign of heavy dissolution (Roth and Berger 1975), which has been proposed as a proxy for dissolution in the sedimentary record (Matsuoka 1999). Only an experimental study could show that separation of the shields is the first observable dissolution feature occurring at less than 8% mass loss (Langer et al 2007) revealing the “weak spot” at the proximal end of the tube (the position of the proto-coccolith ring, Young et al 2004).

L82–86 – Separate citations for dissolution studies and for *G. huxleyi* as a widely used model species. For the latter, the following would suffice: Wheeler, G. L., Sturm, D., & Langer, G. (2023). *Journal of Phycology*, 59, 1123–1129.
<https://doi.org/10.1111/jpy.13404>.

REPLY: We separated the citations. NEW TEXT (replacing lines 82-86): “Despite the importance of experimental studies showing graded dissolution of coccoliths, only a few such studies have been conducted (McIntyre & McIntyre 1971, Burns 1977, Kleijne 1990, Henriksen et al 2004, Langer et al 2006b, Holcová and Scheiner 2023), with a focus on *Gephyrocapsa* spp, in particular *G. huxleyi*, a widely used model species (Wheeler et al 2023).”

L87–94 – The rationale for including the three focal species could be made more explicit. Briefly state their ecological/biogeochemical relevance to justify why they are important to study alongside *G. huxleyi*.

REPLY: NEW TEXT (inserted after line 94): “The latter genera are not as abundant as *E. huxleyi* but play an important role in coccolithophore CaCO₃ production and export in modern oceans (Baumann et al., 2004; Daniels et al., 2014, 2016; Gafar et al., 2019; Ziveri et al., 2007).”

Baumann, K.-H., Böckel, B., and Frenz, M.: Coccolith contribution to South Atlantic carbonate sedimentation, in: Coccolithophores, edited by: Thierstein, H. R. and Young,

J. R., Springer Berlin Heidelberg, Berlin, Heidelberg, 367–402.

https://doi.org/10.1007/978-3-662-06278-4_14, 2004.

Daniels, C., Poulton, A., Young, J., Esposito, M., Humphreys, M., Ribas-Ribas, M., Tynan, E., and Tyrrell, T.: Species-specific calcite production reveals *Coccolithus pelagicus* as the key calcifier in the Arctic Ocean, *Mar. Ecol. Prog. Ser.*, 555, 29–47, <https://doi.org/10.3354/meps11820>, 2016.

Daniels, C. J., Sheward, R. M., and Poulton, A. J.: Biogeochemical implications of comparative growth rates of *Emiliana huxleyi* and *Coccolithus* species, *Biogeosciences*, 11, 6915–6925, <https://doi.org/10.5194/bg-11-6915-2014>, 2014.

Gafar, N. A., Eyre, B. D., and Schulz, K. G.: Particulate inorganic to organic carbon production as a predictor for coccolithophorid sensitivity to ongoing ocean acidification, *Limnol. Oceanogr. Letters*, 4, 62–70, <https://doi.org/10.1002/lol2.10105>, 2019

Ziveri, P., De Bernardi, B., Baumann, K.-H., Stoll, H. M., and Mortyn, P. G.: Sinking of coccolith carbonate and potential contribution to organic carbon ballasting in the deep ocean, *Deep-Sea Res. Pt. II*, 54, 659–675, <https://doi.org/10.1016/j.dsr2.2007.01.006>, 2007.

L109–112 – Consider stating an explicit hypothesis and broader scientific context for the work. Explain why these experiments were chosen and how they address the research gap.

REPLY: NEW TEXT (inserted after line 112): “We hypothesize that dissolution morphologies will be different from malformations (Bianco et al 2025, Langer et al. 2006, Langer et al 2021, Gerecht et al 2015, Meyer et al 2020) and therefore a dissolution reference dataset will enable us to unambiguously identify dissolution in field samples. The experimental setup chosen here is ideally suited to analyse sequential dissolution morphology with nanometric resolution. This enables the identification of different dissolution stages in field samples, providing additional information over and above the mere distinction of dissolution features and malformations.”.

L147 – The phrase “present in the same vessel” is unclear. Consider rephrasing to explicitly state that all three species were combined in a single 2.7 L container for simultaneous exposure to identical seawater chemistry: i.e. container, bottle (most

direct, since you specify 2.7 L bottle later), incubation container, sample container, test bottle, reaction bottle, experimental flask.

