

## Responses to the associate editor

*Your revised manuscript has been re-evaluated by one of the original reviewers, who was generally very positive about the revisions but did make a few minor comments regarding figures 3 and 6. Please consider these before uploading your final files (but do keep in mind the guidelines for colorblindness for Figure 3 - see <https://www.biogeosciences.net/submission.html> for more information).*

Our responses are reported below in normal font, while the editor's and reviewers' comments are in *italic*. The comments by Reviewer #2 have been taken into account, and we checked that the chosen color palettes followed the guidelines for colorblindness. We also made minor text edits in the Supplementary Information.

*To add to the reviewer suggestions for these figures:*

*- In figure 3, you may also consider reducing the size of the symbols to improve the visualization*

*- In figure 6 (B and C), it would be good to also write the variable for the color bar (SOC in B, C:N and C; similar to how you did this in Fig. 3).*

Symbol size was reduced in Figure 3 and colorbar labels were added in Figure 6. Thanks for these suggestions.

## Responses to Reviewer #2

*General Comments: Manzoni and Cotrufo responded clearly to the reviewers' questions and comments, and took them into account when revising the manuscript. They added respective parts to their manuscript and changed figures accordingly. This justifies assumptions and following derivations, which makes it easier to follow the methods, and clarifies the results. Mentioning and discussing critical points increases the reliability of the study. In cases, where the authors decided not to change the manuscript, the decisions are clearly explained. Overall, I'm satisfied with the work that the authors have done, especially with the text edits, but I wondered about some figure changes, which I report in more detail below.*

*Text edits: I especially like the added section 4.2 about model limitations, which show that the authors considered the reviewers' concerns about the study and potential limitations, and I would like to highlight the manifold clarifications in section 2, which justify assumptions and thus support understanding the equations. Also, the replacement of "and" by "+" when speaking about POM + residues, which was not requested by any reviewer as far as I see, improves readability. Additionally, being more precise about the actual number of studies, which are used for each step, instead of mentioning a vague number (around 40), makes the study more reliable.*

Thanks for these supportive comments. We agree that the revised text is easier to follow and more accurate.

*Figure edits: The authors have made a huge effort in editing the figures in response to the reviewers' comments and suggestions, which in general improves the figures, simplifies their interpretation and strengthen their messages. I'm especially happy with the added baseline plots in figure 2 that help to understand general model behavior and thus to interpret changes, and the added time trajectory plots in figure 4, which clearly show the advantage of analyzing within the phase space instead of time trajectories. I also like the simplification of figure 5 by only showing the boxplots instead of all values, because this makes the message much clearer. However, I find the discretizing of data sources (fig. 3b, color bar) hard to see. Not sure, if it would help to either use a wider range of colors (e.g. by adding reddish colors, which may be problematic for color blind people), or by using discrete intervals (1-5, 6-10, 11-15,...) instead of having one color for each number, or to leave out numbers that are not used, e.g. if for example the values 2, 6, 14,... are not used, they could appear black, to save colors for numbers that are actually used.*

We have now added black lines to separate the colors in the colorbar, and reduced symbol size to improve visibility of both data points and colors. It should be noted that the source number has no particular meaning, as it refers to the 'source code' in the database, so grouping data sources would not be useful. Also, pretty much all data are shown in Figure 3B, so skipping some data source number would not help in the visualization. The interested reader can check individual datasets in the open-access database.

*And I'm wondering about the changes in figure 6. E.g. the changed numbers in panel A, and the differences in SOC median (previous version: 0.016) and 50th percentile (revised version: 0.013) in panel B. However, my concerns may root in the fact that I have seen the previous version of the manuscript, but not prevent a new reader from getting the points, and I really like the visualization of the actual data points in panels B and C.*

Median values changed slightly because we have added a dataset to our database, which resulted in additional data points in Figure 6.