

Geosci. Model Dev. Discuss., referee comment RC1
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Comment on gmd-2021-403

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Referee comment on "Representation of phosphorus cycle in Joint UK Land Environment Simulator (vn5.5_JULES-CNP)" by Mahdi Nakhavali et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-403-RC1>, 2021

This is a straightforward paper evaluating the inclusion of P cycle processes in JULES. The work is obviously important for the importance of P in estimating the global C sink and the important role of JULES in the modelling community. I have several comments to hopefully help further strengthen the manuscript.

- Given that the site is a nutrient fertilization experiment, it seems to be a missed opportunity to not evaluate the model performance in response to nutrient fertilization. The evaluation of the CO₂ response is obviously still important, but I don't see enough rationale to do it given that there is limited data available to actually evaluate the simulated CO₂ responses. Can we learn more by simulating the nutrient fertilization response where there is actual data?
- Some details of the model description is not available. For example, how P interacts with N to affect allocation, plant growth, stoichiometry and nutrient uptake?
- Can the authors spend some efforts highlighting the novelty of this work? I understand that adding P cycle into JULES is a significant work, but some readers could take it as "yet another model with P cycle". Considering the spread of the simulated CO₂ responses among CNP models in Fleischer et al. 2019, having yet another model doesn't necessarily reduce the model spread and our knowledge gap. Is there anything specific about having a P cycle in JULES would help to resolve? In other words, what unique features JULES-CNP can provide relative to other models?

Specific comments:

L31: Unclear – what does this 60% mean? Is it the 60th percentile of P availability (doesn't sound like a particularly P limited site)? Or does it mean the total P/available P at the site represents 60% of soil across the Amazon? Be good to make it clearer.

L32: What is the eCO₂ treatment? Show a number is useful.

L32: The model is able to reproduce observed plant and soil P pools under ambient conditions – to what extent are these values provided as parameters and/or targeting values to tune the model?

Abstract: Given that you evaluated the model at a nutrient fertilization site, does it make sense to apply the nutrient treatment to the model and try to evaluate the model against observation? It's quite unclear what to learn from evaluating the model against a CO₂ treatment where you don't have any data. The rationale about the CO₂ effect isn't very clear in the abstract.

L42: net primary production.

L43: C, not carbon.

L47: It's not either or. There are other nutrients involved.

L99: Hou et al. 2019 – are you sure this is a DGVM?

Figure 1. Do you have P leaching flux and biochemical P mineralization flux? What about atmospheric P deposition?

From the equation it seems that you would have a continuous build-up of P in the system, because there is no way out from the occluded P pool.

L239: This exudate term is confusing. Can I consider it as part of autotrophic respiration? It's a missed opportunity where this exudate term isn't pumped into soil to facilitate plant-soil interaction, which could potentially be used to alleviate plant nutrient stress. See for example (Jiang *et al.*, 2020).

L284: What timestep does retranslocation occur?

Table 2: Would be good to show P retranslocation coefficient.

Method: Description on N-P interaction is missing. I suppose P is not entirely independent from N processes? I think it should be useful to describe how P affects N, and vice versa in the model.

L404: What about N only model? What about J_{max} ?

L428: I may have missed this, but does the model assume fixed or variable CP ratios?

L450: What does the symbol $-//-$ mean?

L469: What does a step increase mean?

L664: What is SMCL?

L767: Jiang et al., not Jing :)