Dear Toni Viskari,

Thank you for your thorough feedback on the manuscript. Regarding the CIDET sites you are right, I made the mistake of assuming that the litterbags were buried, when they were, as you correctly pointed out, placed at the surface. I apologize for the oversight, and appreciate you taking the time to go through the material, allowing us to redo the simulations with litter added to the top model layer instead of the third.

Due to your quick submission of comments, we have already had time to set up and run new simulations. At the same time, we also decided to correct the input to the mycorrhizal pools, which where too low due to a bug in the CLM simulations providing the input to MIMICS+ (https://github.com/ESCOMP/CTSM/issues/2120). This means that we have also rerun the simulations for the VCG sites. The consequences of this bug was minor for the results and analysis for the VCG sites, however mass loss decreased slightly at some sites due to increased microbial competition.

Regarding the new CIDET simulations where litterbags were placed in the top soil layer, mass loss was generally higher than when they were put in the third layer, causing a somewhat less fit with the observations, especially at the colder sites. However, the overall conclusions will mainly remain the same in a revised manuscript with the new simulations. See the attached figures, where (a) is identical to Fig. 2 in the original manuscript, and (b) shows results from the new simulations.

In the revised manuscript we will use the results from the original model experiments (where litter was put in the third layer) to discuss consequences of choosing a layer in this kind of discrete-layer model, as well as in the context that litterbags could move vertically during a multi-year experiment

(a)

(b)
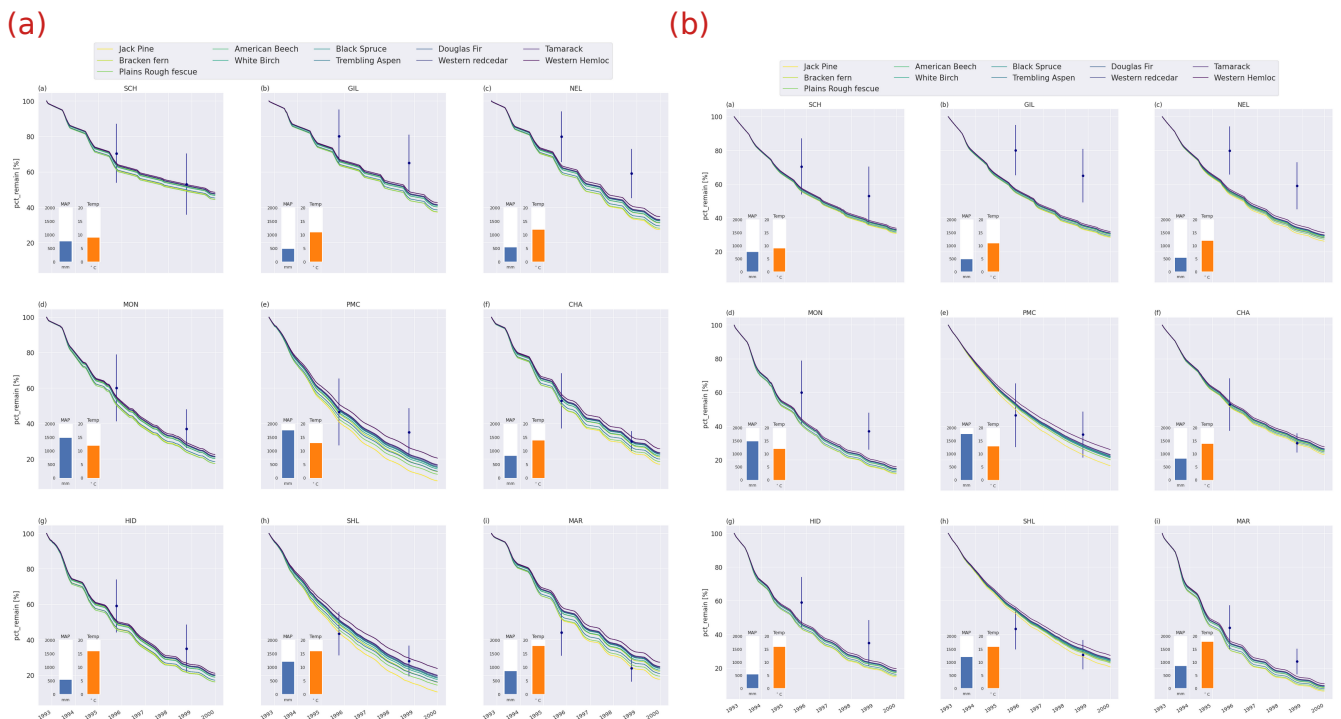
Below follows answers (in red) to the line-to-line comments (in black) to the manuscript:

