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Interactive comment on "Technical Note: A generic law-of-the-minimum flux limiter for simulating substrate limitation in biogeochemical models" *by* J. Y. Tang and W. J. Riley

Anonymous Referee #2

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The goal of the note is to document a method of solving nutrient dynamics in biogeochemical models. Specially it focuses on improving numerical solutions of biogeochemical models (specifically soil model) so that 1) negative nutrient concentrations are not simulated and 2) serial access (i.e. microbes have first access, then plants) to nutrients is not required by the different nutrient consumers. These issues are motivated by specifics to the Community Land Model but can apply to other Earth system models and ecosystem models. Overall, improving the numeric methods associated with simulating nutrient uptake and limitation is important for the field of biogeochemical modeling and the authors show that different methods can lead to different answers.

It would be valuable to discuss model forms where the methods described are nec-

essary and where they might not be as important. The Century model used in the manuscript is an example of a model without rate limitation kinetics (i.e. Michaelis–Menten kinetics) where the efficiency of N uptake does not scale with the inorganic N concentration. In this case method introduced in the manuscript is clearly important. In contrast, some ESMs and ecosystem models use rate limitation (i.e. Michaelis–Menten kinetics) to adjust the efficiency of N uptake rates so that as inorganic N concentrations get smaller the efficiency of N uptake rate declines. In this case, the methods described may not be as important because it is very rare that inorganic N concentration become negative (especially with an adaptive-time step ODE solver) and the competition between consumers is represented in the Michaelis-Menten parameters. See the LM3V (Gerber et al. 2010) and MEL (Rastetter et al. 2013) as examples.

Overall, the main message of the manuscript is clear but it is challenging to understand the specifics and to visualize how to apply the concepts because there are ambiguous subscripts and undefined concepts (see below)

Page 13401, Line 18: Define 'standard operator splitting approach'.

Greater detail in the use of subscripts and variables is needed. In particular:

- Page 13403: subscript i and m are not defined

- Page 13405: The pseudo code describes how qn is calculated but the text does not describe how qn is used or defines qn. Please clarify. (note that qn is also used in Appendix A for the loss rate – which is confusing)

- Page 13405: What does the k index refer to in the first for loop? Why use the n variable in the second for loop when the nomenclature in the text uses j?

Page 13404, Line 18: This is the first time the term 'flux limiter' is used in the main text. Please define. Mechanistically how is the flux limiter used in the equations?

Page 13404, Line 24: Greater explanation is needed for why the S- is used to control the flux limitation. The current explanation is not clear.

References

Gerber S et al. (2010) Nitrogen cycling and feedbacks in a global dynamic land model. Global Biogeochemical Cycles, 24, GB1001.

Rastetter EB et al. (2013) Recovery from disturbance requires resynchronization of ecosystem nutrient cycles. Ecological Applications, 23, 621–642.

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