REPLY: We rephrased the sentence. NEW TEXT (line 147): "... the selected species were combined in a single 2.7L bottle."

L156 – The term " Ω calcite" is introduced here without definition. Consider either introducing it earlier in the Introduction or adding a brief explanatory sentence here (e.g., defining it as the saturation state of seawater with respect to calcite and indicating the dissolution/precipitation thresholds).

REPLY: NEW TEXT (line 158): "Omega calcite is the saturation state of seawater with respect to calcite, with omega < 1 indicating dissolution and omega > 1 potential crystal growth."

L170 – Include the manufacturer (and country) of the pH meter here, and ensure all instruments mentioned in the Methods are accompanied by manufacturer details for consistency and traceability.

REPLY: NEW TEXT: "... Cyberscan 500 pH meter (Eutech Instruments, UK) equipped with..."

L192–194 – The description of post-experiment coccolith morphology assessment is vague. Specify how morphology was evaluated (e.g., visually via light microscopy, SEM), whether any images were taken, and if these observations were documented systematically or informally. This would help readers gauge the reliability and reproducibility of the qualitative note on increased malformations.

REPLY: NEW TEXT (after line 194): "This assessment is based on an informal analysis by means of light microscopy; no images were taken."

L200–201 – The two SEM instruments used have markedly different resolution capabilities (Phenom Pro desktop SEM vs. Zeiss Merlin FE-SEM). Consider briefly noting the resolution differences and explaining whether certain morphological features were only discernible in high-resolution Zeiss Merlin images. This would clarify the role of each microscope in capturing fine-scale dissolution features.

REPLY: NEW TEXT (after line 201): "All the morphological features described in this study are discernible using the Phenom Pro desktop SEM. We used the Zeiss Merlin FE-

SEM only to produce images showing the nanostructure on the proximal side of the distal shield of *C. braarudii* because the latter microscope has a higher resolution. This nanostructure, however, was discovered using the Phenom Pro desktop SEM.”.

L222–233 – The authors appear to assume prior reader familiarity with the terms “V-units” and “R-units.” For clarity and accessibility, briefly redefine these terms at first mention in the Results (e.g., “R-units, the smaller radial crystals...”), as readers may not recall definitions from earlier literature. In addition, introduce these concepts in the Introduction to provide essential context for readers new to coccolith microstructure.

REPLY: NEW TEXT (after line 108): “Coccoliths contain crystals of different orientations, sizes, and shapes. A typical feature, for example, is the presence of crystals with radial c-axis orientations (R-units) and others with vertical c-axis orientations (V-units, Young et al 1992). It might therefore be hypothesized that different crystals display different structural features, not only on the micrometre but also on the nanometre scale. Some of these features might only be discernible in partially dissolved specimens.”.

NEW TEXT (line 231): “... lopadolith R-units, the smaller radial crystals, conspicuously dissolve faster than V-units, the larger vertical crystals (Figs 6, 7)...”.

L245–266 (3.2) – This paragraph mixes multiple points without a clear topic sentence. Consider breaking it into two or more paragraphs, each beginning with a sentence that signals the main point (e.g., “Our experimental dissolution sequence can be directly applied to field samples...”). This would improve readability and help the reader follow your argument.

REPLY: NEW TEXT (after line 244): “Identification of dissolution in field samples: As noted...”. NEW TEXT (after line 256): “Do the conditions under which dissolution occurs influence dissolution morphologies?”.

L253–256 – When noting that similar features in the literature have been ascribed to malformation, briefly explain how your experimental approach enables you to differentiate them from dissolution. For example, you could outline practical diagnostic criteria that can help others reliably distinguish dissolution-driven morphologies from true malformations. This guidance would be especially valuable for field sample interpretation.

