Manuscript Review

Title: Observation-based modeling of permafrost carbon fluxes with accounting for deep carbon deposits and thermokarst activity

Journal: Biogeosciences Discussions

Authors: Schneider von Deimling et al.

General Comments

1. This manuscript uses a relatively simple model structure to examine the release of C from thawed permafrost soils and the potential impact on the global climate. The authors divide C pools into functional types based on depth (shallow: organic vs. mineral, deep: yedoma vs. refrozen thermokarst deposits) redox conditions (aerobic vs. anaerobic), and organic matter quality (fast vs. slow pools). This manuscript advances our understanding of the global permafrost carbon feedback by considering abrupt thaw processes that might result in the rapid release of old C to the atmosphere (e.g. deep yedoma C, and talik development under thaw lakes). The manuscript is generally well written, although I've added some specific comments below where there were grammatical errors. There are also some spots where the authors could add more detail to better clarify methods regarding the model simulations.
2. I agree with Referee #1, who called for a better explanation of the differences between organic and mineral soils in main manuscript text.
3. I have some questions about the treatment of "wetlands" in this study, particularly the application of thaw depth changes under saturated conditions. Permafrost thaw in permafrost plateaus typically results in ground subsidence, impoundment, and collapse-scar bog /fen formation, followed by rapid wholesale loss of near-surface permafrost. This is an abrupt thaw process that could have been considered in this study. The prescribed thermal parameters don't appear to account for non-conductive heat transfer that occurs following these ecosystem state changes, and likely underestimates thaw rates.
4. The authors should describe if and how the depth distributions of soil carbon (e.g. Harden et al. 2012) were prescribed in this model. This seems like an important component, given the approach of tracking recently thawed C released in response to active layer thickness increases.
5. This paper would be greatly strengthened by some additional modeling simulations or sensitivity analyses designed to quantify how the inclusion of yedoma and thaw lake dynamics impacted total C loss and climate warming.

Specific Comments

1. Page 16602, Lines 15-18: I'm not sure that I agree with this statement, although it's difficult to say without a better definition of mineral vs. organic soils. Clearly peatlands are highly vulnerable to permafrost thaw. Ground ice volumes are variable,

and differences between organic and mineral will depending on the thickness of the deposit, no? Please clarify and add citations to justify statement.

2. Page 16602, Line 18: While this statement about anaerobic environments is generally true, some recent studies have shown the potential for large C loss from deep thawed peat deposits
3. Page 16602, Line 21 – Hydrologic ***and redox*** conditions
4. Page 16603, Line 12 – remove hyphen from "bio-geochemical"
5. Page 16603, Line 24 – replace "underline" with "note" or "observe". Also I think it would be good to mention why thermokarst has not been included to date in these models.
6. Page 16604, Line 15, Change this to "pools governed by different environmental controls"
7. Page 16606, Line 3 – Change composition to texture, unless you mean "chemical composition"
8. Page 1606, Lines 25 – 27 –Would be good to cite Gao et al. (2013) and justify here wetland increase in the text here. How do those scenarios reconcile with findings of Avis et al. (2011)? Also add Gao et al. (2013) to reference list.
9. Page 16613 , Line 1 – Use different word here than "exemplarily"
10. Page 16616, Line 8 – Correct grammar here: should be "after the middle of the century"
11. Page 16619, Line 2 – Grammar – omit "of" here
12. Page 16622, Line 13 – Correct grammar here "despite of the organic matter"
13. Page 16622, Line 19 – Omit "of" from "Despite of"
14. Table 1, footnote e – I have some issue with the assumptions regarding thaw rates in wetland soils. In many cases, saturated conditions in high-latitude peatlands function to accelerate thaw rates, due to non-conductive heat transfer processes. This approach for wetlands needs better justification in the text.
15. Table 1, Footnote d – Not entirely sure what you mean by "thaw rates are exemplary". Could you elaborate? Did you conduct a validation experiment in comparing observed vs. modeled thaw rates for some sites?
16. Figure 5 - Add decimals to RCP scenarios?
17. Supplemental, Page 2, Lines 15-18 – The authors should provide more detail here about soil temperature dynamics. This "lag" or "phase shift" in ground temperature has been well quantified in prior numerical evaluations. Please detail the assumptions made here.
18. Supplemental, Page 3, Line 13 – This section primarily describes variation in thermal properties across soil types, but what about variation in thermal properties with frozen and unfrozen ground?