Line 25: Bradford et al., 2016; Joly et al., 2023

It is slightly distracting that the same two articles are quoted on two subsequent lines directly above/below each other. Only the first reference is required or split the references between the sentences.

Good point, this line will be rewritten in the revised manuscript.

Line 33: "…litter are buried…"

Kin of related to the larger criticism given to the manuscript before, but there are plenty of litter bag experiments that are not buried.

The sentence will be changed to "Bags containing native or standard litter are either buried or placed on the soil surface, and collected at pre-determined time intervals. From the mass loss one can estimate decomposition rates and investigate relationships related…"

Line 36: "…and methods using standard litter…"

I would recommend first introducing the issue before stating that there have been suggestion on how to overcome it. In the current form it is a bit confusing as my initial concern was that something had been removed before this part.

Agreed, the text will be rewritten following your suggestion in the revised manuscript.

Line 70: "2. Methods"

I'm putting this comment here as I couldn't figure out where exactly to put in the text. Your description of the two experiments is missing central information regarding the properties of the bags. Not just their dimensions, but the size of the holes they have, are they single or two layer, etc.

This isn't necessary information just for accuracy of description, but a huge challenge in comparing information between different litter bag experiments is that the physical differences in the bags do affect the development of the decomposition timeline, especially in multi-annual experiments.

In the revised manuscript we will include information about litter bag dimensions and mesh size for both CIDET and VCG experiments. In addition, the discussion section will be extended to further discuss consequences of the physical properties of the litterbags, like interference by soil fauna etc. There is a difference in mesh size of the bags used at the CIDET sites (0.5 x 0.25 mm) and the VCG sites (0.28 x 0.28 mm) which will be discussed in more detail in the revised manuscript.

Line 80: "…well-established, relatively long-term experiment (hypothesis 1)"

The litter bags in CIDET are collected every year, so you also have access to the decomposition state after the first years. So why are you only doing using the CIDET data to compare the long-term performance?

This is especially pertinent because just looking at the results in Figure 2, I'm not initially convinced that the MIMICS+ model would perform as well in both time frame here as the litter bag experiment sees the largest drop of the mass during the first year before levelling off, something that doesn't appear to happen in most of the model runs. Although would need to see the measurement comparison there to be certain.

We chose to look at mass loss after three and six years because data were immediately available from previous literature for these years (Moore et al. 1999 and Trofymow et al. 2002, respectively). Comparing with one-year mass loss values presented for the sites MAR, PMC and GIL in Moore et al. 2017 (Fig. 2, https://link.springer.com/article/10.1007/s11104-017-3228-7/figures/2) it seems like the model is indeed underestimating initial mass loss also at the CIDET sites.

This tendency is also evident in the VCG simulations, and the poorer model performance at short time scales is discussed in relation to hypothesis 2. In the revised manuscript we will include references to Moore et al. 2017 for discussing short-term performance at the CIDET sites, but don't see the need to include the data points, as short-term performance is mainly discussed in terms of the VCG sites.

Line 97: 2.3 Description of the soil decomposition model, MIMICS+

First, I don't think that comma there between model and MIMICS+ is necessary, is it? You are right, we will remove the comma.

Second, as far as I could tell neither in the model explanation or in appendix B is there any mention how the model was calibrated? Doesn't need to be an exhaustive explanation, just a few lines about the datasets and methods used.

