

## Reply to Anonymous Referee #1

We would like to thank the referee for her/his suggestions to improve the clarity of the manuscript and open it to a broader audience.

In this reply we give an overview of the main changes we did to address the referee's comments. Changes in the reviewed manuscript are highlighted in blue. Below you will find a point-by-point response to the comments, together with a description of the changes made in the manuscript.

**RC1:** *L25: write the name of the author you are referring to in the sentence and not just into the brackets*

**Reply:** Thank you, we changed the text accordingly.

**RC1:** *Figure 2: I suggest you explain the meaning of  $\sim X$  in the legend as well.*

**Reply:** Thank you, we added the definition of  $\sim X$

**RC1:** *Figure 4: the x labels are cut (bottom of the middle and right columns).*

**Reply:** Thank you, we modified the figure accordingly.

**RC1:** *Figure 5: maybe you can mention in the legend that the P1 and P2 groups have disappeared when following the backward path.*

**Reply:** Thank you, we added the mention that only the P3 group is present in the backward simulations.

**RC1:** *Figure 5: the P4 group is hidden behind the x axis. Maybe you can change the limits of the y axis as so the red triangles will be more visible.*

**Reply:** Thank you for pointing this out, the concentration of P4 group is below observable levels (near 0), therefore we prefer to keep the figure as it is.

**RC1:** *L297: is the Z4 group not present in the backward trajectory?*

**Reply:** Z4 is present in the backward trajectory only for the smallest values of the forcing factor and it is a concentration much smaller with respect to Z5 and Z6, giving therefore no significant contribution. We added to the text a sentence, in which we explain that Z4 recovers for the smallest values of nutrient depletion.

## Reply to Anonymous Referee #2

We would like to thank the referee for her/his suggestions to improve the clarity of the manuscript and open it to a broader audience.

In this reply we give an overview of the main changes we did to address the referee's comments. Changes in the reviewed manuscript are highlighted in blue. Below you will find a point-by-point response to the comments, together with a description of the changes made in the manuscript.

**RC2: L4:** *The phrase "used in operational oceanography" is unclear and does not specify the model's type or relevance to this study. Please describe the model more precisely, for example, as "a 1D water-column physical-biogeochemical model" or a "state-of-the-art biogeochemical model".*

**Reply:** Thank you for highlighting this, we changed the sentence to "state-of-the-art biogeochemical model".

**RC2: L6:** *The referent for "this phenomenon" is ambiguous.*

**Reply:** Thank you, we specified the phenomenon which we refer to.

**RC2: L6–9:** *The logical relationship between the two findings in these sentences is unclear. The first states that responses are commonly reversible, while the second introduces hysteresis driven by nutrient depletion. Please clarify.*

**Reply:** Thank you, we clarified the sentences, as nutrient depletion is the only forcing inducing hysteresis and not reversible response.

**RC2: L10:** *The phrase "under a vast range of environments and methodology" is unclear. Models are tested under varying environmental conditions, not under a "methodology". Please specify what is meant by "methodology" and rephrase for clarity.*

**Reply:** Thank you for this comment. We have specified what we mean by "methodologies". Specifically, we refer to sequential simulations, initial condition perturbation and demographic stochasticity, as clarified in the revised version of the manuscript.

**RC2: L12:** *The concluding sentence is generic. Please connect the conclusion more directly to the key mechanistic insight of the study.*

**Reply:** Thank you for this suggestion. We changed the sentence according to the suggestion.

**RC2: Fig. 1.** *Please explicitly state in the figure caption whether the data shown are model results or observations.*

**Reply:** Thank you, we clarified this point, saying explicitly that they are model data.

**RC2: Supplement:** *several text paragraphs currently placed at the end of Fig. S11 appear to be part of the general model description.*

**Reply:** Thank you for pointing this out. All figures have been moved after the text.