Our replies to the comments of Anonymous Referee #2 are given below *in Italics*.

General comments

This is an interesting study of an important subject, and it improves the way litter decomposition rates are described in global vegetation models. However, the different model scenarios could be more clearly described and better linked to the part of text explaining the new parameterization. I suggest the manuscript to be accepted for publication in Biogeosciences after revision. Please find my more detailed comments on parts of the manuscript that need clarification below.

We appreciated very much constructed comments of the reviewer and tried to address them as much as possible in our reply below.

Specific comments

1. Line 25, page 8819, Could you add more information on how lignin concentrations were measured?

While the protocols for lignin analysis varied in their details across the studies from which data were compiled, they generally used a version of the 'van Soest' method (Allen et al. 1989), which involves sequential acid-detergent digestion steps leaving lignin as the recalcitrant residue (often with a separate correction for silica content through ashing in a furnace).

2. Also, be more specific about the data used, all readers may not be familiar with the database. Are the k values based on litterbag studies? How many years of data (how many years of decomposition in the field) is included when calculating the k values?

We will add a few more lines on the characteristics of the Cornwell et al. 2008 study. In addition to the methods on how lignin (and other leaf chemistry traits) was measured, we will add information on the spread in the duration of the incubation (which was <30 days to >1700 days). We will particularly emphasize that it concerns a meta-analysis of common garden studies, as this seems essential for understanding equation 1 (see our reply to the comments of reviewer 1). We would also like to stress that ARTDECO is currently the largest global database in its kind, derived from more than 40 studies that measured litter k_{leaf} alongside with litter chemical characteristics.

3. For how long is litter considered to be litter and when it becomes soils C in the LPJ model?

We considered k_{leaf} to represent the rate coefficient of litter mass loss (i.e. all organic matter remaining in a litter bag). We do not consider whether litter is lost to CO_2 or to soil C (in which case we assume that it would have fallen through the mesh of the litter bags). For the partitioning, we assume the default formulations in the LPJ model to ensure consistency of the analysis.

4. Are decomposition rates similar for sites with the same MAT, but different seasonal cycle?

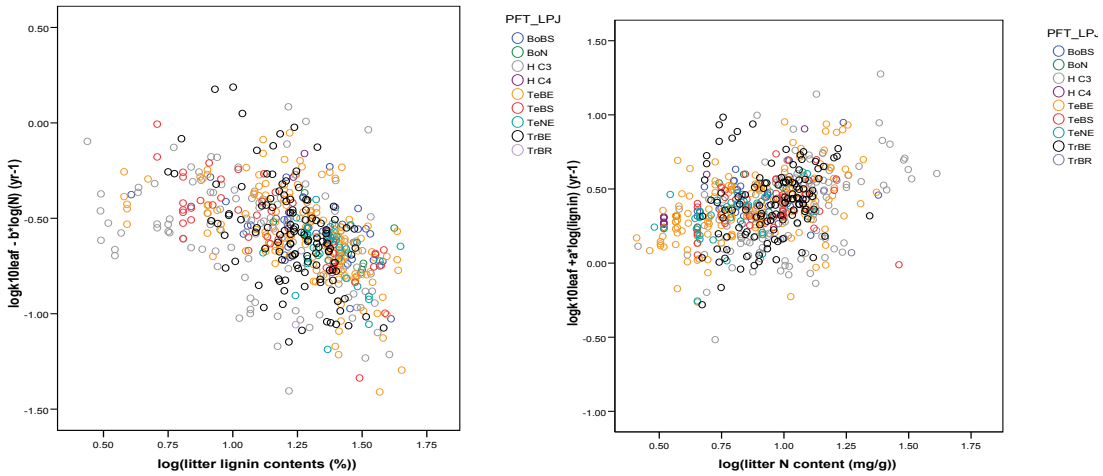
Given that common garden studies may not respond to precipitation (or the seasonality therein) or other environmental drivers in exactly the same way as may occur at field conditions, none of the environmental corrections on k_{leaf} were derived from the ARTDECO database. Instead, always the default environmental corrections as employed in LPJ were applied. Only the differences in log k_{leaf} at reference environmental conditions as a function of litter traits was determined from the ARTDECO database.

