

## Response to Reviewer #1

Overall, this paper is excellent. It usefully adds to the body of experimental results based on the use of quasi-equilibrium models and further develops our understanding of the importance of key processes and assumptions.

Having said that, I was very happy with reading the paper up to page 19, line 5. Introduction and the associated discussion of past research was excellent, detailed and informative and structured to derived useful information and leading to new questions. The description of the model was also clear and gave all the relevant model components.

**Responses:** We thank the reviewer for this positive overall comment on our paper.

It was maybe a little long (34 equations), and there a danger that key model steps might have been swamped within a sea of less important ones. There might be a point in moving some of the model detail to Supplemental Information, and only presenting the key steps in the main text.

**Responses:** We agree that we may have included too many equations in our manuscript. In fact, equations governing the baseline model (Eq. 1-15) have been published previously by a number of insightful studies, which we have provided in-depth reviews in our literature review section (e.g. Comins and McMurtrie, 1993; Kirschbaum et al. 1994, etc.). However, to comply with journal requirement, we need to “contain the justification of the model structure in the main body of the paper” (stated by the chief editor prior to our submission). We therefore cannot move our baseline model derivations into the Supplementary Materials under this consideration. In our revision, we propose to move these baseline derivations, together with derivations of new model assumption, into an Appendix as an integral part of the manuscript. This will help smooth the reading of the story, at the same time providing all fundamental analytical details in the main text. We hope that the journal could allow us adding an Appendix as part of the main text.

However, the remainder of the paper was not well presented. Page 19, line 6 should have started a ‘Results Section’ where the various figure and tables could have been presented and discussed in some detail. As it is, all the key findings were dumped here within half a page. I do not regard this as satisfactory.

**Responses:** We must respectfully point out that the reviewer may have misinterpreted our original Method and Result section. It was our deliberate intention to keep the Method and Result section together because the quasi-equilibrium framework is an analytical way of interpreting the likely impact of a model assumption to model behaviors. Therefore, derivations of equations are fundamental and deeply linked to the analysis of results. In our Method and Result section, we firstly described the baseline quasi-equilibrium framework (section 3.1), then assessed several recently-incorporated model assumptions (section 3.2 and 3.3), and one new model assumption that we propose in this study to represent priming effect in models (i.e. section 3.4 – representing priming effect in models). We have explicitly stated the logic of the Method and Result section in Page 7, Lines 14 – 18. The paragraph starting from Page 19 line 6 describes the result of assessing priming effect using the quasi-equilibrium framework. This is only part of our result, and we believe that it should not be a result section by itself.

To avoid future confusion, we will restructure the Method and Result section by 1). Move equation derivations into an Appendix, as proposed above, and only keep a minimum set of fundamental

equations to describe the quasi-equilibrium framework; 2) Change section headers with section 3.2 renamed as “Analyses of new model assumptions using the quasi-equilibrium framework” (or something similar), then add sub-sections of 3.2.1 (i.e. N uptake representation), 3.2.2 (i.e. Potential NPP), and 3.2.3 (i.e. priming effect). We will also add another paragraph following header of section 3.2 to explicitly state the purpose of each evaluation within this section. We hope that this structural arrangement will make the Method and Result section clearer to readers.

Each figure shows important information that is not immediately obvious. It needs careful text that explains to the reader what we can learn from each figure. A general ‘data dump’ with virtually no explanation is never a good way to proceed, but totally unacceptable in this case, as the essence of the modelling is not immediately obvious, but the reader needs to be led through the various figures to extract the key insights gained from each.

**Responses:** We thank the reviewer for raising this important point. We will revise our manuscript wherever appropriate. But we would still like to respectfully point out that both equation derivation and graphic interpretation are fundamental part of the result, and they complement each other when interpreting the results. We have detailed texts describing the baseline model figure, and each follow-on figures brought various levels of changes to the baseline figure. We have included explanatory texts throughout the derivations to suggest how each model assumption affect the results and therefore graphs. We did not “data dump” all results without any explanation.

Some of that detail is then given in the Discussion, like page 21, line 5 onwards, but only very briefly. That reference is too brief on its own and would have needed a proper description in a results section that could then be referred to. So, the Discussion might be OK if it had an appropriate Results section. But without a Results section, the reference to the various figures is still too brief to be readily and fully understood by the reader.

So, all in all, I would regard the paper as not acceptable in its current form, but that is entirely due to the lacking Results Section and insufficient description of the modeled findings. If that can be added, and the Discussion section then be modified to appropriately refer to text in the Results Section, the paper should be able to make a really strong contribution to the literature.

**Responses:** We will expand our discussion following this suggestion. However, as we argue in the responses above, we believe that the reviewer may have misinterpreted the original Method and Result section. As we stated above, we will make some structural and content edits to improve readability of our manuscript.

Minor comments: Page 3, line 7: The authors introduce the abbreviations QE for ‘quasiequilibrium’. That is unnecessary in my view and just obscures the subsequent text. ‘Quasi-equilibrium’ is short enough and can continue to be used throughout the paper. No need to confuse the reader by an unnecessary abbreviation.

**Responses:** Will modify the text following this suggestion.

Page 7, line 7: When the authors mention ‘concentration-carbon’ feedback, I assume they mean ‘CO<sub>2</sub>-carbon’ feedback. It would be better if that could be spelled out more explicitly as ‘CO<sub>2</sub>-

carbon' or something else that would leave the reader in doubt as to what concentration is referred to.

**Responses:** Great suggestion. Will revise accordingly.

Page 7, line 22: Here, it states that in assumption 3, N uptake is modeled as a saturating function of root biomass. This makes it sound as though there were no upper limit to N uptake other than that imposed by root biomass. However, the detailed model description states that N uptake is also dependent on mineralized N, which seems like a sensible assumption. Just make sure that in the initial description of this assumption, it is also made clear that mineralized N is a co-limiting factor. Currently, that is not included and gives a misleading impression of the model assumption.

**Responses:** Again, great suggestion. Will revise accordingly.

Nothing to add to the Model Description. The text after that needs some bigger overhaul as mentioned above, and I have refrained from referring to specific details as they will hopefully be changed in a bigger re-write.

**Responses:** As we stated above, we will make significant structural changes to the Method and Result section, and we hope that the revised text will be deemed satisfactory by the reviewer.