

Ocean Sci. Discuss., author comment AC2
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Reply on RC2

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Author comment on "There and back again, a journey of many pathways: conceptualising the marine organic carbon cycle" by Maike Iris Esther Scheffold and Inga Hense, Ocean Sci. Discuss., <https://doi.org/10.5194/os-2021-75-AC2>, 2021

We thank the referee for her valuable feedback, which helped us a lot in improving our manuscript. Below, we highlighted our answers to the comments in bold.

****For the following comments, please consider that coming from a numerical model community, the word 'model' is generally associated with equations and numerical output in my mind. While the term 'model' can be used for many purposes to define a representation of reality, I suggest that you should present a 'visual-model' in opposition to 'numerical-model', to avoid to any other biased modeler as me to look for equations and numerical outputs ****

We thank the referee for her very insightful comment. We agree with her and will change the wording to "concept" instead of conceptual model to be more comprehensive. However, we will not use "visual model/concept" because our concept would exist even without visualisation and this term would therefore be too narrow. In any case, we think the reviewer's comment is a wonderful example of the pitfalls interdisciplinary communication can pose and that we must always clearly define terms we are talking about.

Title: While publishing in 'Ocean science', the term 'marine' can appear in the title. Following the first referee's comment, I suggest putting the table directly with the information about your work 'a visual-model for mapping...'

We changed the title to: There and back again, a journey of many pathways: conceptualising the marine organic carbon cycle

Abstract:

p1.Ln 3 : 'other related tasks' sound vague, so I suggest removing it.

p1.Ln 3 : you may use 'cycle' instead of 'pathways', as in the line right after you are adding 'processes and pathways' ?

p1.Ln 3 : 'qualitative-visual' model can be mentioned instead of qualitative model only.

We rewrote the entire abstract.

The first paragraph (p1 Ln15 to 21) is difficult to follow without the table placed. I suggest starting with your current second paragraph (p2.Ln22 to 29) and eventually move/rewrite this first paragraph with the last ones of the introduction where you talk about your work.

We rewrote the introduction and started with a more general paragraph on organic carbon pathways (p 1 first paragraph).

p2.Ln22: Instead of 'marine ecosystems and the OC cycle', can it be reduced to 'marine OC cycle' directly ?

We shifted that paragraph into the discussion and reduced it to 'OC cycle' (p20 L418).

p2.Ln22 to 24 : Why do you focus only on particles on the surface ? You can generalize as 'An OC particle in the ocean can end up ...'

We keep the spatial restriction here (p20 L418), as we have specified that all the pathways we consider start in the surface waters.

p2.Ln23 to 24 : I suggest to re-write to have only one sentence, e.g. ' Each pathways is unique in its sequence of processes, and there is a myriad of them' . As there are a myriad of pathways AND processes.

We rewrote and shifted this part: Each OC compound travels its pathway through the OC cycle. An OC compound in the surface ocean may end up on the surface or in the deep sea, be decomposed, or become recalcitrant, to name just a few possibilities. Each pathway is unique in its sequence of processes. So, there is a multitude of possible pathways. (p20 L417-420).

p2.Ln36 : I suggest to add 'vertical export flux' instead of only 'export flux'

We deleted this part of the introduction.

In these two paragraphs (p2.Ln22 to Ln 37) some link to the feedbacks/conclusions made through those existing tools with the climate can be made, to reinforce the use of this visual-model for further use.

We shifted some of the paragraph (p2 L22-29 to p20 L417-420) and deleted paragraph p2 L29-37.

Ln39-40: I suggest to temper what it is mentioned by providing generalities such as ' ..this destination is mainly considered by changing the particles' **properties (e.g. density, shape)**'. In this case some additional references may be required.

We deleted this section.

p2.Ln40-42: I would be glad if you have in hand a reference to add, that points out these facts.

We have added examples of the described small inconsistencies in visual representations of the pathways and inserted the whole paragraph into the new chain of reasoning (p.2 L47-57).

p3.Ln82 : I do not see the point to add the notion of coral reef here.

We deleted it.

p3.Ln84 : I would have been glad to have already the information that table 1 will provide me with the dictionary of the nomenclature used in the following part. I suggest adding a sentence letting the reader know about Table 1 before moving to the explanation, as the sentence in p2. Ln84 does not sound clear to me.

We have added an insertion: Given that we conceptualise only the OC pathways (for a definition of relevant terms of the concept, see Table 1), we do not resolve carbonate and alkalinity interactions, and do not display marine carbonate systems within our concept (p2 L84).

p3.Ln85 : ` (POC) ****embedding**** living and non-living OC ****particles**** `

We changed the sentence as suggested (see p4 L103).

p3.Ln85 : Thank you for the correction made following Referee's 1 comment regarding the size mentioned/used.

Thanks!

p4.Ln.121: `under the given hygiene conditions'; as we are already in an analogy, barely used in scientific writing, I suggest to restrain the other reference to current society behavior, as in a number of years when people will refer to this manuscript they may not be able to understand the reference to the current pandemic situation as easily as us today. I suggest deleting the allusion.