REPLY: NEW TEXT (after line 256): “It is striking that in the three species studied here dissolution morphologies are clearly different from malformations. The latter do not resemble etching as described here (Figs 1-5). This is remarkable considering that it has typically been difficult to distinguish dissolution from malformation, and even fracture, in *G. huxleyi* (McIntyre & McIntyre 1971, Burns 1977, Kleijne 1990, Holcová and Scheiner 2023, Young 1994, Langer et al 2006b, Langer and Benner 2009, Langer et al 2011). These difficulties in identifying dissolution morphology in *G. huxleyi* are particularly conspicuous in morpho-type B/C, but are clearly noticeable in type A as well (own observations, unpublished). It might be speculated that dissolution is easier to identify in type R because the latter features fused distal shield elements which makes the overall morphology more similar to the one of the species studied here. This conjecture is supported by *G. huxleyi* morphotype-specific dissolution morphologies described in water column samples (Burns 1977). It will be worthwhile studying different *G. huxleyi* morphotypes in greater detail. Species-specific dissolution features such as the serrated rim in *S. apsteinii* lopoliths are also dissimilar to malformations such as type R (Langer et al 2021, Langer et al 2023). The nanostructure on the proximal side of the distal shield of *C. braarudii* is hardly visible in normal as well as malformed coccoliths, whereas it is clearly visible in partially dissolved coccoliths. In *C. braarudii* a concentric hole sometimes appears in malformed coccoliths (Langer et al 2021). This hole is clearly different from etch pits. A typical feature of more severe malformations in placolith bearing species is the distorted architecture of the shields (Bianco et al 2025, Langer et al 2006, Langer and Benner 2009, Langer et al 2011, Langer and Bode 2011, Langer et al 2012, Langer et al 2013, Langer et al 2021, Langer et al 2023, Kottmeier et al 2022, Gerecht et al 2015, Milner et al 2016, Johnson et al 2022) which does not occur as a result of dissolution.”.

L281–283 – The statement that all three species need a coccosphere to live could be expanded by incorporating contrasting evidence from Johns et al. (2023, Science Advances). While your data support the idea that coccosphere collapse compromises survival—potentially due to loss of motility, increased vulnerability to grazing, and reduced protection—Johns et al. observed mixed-species coccospheres in natural assemblages, indicating that coccosphere integrity can be re-established or modified through incorporation of foreign coccoliths. This suggests that survival may depend more on maintaining a continuous covering than on the species-specific origin of

coccoliths. It would strengthen the discussion to acknowledge that coccosphere collapse might not represent an irreversible endpoint if interspecific coccolith exchange or repair occurs, while also noting that the physiological consequences and protective efficacy of such hybrid coccospheres remain to be tested experimentally.

REPLY: NEW TEXT (after line 283): “While a coccosphere comprised of coccoliths produced by the very cell itself is essential for survival in monospecific cultures of these species, mixed-species coccospheres in natural assemblages indicate that coccosphere integrity can be re-established or modified through incorporation of foreign coccoliths (Johns et al 2023). This might mean that a coccosphere compromised through dissolution or malformation might be repaired by incorporating foreign coccoliths. The protective efficacy of such hybrid coccospheres remains to be tested experimentally. However, the vulnerability sequence described above differs from what would be...”.

Johns, CT et al. Adsorptive exchange of coccolith biominerals facilitates viral infection. Sci. Adv.9, eadc8728(2023). DOI:10.1126/sciadv.adc8728

L294–298 – While the description of proximal vs. distal shield nanostructures is clear, the discussion does not explicitly connect these differences to potential roles in dissolution resistance or susceptibility. Consider adding a short paragraph explaining whether the absence/presence of nanostructure could alter etching rates, mechanical stability, or dissolution onset.

REPLY: NEW TEXT (after line 304): “We can only speculate what effect this nanostructure might have on the dissolution resistance / susceptibility of the distal shield elements. Considering that the distal shield elements of *C. braarudii* are the only coccolith parts of all three species that are still present at the end of the experiment (Fig. 6), it seems clear that they are comparatively dissolution resistant. Whether this resistance stems from the nanostructure or some other feature remains an open question but it is fair to say that the nanostructure does not make coccolith crystals highly susceptible to dissolution. The importance of micro- and nanostructures in differential dissolution behaviour of various biominerals has been recently highlighted in the context of vulnerability to ocean acidification (Langer and Ziveri 2025). It is conceivable that the nanostructure in *C. braarudii* slows down etching and / or provides structural reinforcement. This scenario would be plausible if the nanostructure was an

[organo-mineral composite structure as opposed to being composed of calcite only \(Walker and Langer 2021\).”.](#)

L305–311 – The comparison to extracellular calcifiers is interesting but remains speculative. To strengthen this, relate how the hypothesized organo-mineral composite structure might affect dissolution in *C. braarudii*—for example, could it slow etching or provide structural reinforcement?