The MIMICS+ model was calibrated against a database of soil profiles from forested sites in Norway (Strand et al. 2016) in Aas et al. 2024. We will include a reference to this in the methods section of the revised manuscript.

Line 194: "This gave initial decomposer…"

Just to confirm, these initial values are for the date when the litter bags were added? Not steady state approximation?

Correct, it will be clarified in the manuscript.

Line 202: "…we assume minor contributions from…"

Do you mean here in the model context? As this is a very assumption to make for multi-year litter bag experiments.

Yes, this is in context of the model setup, where we only consider mass loss in the litter pools. This will be clarified in the revised manuscript. As for the contribution of non-litter to the mass in the litterbag this will be discussed in connection to the mesh-size of the bags (see answer to line 70, "Methods").

Line 306: "Unpublished results from…"

I will admit being puzzled by this reference as I don't understand how you can have unpublished results from a published paper? Also if you are referencing unpublished results here, they need to still accessible somewhere.

The paper with the analysis is in prep., while the data is accessible from OSF (Telford et al. 2023). We would appreciate the editors opinion on this, but for now the sentence have been rewritten to "Results from the VCG sites (Telford et al. 2023, Althuizen et al., in prep.) show…" .

Line 319: "…leaching processes likely also contributed to the observed mass loss."

This part would benefit from a slight reordering. First explain what the model representation of leaching does and does not include before from there shifting to explaining why it might be contributing here.

Agreed, the sentences will be reordered according to your suggestion here.

Additionally, and this is a little bit tricky, I don't think the leaching being a major factor in the discrepancy is a convincing argument based even on the results presented here. For that to be the case, the leaching needs to be insufficient during the first 6-12 months before kicking in correctly? This isn't mean as a discouraging comment, but rather that the rapid decomposition during the first year of almost any decomposition experiment is a well-known challenge for soil carbon decomposition models and it simply appears to be the case also for MIMICS+.

Line 323: "Their experiment suggested…"

But this is in a bit of a contradiction with the VCG results where the initial decomposition drop lasts for longer than the first couple of weeks, isn't it?

The following is an answer to the second part of the comment to line 319 and line 323:

Our argument is that leaching is a contributing factor (among many) to the initial mass loss of litter in the field. As the leaching process is not captured in the model experiments we speculate in how much of the discrepancy between model and observations might be caused by this lack of process representation. An estimate of how much of (and for how long) mass loss that can be attributed to leaching in the field experiment would therefore help to interpret the model result, and determine whether leaching is a major contributor to the discrepancy or not. We will attempt to clarify the argument in the revised manuscript.

We are not quite sure what you mean with this question: "For that to be the case, the leaching needs to be insufficient during the first 6-12 months before kicking in correctly?" please feel free to clarify this.

Line 403: "Litterbag mesh sizes…"

As already noted, the mesh sizes for the different experiment should have been established in the methods section instead of just mentioned all the way here.

See our answer to line 70 "Methods" above. Litterbag specifications will be provided in the method section, and consequences will be discussed in the Discussion section.

References:

Aas, E. R., de Wit, H. A., and K. Berntsen, T.: Modeling boreal forest soil dynamics with the microbially explicit soil model MIMICS+ (v1.0), Geosci. Model Dev., 17, 2929–2959, https://doi.org/10.5194/gmd-17-2929-2024 , 2024.

Moore, T.R., Trofymow, J.A., Prescott, C.E. *et al.* Can short-term litter-bag measurements predict long-term decomposition in northern forests?. *Plant Soil* 416, 419–426 (2017). https://doi.org/10.1007/s11104-017-3228-7

Strand, L. T., Callesen, I., Dalsgaard, L., and de Wit, H. A.: Carbon and nitrogen stocks in Norwegian forest soils – the importance of soil formation, climate, and vegetation type for organic matter accumulation, Can. J. Forest Res., 46, 1459–1473, https://doi.org/10.1139/cjfr-2015-0467, 2016.