We deleted the part.

p5.Ln127-151 : Be sure that the words used here are consistent with the eventual reswamp of the nomenclature (see my comments below about table 1). This paragraph is really hard to follow even if I greatly appreciate the effort to place a nice analogy for explanation.

We have rewritten the section, taking into account the criticism that the terms were not easy to understand and distinguish (p. 6-7). We have also adapted Table 1 (p. 5) to make it more accessible and added a methodological diagram as a supplement. All this information should serve to define and delineate the terms more clearly.

p7.Ln154 : The repetition of `spatial, spaces, spatially' can be avoided (e.g. ` By defining four spatially bounded volumes with...').

We changed the wording: Hence, pathway patterns cannot be unambiguously defined without spatial information. To systematically add this information, we define five spaces, volumes with distinctly different environmental conditions and processes (p.7 L172).

p7.Ln155 : the reference to Table 1 is not informative and necessary.

We deleted it.

p7.Ln163-164 : I am curious why these specific systems must be represented with these specific numbers of spaces ? Is it to be sure to consider the processes/pathways in these specific systems ? As there are no `numerical' rules for the conceptual model here, I am wondering why this information is here.

We have added that this rule applies in the case that all closed loops are resolved

(p.7 L182). It is not a numerical rule, but since our concept provides a systematic language, there are logical rules that apply when a certain result is to be described.

p7.Ln154-164 : I am wondering why the Atmosphere is not considered here as the LSS is ?

That is true and inconsistent. We added an atmosphere space (AS).

p10.Ln209 : It is confusing that 'pathway patterns' means closed loops. Why not use closed loops directly ?

We have rewritten the first two sentences of this paragraph. In general, pathway pattern is a superordinate term that includes e.g. closed and open loops. Closed loops, in turn, is superordinate to remineralisation and rDOC loops.

p17.Ln311 : Not only fish and mammals, but also reptiles (e.g. McClain CR, Nunnally C, Dixon R, Rouse GW, Benfield M (2019) Alligators in the abyss: The first experimental reptilian food fall in the deep ocean. PLoS ONE 14(12): e0225345. <https://doi.org/10.1371/journal.pone.0225345>)

We thank the reviewer for pointing out this interesting study. We have added it to the relevant paragraph (p.19 L399).

p18.Ln334 : 'biological**carbon**pump'

We changed it throughout the paper.

For Initial position I do not get the meaning of 'Abstract' in the definition. Would 'Start position' will suffice ?

We keep "abstract" because we also mention on page 3 L83 that loops have no initial point, and that the choice of such a starting point is thus abstract.

In the example part, I suggest putting in bold the terms to have an easier reading but to not use the example of the term defined above. It is confusing to have in the example of one term and example of the term above. One should be able to see the example only jumping from one line to another in the example column.

Comments on Table 1 indicated that the whole table was confusing and that some of the terms were not defined clearly enough. We have adjusted the definitions and added three concrete pathways at the beginning to additionally show how we got from concrete process-based pathways to our abstract definitions of pathway patterns (p.5). We also added a flowchart of the methodology as a supplement B.

Process: In the example column you can add 'fish respiration'

We have adapted Table 1, taking into account the reviewers' criticism of the example column and the problems in distinguishing the terms. We now start the table with 3 concrete pathway examples and use these examples to illustrate the different definitions and examples of the terms.

Path segment: In the example column, you can delete the 'Processes line example', remove the 'path segment' and keep only 'OC remineralization (..)'.

See comments above.

Pathway: In the example column, I do not get why OC remineralization (presented above as Path segments) is now considered as a 'sequence of path segments'. Are the pathways defined as 1) how the carbon moves from one 'box' to another along processes, or 2) how the carbon moves in the conceptual space volumes?

It is not OC remineralisation that is the sequence, but the combination of 1) OC size change, 2) OC remineralisation, 3) DIC upward position change, 4) DIC uptake by primary producers. Each of the numbered points is a path segment. When combined, they form a sequence of path segments that define a pathway. We understand the reviewer's comments regarding the different examples per definition. However, we have intentionally added the "process level" in our example column to illustrate what can be part of the examples of conceptual terms and how individual observed pathways fit into the concept. The "process level" is the level that we can observe. For example, the sequence in which OC is ingested and respired by a fish and the DIC produced is ingested by primary producers forms a pathway. At this "level", the OC exudates used by bacteria for remineralisation and the subsequent uptake of the produced DIC by primary producers describe a different pathway. The "pathway level" is the conceptual level. Here we combine the two pathways described earlier into the sequence OC remineralisation and DIC uptake by primary producers. The difference is that OC remineralisation includes both bacterial remineralisation and fish respiration. We use this description to generalise processes rather than individual examples of processes or pathways. We have adjusted the table to make this clearer.