[REPLY: We did include this in the reply to the previous comment.](#)

Figure 1–5:

Add scale bars! Make sure they are clear and correctly labeled — for example, in Fig. 3 the scale bar says “200 n,” which is unclear. If it means 200 nm, please write it out in full.

[REPLY: We added the scale bars.](#)

Use arrows and short labels directly on selected panels to highlight key dissolution features; in dense panels such as Fig. 5, reduce arrow size for readability.

[REPLY: We now use arrows and short labels, and reduced arrow size.](#)

Ensure consistent positioning and sizing of arrows and labels across all figures for visual uniformity.

[REPLY: We now use consistent positioning and sizing of arrows and labels.](#)

Expand captions to briefly define any feature codes or abbreviations used in the main text.

[REPLY: We expanded the captions.](#)

Figure 6:

Use shaded backgrounds or colored markers to highlight the approximate onset point of major features.

[REPLY: We added shaded backgrounds.](#)

Group related features visually by applying subtle color families to aid quick interpretation.

[REPLY: We grouped related features.](#)

Figure 7:

Use different line styles (e.g., dashed, dotted) to distinguish parameters more clearly, currently it is very difficult!

[REPLY: We now use different line styles.](#)

Figure 8:

Add arrows or overlays to the field images indicating matching dissolution features from lab images.

[REPLY: We added arrows.](#)

Include in the caption where and when the field samples were collected for better standalone context.

[REPLY: We added the information to the caption. For details see reply to last comment of RC2.](#)

Citation: <https://doi.org/10.5194/egusphere-2025-1921-RC1>

reviewer comment 2 (RC2)

The manuscript describes a study of the effects of short term (11 hour) dissolution experiment on three species of coccolithophores, presenting detailed observations of the progressive morphological changes over the dissolution experiment and comparing and contrasting these in three modern species. In its current form, the manuscript has two challenges. Firstly, in many sections the manuscript still reads like a draft and has not

yet been brought into optimal structure or organization, with important and details missing from from text and figures.

REPLY: This comment matches comments by reviewer 1 (RC1). In reply to RC1, we have restructured the text, added missing background information and context in both text and figures. For details see Reply to RC1.

Secondly, the focus and scope do not seem well matched to the journal Biogeosciences, since there is (aside from one vague sentence in the introduction) no discussion of the biogeoscience/biogeochemical cycle significance of the observations, but rather detailed micropaleontological observations. This suggests that the paper in its current form is better suited to a micropaleontology journal such as Journal of Nannoplankton Research or Marine Micropaleontology. The paper is currently written to be accessible only to a calcareous nanofossil expert (a small community that usually does not overlap with the ocean carbon cycle community), and it does not give sufficient background to the nannolith morphological elements discussed to have relevance to Biogeoscience readership.

REPLY: Again, these are points raised by reviewer 1 (RC1) as well. In reply to RC1 we have made the text accessible to a non-specialist readership by introducing key concepts and technical terms. We now also state more clearly why dissolution in general, and the species used here in particular are relevant in the context of the global carbon cycle. We also added key references backing up our claims. The usage of coccolith morphological features as diagnostic tools in the assessment of biogeochemically important processes such as shallow water carbonate dissolution and ocean acidification is a topic that falls squarely within the scope of Biogeosciences as illustrated by a recent publication focussing on malformations in *H. carteri* in response to seawater carbonate chemistry changes (Bianco et al 2025, Biogeosciences).

Specific suggestions

Abstract

I found the abstract contains a lot of nomenclature which is very specialized and I suggest revising so that readers unfamiliar with V unit/R unit or lopadolith and murolith

can understand. Probably in the abstract it is sufficient to describe that the dissolution rate depends on the crystallographic orientation of the crystal. At the same time, the “nanostructure” on the proximal side of the distal shield in *braarudii* is vague, and could be described in better detail. I also suggest the abstract start with an introductory sentence or two describing the motivation of the study.

REPLY: NEW TEXT (avoiding R- and V- unit terminology in line 45): “In *S. apsteinii* lopadoliths, dissolution rate depends on the crystallographic orientation of the crystals”.

NEW TEXT (after line 50): “This nanostructure features “units” of ca 50-100 nm and resembles the nanostructure well known from extracellular calcifiers such as molluscs and foraminifera. Whether this resemblance is underpinned by a similar formation mechanisms remains unknown, but we think this unlikely.”.

