

## **Introduction:**

Please describe the potential mechanisms/processes involved with EcM and AM based on previous research;

Please describe the potential improvements over the models in Sulman et al. (2019) and Baskaran et al. (2017) and distinguish your study with other similar ones.

*We will describe mycorrhizal processes in more detail, including the Gadgil and priming effects that are of key importance when mycorrhizal processes are included in soil models that includes both carbon and nitrogen. Through this we will make a stronger link to work presented by Sulman et al. (2019) and Baskaran et al. (2017). In contrast to Baskaran et al., (2017) MIMICS+ models the N cycle, and is vertically resolved, allowing better representation of microbial competition for nitrogen. Compared to Sulman et al (2019), MIMICS+ presents an alternative structure of pools and fluxes with particular focus on mechanisms that are important in boreal/cold climates.*

## **Methods:**

Sensitivity analysis of parameters to modeled soil carbon is routine for model development and therefore is necessary here.

*We agree that sensitivity analysis of parameters (especially poorly constrained ones) should be included. The revised manuscript will include sensitivity analysis for key parameters, such as e.g. CUE, C:N ratios and direct litter-to-SOM fractions.*

Line 103: describe in full C11, C12, N11, N12.

*These fluxes will be described in more detail.*

Lines 162-164: add details about how EcM produces enzymes and the mining algorithm (since it is the import part of this study); is there carbon cost for modeled nitrogen mining?

*These details are described in the detailed figures and tables in the Appendix. The flux C27 is the carbon cost for ECM (from ECM to SOMa). We will add a sentence with references to the appendix in the main text.*

Lines 180-184: do they occur at the same time or sequentially? Please clarify. This is very important for nutrient competition.

*Numerically, they happen in the sequence presented in the manuscript, but since the time step is so short (1h) the order is of limited importance. Our understanding is that the processes in boreal forests are relatively slow, so that the residence times of the reservoirs are much longer than the 1 hour time step. Therefore the inaccuracy implied by the sequential approach is small. We will add a short note about this in the text.*

Lines 195-201: please describe here how the parameters change with depth, in particularly the ones associated with EcM and AM.

*The mycorrhizal parameters like turnover, mining, N uptake etc. are not explicitly dependent on environmental variables (temperature and moisture) and thereby not depth dependent. We will explain this in more detail in the text. During the revision we found that the weighting with respect to the thickness of the soil vertical layers were not entirely correct for the N uptake parameters, and has been changed for the rerun of the model (See our response under the "Results" header).*

Lines 214-216: cannot follow this sentence. Please elaborate.

*The sentence will be rewritten to say "Due to computational resource limitations, we chose a subset of 50 representative sites (out of the 578) for the site simulations with CLM and MIMICS+. The remaining 528 sites was used for further comparison with the modeled carbon stocks." We hope that it is clarifying.*

**Results:**

The poor simulation results in terms of soil carbon (site level one to one), and CN ratio is concerning. Please justify.

*As the model is intended to work on larger spatial scales within an ESM model, a good one-to-one match with specific sites is of less importance than being able to capture larger patterns in temperature and moisture. Norwegian forest soils are also very heterogeneous and local features could have affected measurements in a way that not necessarily represent the general pattern we want to capture in a model. However, we agree that the poor one-to-one match is unsatisfactory. A recently discovered error in CLM in the amount of C allocated to mycorrhizal uptake, thus affecting the forcing of the MIMICS+ model (in terms of how much and in what form carbon was transferred from the vegetation to the soil) might explain at least part of the discrepancy between modeled and observed soil carbon and CN. For the revised manuscript we therefore want to rerun our simulation with the correct (and higher) C allocation to mycorrhiza (with this error in CLM the allocation was too low). The extra carbon is a relatively small fraction of the overall carbon input to the system, but will alter the nutrient competition between microbes and could have an impact on model performance.*

Please show seasonal variation of microbial respiration for model quality judgment. It can be shown in appendix though.

*We agree with the point about seasonal variation of microbial respiration, and will include a figure in the appendix showing this.*

In the main text please show site-to-site correlation in addition to the boxplot. It is more informative.

*The site-to-site correlation will be presented in the main text, in addition to the boxplot.*