

Interactive comment on “Plant-driven variation in decomposition rates improves projections of global litter stock distribution” by V. Brovkin et al.

Anonymous Referee #1

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While the subject of this manuscript is of significant interest the manuscript itself needs clarification of a number of things. I therefore suggest that the manuscript be accepted for publication in Biogeosciences after revisions. In particular, the authors needs to make connection between sections 2.1 and 2.2, which attempts to obtain litter decomposition rates from observation-based data, to section 2.3 which actually uses these data. Also, as a reader I wasn't able to follow what exactly was being done in sections 2.1 and 2.2.

Abstract. Line 9. Please change “with except” to “with the exception”.

Abstract. Please also tell in the abstract the actual difference in CO₂ concentration when observation-based wood and leaf litter decomposition rates are used.

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Page 8820. Line 1 reads “After correction for environmental conditions (temperature), both lignin and nitrogen were highly significantly ($P < 0.001$) related to k (Fig. 1)”. I do not see any lignin and/or nitrogen concentrations in Figure 1, which actually plots measured versus predicted decomposition rates for leaf litter (I presume, because the figure caption doesn’t say so explicitly). I also do not know what the measured and predicted rates actually mean in this context.

Page 8820. Line 15. What does “reference litter site” means?

Page 8820. Line 17. I do not understand what does “Arithmetic means of litter chemistry by PFT” actually means.

In sections 2.1 and 2.2 both leaf and wood litter decomposition rates are referred to as k . Please, at least, use k_{leaf} and k_{cwd} to keep the distinction in the text as is done in some figures.

In its current form, it is little unclear what sections 2.1 and 2.2 are exactly doing. In section 2.1, it appears that observation-based decomposition rates are regressed against leaf litter lignin and nitrogen concentrations to obtain the parameters a and b , which are then used together with lignin and nitrogen concentrations averaged over a large number of samples from a single PFT to determine an average PFT dependent decomposition rate. However, I do not understand why the PFT dependent and reference site decomposition rates are in the numerator and denominator of equation 1.

I am also unable to follow the logic of equations 2 and 3. What does the reference k -value mean in equation 2? Is the primary purpose of these equations to find the betas and the Q10 parameters? If yes, how are these betas and Q10s used to find PFT-dependent coarse woody debris decomposition rates in LPJ. Then, in Figure 2 observed versus predicted decomposition rates are compared. What does “observed” mean in this context and how is “observed” related to Equation 2. What is “observed” – k or k' ? And what is “predicted”. Predicted rates, as the names suggests, are likely from a model – which model - LPJ implemented in the ESM or is equation 2 the model

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that is being referred to here.

In Section 2.3, it is not described clearly how the information obtained in sections 2.1 and 2.2 is actually used. Also, please describe the simulations clearly. Please explicitly say how many simulations were performed, name them and then clearly say what they do and for what duration were they ran. After reading section 2.3, I am unclear how long were the 1750 pre-industrial simulations ran, what was the difference between two transient simulations (line 18, page 8824) and how long were these transient simulations. I am guessing the difference between transient simulations is that they were run 1) with LPJ's default leaf and wood litter decomposition rates and 2) in the WKQ configuration. If yes, please say this explicitly.

In section 2.3, line 14 reads, “ . . . to represent land surface processes at high resolution”. What resolution was CLIMBER2-ESM run at?

The last sentence of Section 2.3 reads “In the transient simulations, CLIMBER2-LPJ was driven by SRES A2 scenario of fossil fuel and land use emissions . . . starting from pre-industrial equilibrium at year 1750”. This means there was a historical 1750-2000 simulation also performed. Isn't it necessary to describe how the historical simulation was done? The authors also appear to assume that the reader knows that transient simulations with A2 emissions are for the 2001-2100 period.

Page 8825, line 2. “ . . . comparison with data for woody litter . . .”. Replace “data” with “observation-based estimates” and give a reference. This sentence refers to the CTL simulation, but the CTL simulation does not make the distinction between leaf and woody litter so it is not possible to make this comparison. Except, of course, the assumption that would go here is that most of the litter biomass is made of woody litter.

There should be some more discussion in the manuscript about the higher simulated litter mass (~ 180 to ~ 190 Pg C) compared to other estimates. What is also surprising is that while simulated litter mass in the CTL and WKQ simulations are generally lower than or similar to their observation-based estimates in Figure 5, the simulated global

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litter mass is higher than observation-based estimates. The caveat here, of course, is that observation-based estimates are from different sources. A comment on this would be useful for the reader.

On Page 8825 the following two sentences essentially convey the same message. Please consider combining these two sentences into one.

“At the northern boundary of boreal forests, the model overestimates the living biomass stocks by a factor of two, in particular because of the absence of a permafrost parameterization which otherwise would limit tree growth substantially, and this is reflected in the high litter stocks.”

“However, because of a bias in living biomass stocks, a mean litter stock in boreal needleleaved forests is overestimated by ca. 80% (Table 2).

In Table 4 the transient CTL and WKQ simulations are referred to as CTL-T and WKQ-T simulations but this terminology is mentioned in the text in a very subtle way. Like I suggested earlier, it would be really useful to introduce all the simulations names early on, what they do, and how long they ran. Authors can also consider using a table.

Page 8827, last paragraph. The discussion about the effect of litter mass on fire seems somewhat unnecessary. Fire behaviour can be very complex and in my opinion this discussion requires more than few lines. Fire CO₂ emissions also depend on area burned. Did the area burned change between the CTL-T and WKQ-T simulations? I suggest that this discussion be left out completely.

Page 8828, line 24. Replace “is” by “are”.

Figure 3 caption. I wouldn't call these curves “modelled sensitivity of cwd decomposition rates to temperature” because these are not modelled per se. I would call these “Temperature sensitivity of decomposition rates used in the WTQ simulation” or something along these lines. I would also suggest to show the curve based on the standard Q₁₀ value used in the LPJ model. Also, I don't think the caption needs to include the

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words “mean annual”. This is just the sensitivity to temperature.

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