5. Line 27, page 8819: "After correction for environmental conditions (temperature), both lignin and nitrogen were highly significantly ($P < 0.001$) related to k (Fig. 1). What does this mean? Can you be more specific of how the statistics were actually done?

As indicated in our reply to comment 4, we derived the differences in k_{leaf} at reference conditions as a function of litter quality from the ARTDECO database. Therefore, the sentence should read: "Both lignin and litter nitrogen were highly significantly related to k_{leaf} ($P<0.001$; analysis based on a general linear model with lignin and nitrogen, while using site as a random factor)." Subsequently, using the LPJ formulation of leaf decomposition dependence on temperature and moisture , the k_{leaf} at the environmental conditions prevailing during the respective incubations were calculated. The k_{leaf} values predicted this way explained 75% of the variance in observed litter k_{leaf} values. At that point a reference to Figure 1 should have been included (instead of the current position in the text).

6. Lines 1-2., page 8820: Figure 1. Does not show the relation of lignin and N concentrations to decomposition rates as stated here, but a plot of predicted vs. measured values. Can you please include a figure showing the relationship of k with lignin and N. Also, clarify Figure 1: What are the observed values (are they from the ARTDECO database? What is n?). Could you also add statistics on the goodness of the model fit/ model performance? Qualitatively if looks to be close to the 1:1 line, but could you please add a quantitative measure. Also, could you clarify in the Figure caption that it is about the leaf litters?

Concerning figure 1: Observed k indeed reflects that measurements from the ARTDECO database. The slope of predicted vs. observed equals 1.00+/-0.025. Please see in addition below a figure on lignin vs. k. It shows observed k_{leaf10} (after correction for the trait not shown in the respective figure panel) and had n=542 (for which we had simultaneous measurements of lignin, litter N and k). We can add this figure into supplementary material in case the reviewer finds it useful.



7. Line 10, page 8820: Why is the k determined at a reference temperature of 10°C?

The reference temperature of 10°C is used in LPJ in the soil and litter decomposition module. 10°C is a typical reference value for many other carbon cycle models as well.

8. Later on page 8823, in the beginning of part 2.3, it becomes clear that this is how decomposition rate was determined in the original formulation of the model (0.3 yr-1 for the reference temperature of 10 ◦C for all sources of litter). For a reader not familiar with the model, it would be helpful to clarify here, how decomposition was modeled with the earlier model version, and what are the improvements/changes made here. It would be then easier to follow the different modeling scenarios. Could you be more specific about how decomposition depended on temperature and moisture in the original model and in your model simulations? Based on the footnotes of Table 1. I would understand that moisture had an effect on decomposition rates in the original model, but it seems it is not taken into account in the new parameterization for leaf litter decomposition rates. What are the grounds for omitting the effect of moisture on leaf litter decomposition, but including it for coarse woody litter? Later on page 8826, on line 19 it also reads that "W, WK and WKQ simulations excluded the modulation by soil moisture on litter decomposition", which seem contradictory to equation 2.

We will clarify how decomposition was modelled in the original LPJ formulation. In addition, as explained in our reply to comment 1 of reviewer 1, we will better explain how the information from sections 2.1 and 2.2 match the model experiments, as described in section 2.3.

9. Line 15, page 8820, It is not explained what is meant by reference litter site in Equation 1. Reference T is 10 ◦C, but is there also a reference litter type relative to which the decomposition of other litters (average of each PFT) is determined? It is not clear. Can you also be more specific on how the parameters a and b were obtained? It would be useful to include a table representing the lignin and N concentrations (%) averaged per PFT, and also show variation between and within PFTs. In the discussion you talk about k varying within PFTs. It would be nice to see in a table how big this variation between species is compared to the variation between different PFTs?

Indeed, there was also reference litter relative to which the decomposition of other litters was determined. As indicated in our reply to the comment 5 of reviewer 2, we will extend the description of the statistics applied to derive the parameter estimates of equation 1. In addition, we will add PFT-average values for litter nitrogen and litter lignin incl. standard deviations (as derived from the ARTDECO-database) to Table 1.