To the referee's question: Pathways are defined as a sequence of processes that can be grouped into path segments if they have the same functionality, and the spaces in which these path segments (processes) take place. Pathways thus describe how carbon is subjected to processes in a certain order and how it changes its properties and position in the process.

Space: This is not necessary for me to be defined here.

We keep this definition here, as the table should provide all relevant information.

Closed loop/Open loop: To the current state I unfortunately do not get clearly the distinction between pathway or loop. There is no need for two pathway examples here, it leads to confusion between pathway and loop. You can stick only with 'surface remineralization loop'.

Open and closed loops are superordinate classifications of pathways. See comments above, we adapted table 1.

Process option: While I get that you want to define all the process options that we know, I suggest that the options should be already included in the 'conceptual' processes. By itself each process option is a process.

We agree and changed it to processes.

Pathway pattern: Similarly I get confused with the distinction.

We hope that by changing the table and the explanations in the text we have made the terms clearer.

Other proposition: To help the reading between the text of the manuscript and the table,

you can refer as example to the same example available in the text such as for Path segment (mention the six critical path segment of the OC cycle (p5.Ln37-39)) ; for Open loop (mention the five ones (p7.Ln165)) ; and for Close loop (mention the 3 ones (p9.Ln202-206)).

We adapted table 1 with three example pathways that are part of the defined closed and open loops.

To help to connect with the text, Is it possible to have a specific code in the legend and the figure for the loops and one for the path segments?

Following referee 1, we added a flow syntax to the publication where helpful and necessary. In the figures, path segments are indicated by arrows, critical path segments by capital letters and loops by a colour code. We added this information where it was missing.

The atmosphere term should be appearing as the long-term sediment one is appearing.

True, we added it.

For the nomenclature see one of the last comment made below for the link between Table 3 and Fig2.

True, we changed the names so they fit. We thank the referee for this comment.

I suggest deleting the repetition of the column name each time we are moving to another path segment and therefore place the column name as the first line before the first path Organic Carbon position change (A).

We tried it and it did not help to understand the table better. Firstly, because the names of the columns then do not match the next row where the path segment is named, and secondly, because the table is long and repeating the column names makes it easier to follow the table. So, we keep the repetition.

I suggest to either place in the center the name of the path to cut the reading among the table each time the path changes, and/or use a double line before and after the name of the path, similarly to help the eyes to see that we are moving to another path.

We added spaces and double-lines to allow a more structured reading of table 3.

On the part of the table in p16, I do not see why we have again the path C, and why the path E is reduced only as a name in the first column? I guess it is a typo and the following processes refer to path E following the infos available in Figure 2.

This was a mistake in the original table. Thanks for pointing that out.

I suggest removing the column Process description as it is already well explained in the text and in figure 2, as well as the column Involved organisms. It will save space and help the reading. If you want to keep one among the two I suggest keeping the process description one.

We kept the information as we consider the table a useful and necessary summary of the section 3.2.

However, an effort can be made to smooth again the nomenclature used between Figure 2 and Table 3 First column, to allow the reader to proceed to an easy retrieval of the

processes (description or representation) between the Figure 2 and the Table 3.

We agree and did it accordingly.

Organic Carbon Position Change: Following Fig.2 it seems that the biotic direct transport is not writing in the process column while infos related to seem appearing in the other columns (?)

We agree. Added it.

OC Remineralization (D): Following Fig.2 it seems that the DOC consumer respiration is not writing in the process column

We agree and added it.

Editorial/Typo comments :

p2.Ln49 : 'DOC' acronym has not been defined yet.

**The DOC acronym is now defined before the acronym is used (p.4 L104).
Mentions of dissolved OC before are written out.**

p2.Ln52 : As defined in the p2. Ln49, you can use the acronym

Part is now on page 2 line 32 and not defined before.

p3.Ln60 : Extra parenthesis

p3.Ln60 : Part is deleted.

p3.Ln65 : Missing parenthesis

p3.Ln65 : Part is deleted.

p5.Ln126 : Missing a dot at the end of the sentence

Full stop is added (p.6 L132).

p7.Ln167-176 + other parts in the text : To help the reading of acronyms, can you think about having the related space ones (SLS,WCS,USS) in italic and the one related to the loop in normal?

We highlighted acronyms in italic when we mention them for the first time.

p10 to 13 : 1) Can we have subtitles for each path segment you are talking about ? Like it is done clearly in Fig.2 (Path segment A, Path segment B, etc.) ? 2) Can we have just one sentence at the beginning referring to Figure 2 and Table 3 for this entire part, instead of having it mentioned everywhere ? It will make the text easier to read.

We do not add subtitles to not disturb the text flow but table 3 is the structured summary of the text.

We referred to table 3 and figure 3 in the beginning of the section and reduced the references in the following text.

p11.Ln253 : Extra parenthesis

Extra parenthesis is deleted (p.15 L283).

p18.Ln336 : `e.g.` before via

We deleted this part.