

Response to the topical Editor's Comments

Dear Carlos,

Thank you very much for this positive assessment of the revised manuscript! We agree with your opinion and have addressed the issues raised as detailed below.

Topical Editor Decision: Publish subject to technical corrections (19 Mar 2018) by Carlos Sierra

Comments to the Author:

Dear authors,

thanks for preparing a revised version of your manuscript addressing reviewers' comments. The new version is much more improved and addresses well the main issues raised by the two reviewers. I only have a few minor comments that may help to improve the manuscript. Once they are addressed, we can proceed with manuscript for publication.

I also shared the concern of the reviewers about the potential violation of assumptions of the impulse response approach for the time-varying case. This issue is now clarified both in the answers to reviewers' comments and in the main text. However, I think there's still a few minor issues that could help to further clarify the issue.

- At the end of section 2.3, you added new text clarifying that the IRF approach is only valid if the subsystem is linear. Although the emphasis in linearity is very important, I think it is equally important to emphasize that the approach also relies on the assumption of time-invariance of the time-scales of the system. You may want to emphasize this assumption separately from the assumption of linearity since you may still have a linear model with first-order rates that doesn't meet the assumption of time-invariance.

We have edited the 5th paragraph on page 9 in section 2.3 as follows: "The IRF representation is, strictly speaking, only valid if the described subsystem is linear and the time scales of the system are time-invariant."

- In several parts in the manuscript you make reference to 'box models', and I got the impression that the term may have different connotations in different contexts. Box model may mean very different things to different people. I would prefer if you use a less ambiguous term. For instance, it would be better to say that the IRF can be interpreted as a system of uncoupled first-order ordinary differential equations. Alternatively, you may want to provide a definition of box model when you first use the term.

We have changed the introduction of the box model in the second-to-last paragraph of the introductory text of section two on page 5:

"More illustratively, the ocean and land models can be considered to consist of systems of uncoupled first-order ordinary differential equations or "box models", which are an equivalent representation of the IRF model components (Figure 1)." and in the second paragraph of page 9,

"The differential equation system (21) can be considered to consist of several boxes, whereby each box m_k receives a fraction a_k of the input f , and has a characteristic turnover time τ_k (Figure1). In the following, this is referred to as a "box model"."

- Eq. 1. In the text before the equation, specify that the budget equation is for 'atmospheric carbon'.

Done

- Eq. 12. In the text before the equation, specify that the equation applies for a linear system with time-invariant rates with time-dependent forcing.

Done

- Appendix A2. In the equation for NPP, is there a negative sign missing in the first exponential term? Please check.

The term is actually positive. However, we noticed that the parametrization ranges should be mentioned and added the following sentences

- For HRBM NPP: "This expression holds up to a CO₂ concentration of 1274 ppm and is capped at that value." and "This expression holds up to a SAT increase of 5°C."

- For HRBM IRF: "The temperature sensitivities of the HRBM IRF are parametrized for a warming of up to 5°C."