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Interactive comment on "Implications of incorporating N cycling and N limitations on primary production in an individual-based dynamic vegetation model" *by* B. Smith et al.

Anonymous Referee #1

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Overall, this is a nicely done study on the addition of N cycling to the LPJ-GUESS gap dynamics vegetation model to assess the effects of N limitation on primary productivity responses to environmental changes. Most of my questions/issues with the paper are related to how N cycling processes are incorporated into the model: 1) To the authors' credit, they do a reasonably good job of addressing the N fixation algorithm in the Discussion section, but I have to agree that this is a weakness in the model. Tying biological N fixation to evapotranspiration rates may work fine at very broad and coarse geographical scales (largely because ET is related to moisture and temperature, which are two important controls on N fixation), however we know that this will not hold across landscapes, or even regions, where N fixation is a function of soil N and P, as well as

species composition. I think this should be one of the very next enhancements to the model, but I do commend the authors for not ignoring this issue. I was also curious (as this wasn't clear in the paper), at what temporal scale in the model is N fixation tied to ET, i.e. is daily N fixation calculate from daily ET, or is this done at coarser temporal scales? 2) Just to clarify (page 5, lines 15-17), gross N mineralization is determined by the C:N ratio of a receiver pool, which I think means that carbon entering the receiver pool drives N mineralization. So, if C and N are being transferred from donor pools to a receiver pool, the amount of available C (and the prescribed C:N ratio of the receiver pool) determines the N to enter that pool. If the supply is greater than the demand, then N is mineralized. If demand is greater than supply, then N is immobilized, assuming mineral N is available. Maybe this can be clarified in the description. Also, what happens if N amount required to meet the C:N ratio is not present in the mineral N pool? 3) The plant N uptake algorithm assumes no luxury consumption of N – how reasonable is this assumption? 4) The assumption that plants retain half of the N in shed roots and leaves, and the conversion of sapwood to heartwood is extremely general. N resorption represents a large pool of N for plants, and this parameter could be much better constrained. One other model question that I had was with regard to C4 grasses. The model assumes that C4 grasses are constrained to areas with a coldest mean monthly temperature of 15°C. This seems to me to be grossly incorrect. There are locations, where C4 grasses are about half of the productivity, that have coldest mean monthly temperature less than 0°C. This could be a factor in some of the model misclassifications. Related to this, on page 17 (lines 4-9), the authors state that the mechanism for increased CO2 fertilization effects with decreasing latitude (increasing temperatures) are due to suppression of photorespiration, however in C4 grasslands, photorespiration would already be minimal.

Minor corrections: 1) Page 2, line 14 – "Cramer's" should be "the Cramer" 2) Page 4, line 26 – "effecting" should be "affecting" 3) Throughout document – "savannah" should be "savanna" 4) Page 21 – line 12 – "necessary" should be "necessarily" 5) Page 21 – lines 27-29 – remove the sentence

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