Geosci. Model Dev. Discuss., 8, C2960–C2964, 2015
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Geoscientific Model Development Discussions
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Interactive comment on "Towards a representation of priming on soil carbon decomposition in the global land biosphere model ORCHIDEE (version 1.9.5.2)" *by* B. Guenet et al.

Anonymous Referee #1

Received and published: 18 November 2015

General comments

Recently, there was a debate on Science (van Groenigen et al., 2014) and Global Change Biology (van Groenigen et al., 2015; Georgiou et al., 2015) about how to represent priming effect in large-scale CENTURY type decomposition models. In this regard, Guenet et al. presented a timely and important study, which offer a simple way to include priming effect in large-scale land surface models. In addition, it's good to see that the proposed PRIM model was evaluated against multiple datasets.

However, writing was a little weak in terms of conciseness and smooth, please check my details comments, I listed some issues, author should carefully refine the paper on

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their own, I believe you will find more.

I have two major concerns, the first one may be out of the scope of PRIM, but it is important in terms of modeling priming effect. I am not asking the author to modify PRIM accordingly, but more discussions are definitely needed.

Major comments

1. Priming effects is related to nitrogen availability. Why choose ORCHIDEE not O-CN?

The priming effect is closely related to soil nutrient availability. Both positive and negative priming have been observed when soil N is limited. Basically, there are two prevailing N-centric priming hypotheses (1) when N availability is low, microbes use fresh carbon to mine old carbon and obtain nitrogen, leading to a positive priming effect; (2) when N availability is strongly limited, adding fresh carbon enhance competition between roots and microbes, consequently reduce microbial activity and depress microbial growth.

It is interesting to see how PRIM work with O-CN. In some sense, I would argue that the priming effect modeling must consider nitrogen, because that is the theoretically "correct" way and supported by large amount of priming observations. But having priming effect coded in carbon only model is a good start. Considering nitrogen in PRIM will be a big plus. The author should have more discuss on this issue including existing theories and observations, potential model development.

2. About model core assumption

The most attractive part of PRIM is that it does not require explicitly microbial dynamics (e.g., microbial biomass), by assuming microbial biomass is always equilibrium with FOC. Such assumption is suitable in terms of simplicity, but is it suitable for model predictability? What's the theoretical basis of this assumption? What's the potential bias by imposing this assumption? Please have more discussion, because this assumption is the backbone of this study.

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Specific comments

1. Title: better not use such a detail version number, first of all people who do not work on ORCHIDEE would not care about the version, secondly you can put the details in other section (such as your code availability section), but not in title.

2. P9198. L18-19. Be concise: “the soil carbon model structure of ORCHIDEE land biosphere model” -> “ORCHIDEE soil decomposition model”

3. P9198. L21-23. Sentence doesn’t make sense. Rewrite it. How about “SOC decomposition is modulated by soil temperature and moisture functions. Active SOC decomposition is further modulated by a clay function. These functions are the same as in CENTURY.”

4. P9199. L3. that simulate a priming effect -> to simulate priming effect

5. P9199. Eqn 1-3. SOCLabile , please be consistent throughout the paper. Either use labile SOC or active SOC. It’s confusing to have both active SOC and labile SOC meaning the same thing.

6. P9199. Eqn. 2-4. Does clay function (gamma) only affect active SOC pool?

7. P9199. L11. FOC, first time used in materials and methods section, better to have a full name.

8. P9199. L22-23. Be concise, “assume instead a linear relationship between microbial biomass and FOC. Thus, it implicitly assumes that MB is always in equilibrium with FOC” -> “assumes that MB equilibrates with FOC thus the relationship between MB and FOC is linear”

9. P9200. L2. The decomposition model runs at a daily time step. duplicated statement with 9199 Line 1, remove it.

10. P9200. L13. “very different situations” What are these situations? elevated CO2? warming? dry/wet?

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11. P9200. L15. “three different models” -> “three different sub-models”.

12. P9200. L19. “manage the aspects related to” -> “deal with”

13. P9200. L24. “describe” -> “classify”

14. P9201. L8. . . . priming effect was measured . . .

15. P9201. L9. “by comparison with a control without FOC” -> do you mean “by comparing a control study without FOC with a perturbation study with FOC”?

16. P9202. L8-10. I don’t fully understand. Did you run run ORCHIDEE-PRIM to get equilibrium carbon states? If you run ORCHIDEE till equilibrium and use ORCHIDEE-PRIM to run transient, SOC pools are out of equilibrium at the beginning of the simulations.

17. P9202. L19-20. how to estimate initial fraction of each pool with location formation?

18. P9203. L13-14. Be concise: “turnover rate (kSOC) for each of the three pools as well as the priming parameter c of Eqs. (1), (2) and (3) specific of each pool” -> “turnover rate (kSOC) and priming parameters c for each of the three pools”

19. P9203. L21. “use all data streams assimilated” -> “assimilating all data streams”

20. P9204. L10. How do you calculate J(x) gradient? By finite difference method? adjoint method?

21. P9204. L24. “only too studies” -> “only two studies”

22. P9204. L25. No covariance between c and k? Intuitively, should active C pool have faster turnover time as well as get easily primed (high substrate quality and easily get attacked by extracellular enzyme)?

23. P9205. L11-14. I’m confusing.

(1) Did you use observed total SOC, but simulated fraction. Any motivation? (2) is this fraction important in terms of controlling priming effect, my guess is positive. (3) you

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can easily do a sensitivity analysis by varying the fractions

24. P9206. L5. Same proportion. Why use proportion not absolute amount?

25. P9207. L15. why the uncertainty of slow pool is so tiny compared with active and passive pool. Looks like this parameters is perfectly constrained (tiny posterior error)?

26. P9207. L21-22. If original ORCHIDEE succeeded, then what's the value of introducing PRIM.

27. P9208. L11-13. PRIM works pretty bad. Any comments? Why? How to improve it?

References

Georgiou, Katerina, et al. "Towards improved model structures for analyzing priming: potential pitfalls of using bulk turnover time." Global change biology(2015).

van Groenigen, Kees Jan, et al. "Application of a twoâĂŘpool model to soil carbon dynamics under elevated CO2." Global change biology (2015).

van Groenigen, Kees Jan, et al. "Faster decomposition under increased atmospheric CO2 limits soil carbon storage." Science 344.6183 (2014): 508-509.

Interactive comment on Geosci. Model Dev. Discuss., 8, 9193, 2015.