

Reviewer 1:

How much of a reduction in litter post-fire is there? Fire burns some portion of litter, of course, and the reduction in LAI means there's less litter being generated. But is any of that lost LAI dropped to litter? It might be helpful to see a time series of net litter flux in burned areas before and after fire.

Response: Thanks for the comments. In our model, litters are added to soils as soil carbon. Fire will directly remove portion of vegetation and soil carbon based on the burn severity. We assume there is no extra litters from vegetation after fires into soils. As a result, soil organic C decreases after fires depending on burn severity due to burn (Figure 1).

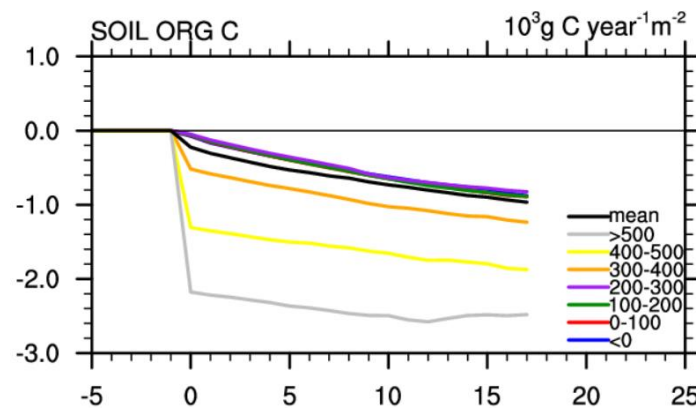


Figure 1 Changes of soil carbon before and after fire under different burn severities (dNBR values).

Does litter have an insulating effect like moss does?

Response: Yes. Litters are treated as upper organic soil layer, which have different thermal properties from mineral soils to influence thermal dynamics (See Zhuang et al., 2002).

Zhuang, Q., A. D. McGuire, K. P. O'Neill, J. W. Harden, V. E. Romanovsky, J. Yarie (2002) Modeling the soil thermal and carbon dynamics of a fire chronosequence in Interior Alaska, *J. Geophys. Res.*, 107, 8147, doi:10.1029/2001JD001244.

I was surprised to see negative dNBR values. I see now that's mathematically possible, but how should a reader interpret such values?

Response: A reader should interpret such values as enhanced regrowth. Negative values are found in areas where the vegetation in the post-fire image has greened up

significantly after the fire, thereby making a strong signal in the NIR part of the equation. It can also occur if there was no available post-fire image for quite some time after the burn. It is not uncommon to see these values in areas that have graminoid cover that regenerate relatively quickly as long as the root mass was not disturbed. It is a place that should be put into the "burned" category - low severity.

Any ideas why fire might decrease soil temperature in some places?

Response: Fire removes moss layer and litters that serve as heat insulation, leading to higher soil temperature in summer. Fires also influence the soil hydrological process and surface energy exchange, such as sensible heat flux, thus soil surface temperature that is used to drive soil thermal model, especially in nongrowing season, the less insulative materials due to fire will cool the soil surface temperature, leading to cooler soil temperature, leading to cooler annual soil temperature in some places (Xu and Zhuang, 2023).

Xu, Y. and Q. Zhuang (2023), The importance of interactions between snow, permafrost and vegetation dynamics in affecting terrestrial carbon balance in circumpolar regions, Environ. Res. Lett. 18 044007, DOI 10.1088/1748-9326/acc1f7

Minor comments/corrections

P3L19: Citation needed for Landsat data?

Response: Thanks for the advice. We have added the link.

P7L1-2 (Fig. 2 caption): Is gray nonforest/not simulated?

Response: Grey areas are not simulated since there are no fire records in these places.

P11L21: The “previous estimates” referred to are the Pan-Arctic ones, yes? This could be mentioned in this sentence for clarity.

Response: The ‘previous estimates’ refers to our study on fire combustion emission in North American boreal forests (Xu et al. 2024). Combined with this study, we can have

an estimation of the whole pan-arctic region in the future. We have revised this sentence.

Xu, Y., Zhuang, Q., Zhao, B., Billmire, M., Cook, C., Graham, J., ... & Prinn, R. (2024). Impacts of wildfires on boreal forest ecosystem carbon dynamics from 1986 to 2020. *Environmental Research Letters*, 19(6), 064023.

P12L10: I think this should be equation 4, not 2.

Response: Thanks. We have corrected this.

P13L8-9: Worth pointing out that this limitation doesn't apply to your per-watershed analysis (Table 2).

Response: When calculating the runoff differences in each watershed, we simply calculate the sum of runoff differences in each grid cell that is close to the river. The exchange process might have some non-linear impacts on runoff estimation. Thus, we believe this limitation might still affect the analysis in each watershed.