

Comments to the authors

General comments:

The authors investigated the response of a biogeochemical models to extreme environmental changes. Specifically, they studied the response of the “system” to various perturbations and whether it was reversible or not. This article examines an interesting and important topic, i.e. how biogeochemical models and the biological systems they represent are responding to extreme perturbations, before and after it has occurred. However, I struggled to understand the analyses that have been done as well as the results and the conclusions. Note that my background is not in biogeochemical modelling, so I may not be the best person to review this work, which may explain my misunderstanding. I have tried to make some comments that should help less specialised readers to better understand. My aim is not to discourage the authors but rather trying to make the article clearer.

First, I think the authors need to clarify the vocabulary they use. For example, I do not understand what they mean by “*regime*”, “*dynamic regime*”, “*alternative regime*”, “*system*”, “*alternative dynamic regime*”, “*operational model*”, etc. The paragraph lines 103-109 page 4 also really confused me. For example, you say that you “*call the stable states dynamic regimes*” while to me, “stable” and “dynamic” are contradictory.

Second, the main figures are hard to understand. What are the authors trying to display? As you are talking about plankton dynamics, regime shifts, environmental data covering a given time period, etc, I was expecting to see time series, starting from a data t and ending at a time $t+45$ years (for example, a 45 years simulation is mentioned line 148 page 8), with maybe an indication that a perturbation was implemented at some point, so we can see the changes in the modelled plankton community, with and without the perturbation. Instead of that, we have a series of experiments, which make sense in the method, but no more in the results. For example, they say, for the EXP-SEQ experiment, that the regime returns to its original values, but when I am looking at Figure 3, I cannot really understand where I am supposed to see that. Furthermore, as the authors worked with a biogeochemical model, I was also expected to see how those modelled regime shifts impact the carbon cycle (for example) but only chlorophyll was investigated.

Third, I have been disappointed by the title, which mentions “plankton communities”, and the method, which describes various plankton functional types (PFT). Therefore, I was expecting to see the changes observed for those different PFT (diatoms, dinoflagellates, microzooplankton, etc) in response to the environmental perturbations. Instead, the only variables describing plankton dynamic are chlorophyll bloom, deep chlorophyll maximum and total production of chlorophyll. I also wonder how is it possible to talk about dynamic regime of plankton community while changes in community composition

are not even displayed in any of the main figures? In the same way, the authors mention the seasonal cycles many times, but I cannot see how their results relate to the study of seasonality/phenology (except Fig S1?).

I am sorry for those comments. I think the study is of interest, but I have not been able to understand the results. I suggest the authors should rewrite their article, e.g. reconsidering how their results are presented as well as clarifying the vocabulary they use. It will not be a huge work. For example, they should not mention "*plankton community*" but directly "chlorophyll" in the title and throughout the text. I would also highlight that the model is applied at a fixed point in the Mediterranean Sea (if not in the title, at least in the abstract), so those results may not be applicable at a world scale(?). For the figure, maybe the authors should add an arrow below the panels, to highlight that the value of that environmental parameter is increasing forward and then backward, and also highlight where (and when?) the extreme values are reached for each environmental forcing. Adding a figure legend describing the meaning of the different lines/triangles would also help to understand quickly the figures after a first look.