

Interactive comment on “The role of snow cover and soil freeze/thaw cycles affecting boreal-arctic soil carbon dynamics” by Y. Yi et al.

Anonymous Referee #2

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Authors used a modeling study to investigate the role of snow cover, surface air temperature, and freezing and thawing of soils in soil organic carbon sensitivity and decomposition across the northern circumpolar region. This manuscript is well written and the study presents interesting finding about the role of snow thickness in causing soil respiration from deeper soil layers. Finding of this study is well suited and within the scope of multidisciplinary readership of Biogeosciences.

However, SOC decomposition is not only a function of temperature and moisture as assumed in this and many other modeling studies. There are many other important environmental controls on SOC decomposition which largely remains not included in any modeling studies such as organomineral controls, microbial controls, soil aggregation, and other pedogenic controls. Relative sensitivity of these environmental controls

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on total magnitude of soil respiration remains unexplored, and I will be pleased if authors include these missing controls in the limitations section. Further, please include discussion about winter warming impacts on soil respiration.

Another important area I like to point is authors mentioned at multiple places in the manuscript about large spatial heterogeneity in the study area. They used a variety of data sources with diverse spatial resolutions in their modeling efforts. It will be interesting to know about the contribution of this spatial mismatch of driving datasets in determining the total uncertainty in the modeled outputs. In my knowledge, no analysis was conducted to determine the spatial distribution of uncertainty across the study area. If so, please include this in your limitation section.

Apart from these, I generally agree with the presented research results and offer minor edits below:

P5L15-16 Surface organic layer is an extremely important factor in regulating active-layer dynamics and extremely heterogeneous soil property, and not/or improperly represented in current model structures. I am not clear how surface organic layer was represented in this study? Please make sure that surface organic layer, soil organic layer and SOC layers mean different things, and use these terms appropriately.

P6L20, may be you mean surface organic layer by “SOC layer”?

P6L6-8 please explain more how was this effect was represented in this study?

P6L28-P7L3 I don't understand the meaning of this citation here, Hugelius et al. (2014) did not partition SOC into fast and slow pools, and neither the depth distribution adopted in this study is consistent with Hugelius et al. (2014).

P7L25-P8L2. No consistency between this statement and table, please correct this. Table shows only one tundra site and one boreal forest site.

P8L12-14 Do you think measurement at 5 cm depth is representative of entire soil profile? Your earlier description assumes 0-20 cm litter pools (P6L28-29), so I think

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this measurement might qualify litter pool temperature not soil temperature.

P15L12 Mishra and Riley (2014) reported observation based high resolution ALD estimates for entire Alaska. This data might be useful to compare with your model results. Mishra U., and W.J. Riley. 2014. Active-layer thickness across Alaska: comparing observation-based estimates with CMIP5 earth system model predictions. Soil Science Society of America Journal, 78:894-902.

P18L23-28. Can you support your statement with appropriate citation? This statement is saying snow depth causes more soil respiration than surface air temperature?

Table 2 and Figure 4,5,6. I prefer validation results presented as R2 values, as its functionally related. Is it possible to convert R to R2 values?

Interactive comment on Biogeosciences Discuss., 12, 11113, 2015.