Response to Reviewer #3

We would like to thank all reviewers for their insightful comments, which helped us to improve the manuscript. Our revisions reflect all reviewers' suggestions and comments. For detail, please refer to the responses as follows: reviewer comments in black fonts, responses are in blue fonts.

Surface organic layer (SOL) plays an important role in soil thermal dynamics and especially permafrost dynamics. There are several modeling studies, which have already implemented the effects of SOL, in land surface models and ecosystem models. Jafarov and Schaefer tried again to implement SOL in SiBCASA. This work is worth for publish after the following issues on dynamic SOL are addressed.

1. How dynamic SOL is implemented?

The description of SOL dynamics might be too simple. For example, in Pg. 3144 Ln.

We added an extended description of the SOL almost in every section of the manuscript.

2 "the excess organic material was essentially "compressed" into the top soil layer, resulting in a 2 cm simulate SOL".

Does SiBCASA have dynamic soil structure? When top soil layer has excess soil carbon, will a new soil layer be created and added to the top? It is well-known that above-ground litter fall will accumulate on the top of soil, it will not transfer quickly down to the next soil layer as implemented in the SiBCASA. I suggest the authors make this point clear.

SiBCASA does not have a dynamic soil structure. It shifts the extra SOL to the layer below. We clarified this in the text.

2. What will SiBCASA do if disturbances happen?

The authors claimed that SiBCASA performed better than previous version in regions with discontinuous permafrost. These regions have boreal forests and usually have wildfire. Yi et al. (2010) also implemented the processes of buildup of SOL and removal by wildfire in Terrestrial Ecosystem Model; and Yuan et al. (2012) evaluated the role of wildfire in soil thermal dynamics and ecosystem carbon in Yukon River Basin of Alaska. Although the authors mentioned that SiBCASA does not consider disturbance in this version. It is important to provide a prospective for the further development and application of SiBCASA in relating to disturbance since wildfire is common in boreal forest regions. Tundra regions are having more wildfires.

Currently, the Discussion part is too short. I suggest the authors provide more discussion on 1) the differences among different methods of dynamic SOL implementation; 2) the shortcoming of assuming soil carbon transferring downward; and 3) disturbances.

We expanded the discussion section as suggested. The current version of the model does not include fire disturbances. To clarify this we inserted the following paragraph in the discussion section.

Including dynamic organic layer in the model allows us to study the interaction of plant dynamics and soil thermodynamics. In addition it allows us to study other processes in the future, such as fire impacts on soil thermodynamics and recovery from fire, both of which are strongly influenced by the changes in the organic layer (Jafarov et al., 2013). For example, Yuan et al. (2012) evaluated the role of wildfire in soil thermal dynamics and ecosystem carbon in Yukon River Basin of Alaska using Terrestrial Ecosystem Model (Yi et al., 2010), showing wildfires and climate change could substantially alter soil carbon storage. The current version of the model does not include the effect of fire, which means that topsoil carbon stays in the system and provides resilience to permafrost. However, in reality upper SOL could be removed by fire, which would alter soil thermal properties and perturb permafrost carbon stability.

References:

Yi, S., A. D. McGuire, E. Kasischke, J. Harden, K. L. Manies, M. Mack, and M. R. Turetsky (2010), A Dynamic organic soil biogeochemical model for simulating the effects of

wildfire on soil environmental conditions and carbon dynamics of black spruce forests, J. Geophys. Res., 115, G04015, doi:10.1029/2010JG001302.

Yuan, F., S. Yi, A. D. McGuire, K. H. Johnsen, J. Liang, J. Harden, E. Kasischke, and W. Kurz (2012), Assessment of historical boreal forest C dynamics in Yukon River Basin: Relative roles of warming and fire regime change, Ecol. Appl., 22, 2091-2109.