

# ***Interactive comment on “Improvement of Soil Respiration Parameterization in a Dynamic Global Vegetation Model and Its Impact on the Simulation of Terrestrial Carbon Fluxes” by Dongmin Kim et al.***

## **Anonymous Referee #2**

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Q10 is a critical parameter for simulating soil respiration and C cycle and therefore feedback between C cycle and climate. Yet most ESMs adopt constant Q10, which can possibly lead to unrealistic simulations of soil processes and other C cycle processes. Therefore, this paper contributes to improve model performance by implementing a new Q10 parametrization. This has significant implications to modeling studies.

I have two major concerns. One is the authors did not explain why improvement of Q10 parameterization and resulting improvement of soil respiration can help improve simulations in GPP. Is it because nitrogen availability resulting from changed soil respiration

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rates or other mechanisms? Another is the confusion of sensitivity of soil respiration to temperature (i.e., Q10) and sensitivity of Q10 to parametrization.

Specific comments are listed below.

Lines 84-85. Please cite literature(s) for this statement.

Lines 86-87. Please cite literature(s) for this statement too.

Lines 89-90. There are many studies on soil respiration under experimental warming that which should address this point better.

Lines 93-94. There is a recent review paper talking about this issue (Global Biogeochemical Cycles, 2016, 30: 40-56)

Lines 102-103. I would not say that because there are many field studies examined Q10, but it is true, we lack long-term observation data on how Q10 changes overtime. It may be difficult for regular field studies to explore dependency of Q10 on temperature as they derive Q10 through entire seasonal temperature range when Rs is measured. However, it can be tested via lab incubation experiments or field experiments with warming treatments.

Lines 104-105. I think they meant Rs tends to decrease with temperature increase. This needs to be clearly stated.

Line 135. Both the name of the ESM and the name of land model in the ESM should be given.

Line 145. Add “time resolution/interval/step” before “is monthly”.

Line 151. “Each tile is 1200 X1200 km” needs to be clearer. Does it refer to original MODIS17A3 GPP and NPP data?

Lines 155-156. Which year are these data for or are they the average from 2000 to 2006?

Line 157. This sentence is not clear. Did they mean that they compared modeled  $R_s$  against the data by Hashimoto et al. (2015) for validating their model? What is time period of  $R_s$  data by Hashimoto et al. (2015)?

Line 159. What is “SRDB”? It needs to be fully spelt.

Line 162. Year for the literature should be given.

Lines 165-167. What does “assuming” mean?

Lines 176-177. Why is the decomposition flux calculated by multiplying carbon amount from dead leaf? Soil respiration include both microbial respiration and root respiration. The substrate for microbial respiration is SOM in the soil, which is originally derived from litter (dead leaf, wood, and root). And root respiration is respiration by live roots, which is related to root biomass. If their model does not separate the two components, it should be carbon content of soil.

Lines 186-187. It should be “the water potential for soil decomposition”.

Lines 212-213. In a multiple regression analysis, why are the relationships between  $R_s$  and T and between  $R_s$  and M separately?

Line 223. Use soil temperature may be clearer than subsurface data.

Lines 224-235. This paragraph is very confusing. The authors need to give time step of each dataset to avoid confusion. Are GPCP and TRMM data used to rescale precipitation data by Sheffield et al. (2006) to a time step of daily and 3-hour step for forcing CLM? And CLM is forced by 3hr data, then why daily data are needed? Is it for regression analysis? In addition, Sheffield et al. (2006) data have radiation, so what are radiation data by NASA for? If they are for all descriptions of Sheffield et al. (2006), it needs to be clear.

Line 226. Year for the literature is needed.

Lines 233-235. Please give the source of the data.

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Lines 235-237. What does “integration” mean? I understand it is model simulation.

Lines 236-237. How can an audience find a reference that is not published?

Line 238. I think they are talking about soil respiration by Hashimoto et al. (2015), but this needs to be specified.

Lines 246-247. The period of forcing data by Sheffield et al. (2006) is reduced to be the same with GSWP2?

