

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-403

Anonymous Referee #2

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-RC2>, 2022

This study implements phosphorus cycle processes into the JULES land surface model. The authors calibrate and test their model using observation from the Amazon Fertilization Experiment site and perform a theoretical elevated OC2 experiment. The inclusion of the P cycle in models is critical to our ability to predict ecosystem responses to elevated CO₂ and climate change in low-P systems such as the tropics and subtropics, and the majority of land surface models are now adding these processes.

My main concern about this paper is not with the model development per se, which is largely robust, but with the very extensive calibration. The authors calibrate their model very intensively using data from a very well instrumented site, which leaves me wondering if JULES CNP can be applied to any other site. In particular, the leaf C:P ratio, which the authors themselves show is a very sensitive parameter (Fig. 4) can be highly spatially variable and I do not see how the model can be run at sites where this data is not available, not to say anything about globally. Ideally, I would like to see the model validated at a site at which it has not been calibrated, but I understand this can be very difficult as it would involve obtaining more data. Alternatively, the authors could perform a more comprehensive parameter sensitivity analysis and include a discussion of the generality of their model.

Additionally, I think the paper would benefit from a more extensive discussion of the implementation of exudates and the knock on effect on CUE. The question of what to do with excess carbon under nutrient limitation is one that all models face and there have been a variety of solutions: respire it (what JULES CNP does too), down-regulate photosynthesis, decrease tissue nutrient content etc. I am not saying that the choice made here is necessarily wrong, but it does have implications for the model results. In particular, changes in carbon use efficiency are a direct result of this modeling choice and do not necessarily have an interpretable meaning.

Detailed comments:

L 241 As far as I understand from the description here, what the authors term 'exudates' is just excess C that is respired by the plants. However, the term normally refers to carbohydrates released by plants into the soil for a potential benefit in additional nutrients. This is a complex process and extremely difficult to include in models, so I am not suggesting the authors include it here, but maybe a different term for this flux can be used here. I am also not clear what 'spread' refers to here.

L 367 Table 2 Check the notations here - doe eta_CP refer to litter or soil CP?

L 460 by 1000 times, do you mean 1000 years?

L 564 Figure 3 Would it be possible to label the panels more clearly? I have to assume that the one on the left is fluxes and the one on the right, pools?

L 581 Figure 4 Could you discuss why a change in biomass production does not result in a change in plant C?