NEW TEXT (after line 37): “Coccolith dissolution in the water column is an important process in the marine carbon cycle. Identifying dissolution in water column samples has been difficult due to a lack of experimental reference datasets showing dissolution morphologies.”.

Introduction:

I think this needs to be restructured/reorganized a bit.

The first paragraph describes the motivation – that dissolution is important in the carbon cycle – it needs to go a bit further and explain why, eg what is the effect on upper ocean alkalinity.

REPLY: NEW TEXT (after line 61): “The importance of dissolution for the marine C-cycle has two main aspects. Firstly, dissolution of CaCO₃ releases two moles of alkalinity per one mole of dissolved inorganic carbon, thereby shifting the seawater C-system towards higher pH values (Zeebe and Wolf-Gladrow, 2001). Secondly, the loss of ballast minerals reduces carbon export efficiency thereby influencing the C-cycle long-term (Klaas and Archer 2002).”.

Then, the bridge to the next concept is a bit vague – is the goal of characterizing dissolution morphologies to distinguish in upper ocean water column samples whether

dissolution has occurred? Is it to distinguish in ocean sediment samples if dissolution has occurred? Is it to use the variance in dissolution morphologies to assess changing causes of dissolution intensity either in the upper water column (as a function of deep export mechanisms or water column chemistry) or changing dissolution intensity experienced at the seafloor? Bring the information in lines 102-108 earlier in the introduction and use it to motivate the study.

REPLY: We moved lines 102-108 up and added a clarification explaining in what context our study is most useful. NEW TEXT (after line 66): “Knowledge of such differential dissolution morphologies will aid interpretation of field samples, e.g. the degree of dissolution in one species will inform inferences about the degree of dissolution in other species. More fundamentally, knowledge about dissolution morphologies will enable us to accurately distinguish malformation / under-calcification from dissolution, which is not necessarily an easy task (Young 1994). Finally, dissolution might reveal informative structural features (Langer et al 2007). The main goal of our study is to provide a dissolution-morphology reference dataset which can be used to identify dissolution in water column samples. The applicability of our data to sediment samples might be more limited as discussed below.”.

Then two aspects of dissolution are mixed – the selective dissolution of different species relative to each other, and the evolution of morphology of a given species with progressive dissolution. Separate these and distinguish them. Comment which have been tested experimentally and which are inferred only from field studies.

REPLY: NEW TEXT (after line 112, before new text inserted in reply to RC1). “Here we analyse two important aspects of dissolution. Firstly, the selective dissolution of different species relative to each other. Secondly, the evolution of morphology of a given species with progressive dissolution.”.

You can point out that experimental dissolution studies provide good source of information on the evolution of morphology with dissolution, without confounding factors from field studies such as variance in the primary biomineralization morphology.

REPLY: NEW TEXT (after line 112, and after the newly inserted text of the previous point): “Experimental dissolution studies provide a good source of information on the evolution of morphology with dissolution, without confounding factors from field studies such as variance in the primary biomineralization morphology.”.

Discuss the prior results of experimental dissolution studies together and in a similar way, eg details are given about the findings of dissolution intensity of *C. leptoporus* but nothing is mentioned of *G. huxleyi*. Review together what previous experimental studies have been done and what they found, before motivating study on other species which expand knowledge about other species which are a significant part of the carbon budget.

REPLY: We added the information regarding *G. huxleyi*. NEW TEXT (after line 86): “The degree of dissolution in *G. huxleyi* water column samples is difficult to assess as there are variations of progressive dissolution patterns with e.g. warm- and cold-water phenotypes (Burns 1977). The latter author pointed out that a tropical *G. huxleyi* loses the central grille in the first stages of dissolution, while a cold-water phenotype does not. Calcite removal from the long margin of the radial elements is a sign of early dissolution in the cold-water phenotype but not in a heavily calcified phenotype. These and similar observations made by Burns (1977) show that assessing the degree of dissolution in *G. huxleyi* is not an easy task and morphotype-specific assessments are required.”

Materials and methods

Lines 154-171 - it is justified that precise omega calcite is not important for the study but it would be helpful to provide some estimates of the uncertainty around the 0.033 value given. Overall this paragraph could be made a bit more concise and less informal.