Line 251. Does this mean a global constant and unchanged over time? Fig. 1. Why 28 years? Is this because of time period of data by Hashimoto et al. (2015)? The title is confusing and needs to be revised. It would be useful for audiences to see regression models for all PFT as supplementary information.

Line 252. CESM run needs to be described before “Figure 2”.

Fig. 3. CTL should be included in the figure title.

Line 272. The title should be “results and discussions”.

Line 330. Sensitivity of  $R_s$  to soil temperature?

Line 334. Which panel in Fig. 6 did they refer to by “enhanced relationship between  $R_s$  and temperature” for the northern Eurasian and Chinese regions?

Line 273 and the whole paragraph. In method section they never talked about CMIP5, why here a subtitle for CMIP5 GPP? If they use CMIP5 to evaluate or compare CLM EXP, they need to describe it in method and need to include EXP or CTL in this section and in Fig. 4. They also need to give some details such as how many CMIP5 models, model names and if MME includes CESM-BGC and NorESM. There are few papers with figures that do not include results from their present study. If they want to discuss the issue of underestimation of GPP by coupled N cycle, this part should be put into discussion and the figure should be in the supplementary document. Overall, this part is not very relevant to the main purpose of this study.

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Figure 4. Figure title needs more information. “MME” needs to be fully spelt. I would use “CMIP5” instead of “MME” in the legend. Are blue bars the average of CESM-BGC and NorESM? Why no results from EXP? Global GPP can also be shown in this figure since it is mentioned in the text. In addition, no y axis (unit) in this figure.

Line 288. What are they talking about by “these two”? In addition, according to the figure, GPP 60N-80N is not major region.

Line 293. This should be Rs, not GPP.

Lines 293-296. Delete this since it is a repeat of last paragraph.

Lines 296-300. How could they conclude that from Fig. 5 since a) is difference between EXP and observation, not the absolute values of observation and EXP. They can show maps of all three data sets (observation, EXP and CTL) in supplementary documents to support this statement.

Fig. 5. I would suggest to add another panel for the difference between CTL and observation. Unit is missing for both panels.

Lines 304-305. I did not see this in Fig. 5.

Lines 293-331. It would be easier to give panel number such as “Fig 5a”.

Lines 310-311 Increase compared to CTL and underestimation compared to observation should be stated clearly.

Lines 312-313. Fig. 6 does not support this point because the y axis is the difference between EXP and CTL. It is not the absolute Rs of EXP or CTL. More changes do not necessarily result in higher absolute Rs. The point may be supported if they draw scatter plots for both EXP and CTL in each panel and show better correlation between Rs and temperature in EXP than CTL.

Line 314. “The difference between EXP and CTL increases with temperature” is not supported by Fig. 6 since they are only the cases in a few panels.

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Fig. 6. The categories are confusing. Some are regions such as temperate but some are ecosystem types such as grass. P values are needed for the correlations. The abbreviations should be fully spelt.

Lines 317-318. This reason is not convincing.

Lines 319-322. This explanation is not convincing because tropical is the opposite and it cannot explain shrub, grass and crop.

Fig. 7. Unit should be given.

Lines 336-334. Please explain the mechanism for this.

Lines 337-340. The global GPP in FLUXNET should also be given here. "SH" should be fully spelt.

Line 344. Are the numbers in Fig. 8 zonal mean or zonal sum? I think they are sums.

Line 345. The word "budget" is not suitable here. Use GPP.

Line 348. Are they talking about Fig. 3? Please indicate.

Fig. 8. Adding global data to this figure would help. This figure should merged with Fig. 7 (i.e., three panels). Y axis is missing.

Lines 349-350. What did the authors mean here? How can carbon pool in the soil system affect plant assimilation? Plants do not absorb carbon in soil.

Fig. 9. No y axis.

Lines 393-394. This has never been mentioned in the text. Why are they interested in this ratio? I do not see any implications of this ratio.

Lines 398-400. Please cite literature here.

Lines 404-405. This sentence is not clear.

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