10. Line 17, page 8820 it reads "Arithmetic means of litter chemistry per PFT and overall averages across the ART-DECO database were applied". Is it these "arithmetic means of litter chemistry per PFT" that were used to obtain parameters a and b? Or were the parameters obtained for different species and then averaged per PFTs? I'm not sure if I understand the meaning of the rest of the sentence " and overall averages across the ART-DECO database were applied." What were the overall averages of lignin and N% used for? Later on page 8826, line 9 it reads: "The W simulation uses k values averaged from the trait databases. . .", so I would understand that the overall averages are used for the W simulation, but this information could have been given earlier, to better link the new parameterization to the simulations made.

With this sentence, we meant that the average litter trait concentrations per PFT were used to calculate k_{leaf10}^{PFT} *for each PFT, applying equation 1, for the K-simulations. With the remainder of the sentence, we meant that* k_{leaf10} *of the W-simulation was derived applying overall average litter trait concentrations from the ARTDECO database in combination with equation 1. Both sentences fit better in a revised section 2.3 to avoid confusion. The original species and site-specific litter trait data (n=542) were used to derive parameters a and b.*

11. Page 8822, what is reference k value in equation 2?

Please see our reply to the comment 9 of the reviewer 1.

12. Page 8823-8825, I think it is not clear what the CTL simulation represents. On line 10, page 8824 it reads that it represents the original LPJ parameterization. On page 8825, line 3, and in Figure 5. woody litter is compared between CTL and WKQ simulations, but CTL was supposed not to differentiate between woody litter and leaf litter.

See our reply to the comment 13 of the reviewer 1.

Figures and Tables:

12. Table 1. Why are only the Q10 values of coarse woody litter presented? Are there differences between plant functional types in the Q10 values of different leaf litters?

We have not analyzed a difference in Q10 between PFTs for leaf litter. Study by Parton et al. (2007) using the LIDET dataset did not reveal a substantial effect of temperature response of leaf litter decomposition among biomes. Nitrogen content of litter seems to be the dominant factor for difference among PFTs. Also, Cornelissen et al. (2007) found only negligible interaction between plant functional type and temperature regime during leaf litter incubation. Besides, the ifetime of leaf litter is very short relative to woody litter. Therefore, the effect of different Q10 values on the leaf litter storage is negligible in comparison with the Q10 effect on woody litter storage.

13. Are the Q10 values in the table also calculated at a reference temperature of 10°C?

Yes, but this is not crucial. The Q10 parameterization assumes that Q10 value (a response to temperature increase by 10°) is constant, i.e. it is the same for all reference temperatures. One can take 10°C or any other temperature as a reference temperature.

14. In the table caption it reads: "In the CTL simulation, decomposition rates for the leaf and woody litter at 10 ◦C were set uniformly to 0.3 yr-1. The sensitivity to temperature and soil moisture was defined following parameterizations by Lloyd and Taylor (1994) and Foley (1995), respectively."

The Lloyd and Taylor (1994) parameterization was developed for soil carbon, not for the litter. While we use it for simplicity for leaf litter, decomposition of woody litter is different from the soil carbon. This is why we performed detailed analysis of woody litter decomposition in the section 2.2.

15. You should show the temperature sensitivity parameters also here, either in Table 1., or by adding a curve to the Figure 3 showing decomposition rates vs. MAT, so that the reader could see what is the difference compared to the earlier parameterization.

We prefer to add the Lloyd and Taylor (1994) parameterization of respiration increase with temperature in the section 2.3:
f(T)=exp($\left[308.56 \cdot \left(\frac{1}{56.02} - \frac{1}{T + 46.02}\right)\right]$*, where T is a temperature in °C.*

For comparison, the Q10 parameterization is f(T)=$\left[\frac{T-Tref}{10}\right]^{Q10}$

16. Fig 2. Could you add that the data (observed values) is from the FET dataset?

Yes.

17. You could also add the number of observations and a goodness of fit.

n = 1409, adjusted R^2 = 0.43. We will specify these values in the legend of the Figure 2.

Christian, can you help here?

18. Technical comments Fig. 5. Name of the third PFT in the figure is written as TeN, should be TeNE

Will be corrected