REPLY: The uncertainty of the omega value is given in line 167. As reviewer 1 (RC1) pointed out, the information given in this paragraph is necessary and useful. We therefore refrain from shortening this part. The Methods are described in the typical technical way; we do not understand in what sense the reviewer thinks the style is “informal”.

If the study goal was to distinguish the evolution of coccolith morphology due to post-mortem dissolution in the ocean during sinking, it is unclear why the dissolution experiment was conducted on living cells which were only subject to transient (11 hour) dark dissolution and then later returned to viable conditions. The duration of the dark period is comparable to a typical dark cycle during cell growth when respiration maintains cell metabolism, only the temperature shock may have suspended normal operation. What advantage does this have compared to lysing a cell population and then completing the dissolution experiment over 11 hours on post-mortem material?

REPLY: The duration of the experiment and the chosen physico-chemical conditions are ideally suited for our purpose as explained in lines 172-188. We agree with the reviewer, however, that our justification for using living cells was insufficient. We added a detailed rationale.

NEW TEXT (after line 160): “We chose to work with living cells, as opposed to isolated coccoliths for the following reasons. Firstly, we wanted our results to be useful for comparison with various dissolution scenarios such as whole cells in copepod and micro-grazer guts, whole cells in marine snow aggregates, whole cells in ocean acidification-affected corrosive waters. Secondly, we wanted to analyse effects of dissolution on coccospheres, as opposed to only on individual coccoliths. Thirdly, removing coccoliths from cells is not always an easy task and often requires chemical or heat treatment which might alter structural integrity and organic content (Manuela Bordiga, personal communication, 2025). Since this is a pilot study, we wanted to keep the experimental setup as straightforward as possible. Follow up studies should deal with modified setups to explore additional factors influencing dissolution patterns.”.

Was the decreased temperature during the incubation accounted for in the carbon chemistry calculations?

REPLY: Yes, it was.

Results

As background, potentially at the start of results or discussion or potentially as background before the methods, the nannolith or coccolith morphology of the three species needs to be presented (eg contrasting placolith vs nannolith, describing R units, V units, loadoliths, muraliths) .

REPLY: This comment echoes one of the comments of reviewer 1 (RC1). In reply to RC1 we have added background information to make the text more accessible for a non-specialist readership.

Figures 6 and 7 reflect a useful presentation of the progressive dissolution features over the course of the experiment.

REPLY: We appreciate the positive feedback.

The discussion of field samples and the Figure 8 caption should indicate the origin of the field samples, the trap depth and omega in the sediment traps, the typical transit time (eg length of time exposed in the water column before capture in trap based on settling velocity and trap depth). This section is still rather underdeveloped. Lines 280 to 284 need some contexts – in today’s photic zone are there really areas with comparable undersaturation that living coccolithophores are trying to survive in? If so then this should be noted and contrasted with the majority of the photic zone which lies in strongly oversaturated waters.

REPLY: We added the sampling details. NEW TEXT (in caption of Fig 8): “A, B - sediment trap samples from 3200m, N. Atlantic; C - surface water sample, NW Atlantic; D- sediment trap sample, Canaries, 200m; E plankton sample from 120m, Gulf of Mexico.”

Detailed environmental data of the type suggested as relevant are not available. However, the purpose of showing these images is to show that dissolution features in natural samples are directly comparable to those seen in the experiments and hence that they are not culture artefacts. Partially dissolved coccoliths are common in deep water samples, whether collected direct from the water column or from sediment trap samples, however isolated coccoliths in these samples may have been produced weeks before they were collected and have been subject to waters of varying pH, and saturation state of seawater with respect to calcite, hence it is not possible to relate coccolith morphology to ambient conditions even when they are fully known.

We also added some background to contextualise the vulnerability of coccolithophores to corrosive waters. NEW TEXT (after line 292): “Although bulk surface waters in most parts of the global ocean are currently supersaturated with respect to calcite, ongoing ocean acidification drives the calcite saturation state towards undersaturation which will be reached in some areas, e.g. the Southern Ocean, around the year 2100, posing a threat to calcifying organisms including coccolithophores (Langer and Ziveri 2025). Regardless of the actual threat posed by corrosive waters to living coccolithophores, the argument we are making here centres on relative vulnerability of different species in case of calcite undersaturation.”

Citation: <https://doi.org/10.5194/egusphere-2025-1921-RC2>

Field Code Changed