Please find our responses given in italics below after each individual comment or section provided by the reviewer.

Soil organic matter diagenetic state informs boreal forest ecosystem feedbacks to climate change"

The manuscript deals with the fate of the soil organic carbon in a climatic gradient from a cold to a warm region. The authors used several metrics to assess the influence of climate change on the cycling of C and N in soils. They applied the lignin diagenetic index, and evaluated the variation of this index in different soils strata. In general, the manuscript is well organized and easy to follow. I recommend the manuscript for publication after some minor revision.

Response: *Thanks for your positive feedback.*

Minor comments:

Line 230 I did not find the AADI data in the original paper (Philben et al., 2016).

Response: *The AADI is not referred to exactly as such in Philben et al. (2016). Rather it is simply referred to as 'the degradation index' in that paper as that work only contains amino acids datasets (e.g. see figure 3 in Philben et al. 2016). This is a simple point of clarification that will be made when referencing the original paper to avoid confusion.*

Figure 1, This figure is very interesting. Why do the authors think that in some parameters (e.g. V ad/A<l, S/V, %side chain alteration, diOHBAVV, S Ad/Al) there is a great variation in the deepest soil horizon? Does the H horizon reflect older and more variable long-term effect of climate?

Response: *Good question. We suspect that the increase in variation observed for some LP parameters within the deepest horizon reflects a combination of variation in how degraded the lignin is, the impact of hydrology (e.g. Hernes et al., 2007) and root inputs or processes (Otto and Simpson, 2006) on these signatures. The deepest layer (H) exhibits the greatest degradative state. However, with spatial heterogeneity particularly in hydrology and root inputs (mainly concentrated at the interface between the organic layer and surface of the mineral soil and thus right around the H layer) we might expect greater variation in resulting degradative state as timing and magnitude of new inputs of root or dissolved organic matter, which both carry lignin phenol signatures, varies. We will add a phrase in the revised manuscript to refer to this possibility.*

Figure 2 The linear relationship is very strong, it may help the reader if the authors include a description for example "increase lignin degradation" to the right of the plot.

Response: *This is a great suggestion! We will add an arrow and phrase to help link the ratio to the degree of degradation.*

Figure 3, In previous figure, the y axes was "layer", and the factor analyzed was the "depth", please homogenized the figures.

Response: *Thank you for pointing out the various nomenclature used for the same variable. We noticed that the figures also refer to horizon interchangeably with depth and layer. We will*

review all figure captions and text to be sure that we are consistent in referring to the use of soil layer to understand the impact of soil depth on factors presented or assessed throughout.

Figure 4, the deepest soils layer (H) has a broad variation compare with surface, any possible explanation?

Response: *See comment above. Importantly for this figure, the amino acid-based degradation index contributes to variation in this ratio, cumulatively increasing variation with depth with the spatial variation in lignin signatures, with those of amino acid signatures, such as lower amino acid content at depth due to the increased degradative state. We will add information conveying the probable causes as described above in addition to the reduced amino acid content at depth in the revised manuscript.*

Line 436, Add “The” before SOC and SON.

Response: *Thank you for noticing this typo and we will fix that error in the revised manuscript.*