Dear referee 2

Thank you for the comments.

Following the comments, we are now presenting our results only with thermal conductivity of 3 W m^{-1}K^{-1}.

All other questions and minor corrections were corrected.

The correction refers to the clean version.

Dear authors,
Thank you for the review. The line numbers I present here refer to the PDF with tracked changes. I am pleased with most of the responses to my review, except for the thermal conductivity (k) estimations. I would like to better explain my concern in this review round. My comments are divided into major and minor sections.

Major comments:
In the equation 2, theta represents the porosity and B represents the fraction of unfrozen water in the pore space. If B=1, then all the water in unfrozen.
K = (1-theta)*ksoil + theta ((1-B)*kice + B*kwater)
This is basically an equation for saturated conditions. For the mineral fraction we simply subtract theta from 1. The problem is that the authors multiply the mineral fraction by dry soil thermal conductivity. But, the dry soil thermal conductivity is a bulk value that considers air in the pore space. So, the authors cannot use a dry thermal conductivity value for k if the pore space is filled with water and/or ice. Here is a paper by Cosenza with appropriate values for k_mineral: https://doi.org/10.1046/j.1365-2389.2003.00539.x
This error also applies to the density estimation, because once again, the pore space is saturated. Is p_soil in this case the density of dry soil that accounts for air in the pore space? And depending how you estimated the volumetric heat capacity; this equation would also have a mistake. In general, you need to make sure the values you use in your equation represent saturated conditions. I recommend keeping the simulation results with a mineral thermal conductivity of 3.0 W/mK and removing the results with a mineral thermal conductivity of 0.35 W/mK. If you wish to include a sensitivity analysis, then please use a lower mineral thermal conductivity that makes sense.

We now changed all to 3 Wm^{-1}K^{-1}, as suggested.

My point about the thermal conductivity is also revealed in line 258 of the tracked changes PDF.
Line 258: The thermal conductivity range is defined by dry soil at the low end (a bulk value that includes air) and the mineral conductivity of quartz (8.8 W/mK) at the high end. The thermal conductivity of quartz is the mineral thermal conductivity and not the thermal conductivity of dry sediment.

We made changes also in this part and cited more literature – lines (248-250)

Line 375: Is this because the seasonal change in thermal properties is less pronounced when a higher mineral thermal conductivity is applied in the bulk thermal conductivity estimation?

Yes, the updated, higher conductivity of soil results in enhanced heat loss during summer. Nevertheless, careful examination of simulation results showed that a thin layer (0.5m) may actually formed also with -5°C and 3W $m^{-1}k^{-1}$ (Although not under -6°C). Please see revised text (lines 370-377)

Line 395: Why is there a small difference between the 100% and 25% freezing conditions for a WFT of -2 degrees Celsius? Is it because the thermal gradient between the WFT and the upper boundary forcing is low?

Correct. With small difference between the two, partial freezing becomes similar to complete freezing.

Line 409: Why does increasing the thermal conductivity result in less permafrost aggradation in this case (9.5 m instead of 12 m)?

Permafrost aggradation depth largely depends on the difference between frozen soil conductivity (winter) and thawed one (summer). The difference between the two is more effective with low dry soil conductivities (0.9 and 0.4, respectively, with the 0.35W $m^{-1}k^{-1}$ for dry soil) than with the high dry soil conductivity of 3W $m^{-1}K^{-1}$ (2.8 and 2.3, respectively). Nevertheless, in the revised version we are left only with the 3W $m^{-1}K^{-1}$.

Line 520: If the salt diffusion into the sediment produces only partial freezing, then shouldn't the freezing front advance faster? This would be consistent with your partial freezing simulations where you keep the freezing point depression fixed. However, because of the salt build-up via diffusion, saline cryotic unfrozen layers can perhaps develop and affect groundwater flow.

- Thanks for this question. We basically suggest that freezing of the topmost soil (a few m) inhibits infiltration (also up valley from the ADE site), therefore hinders FSI deepening. We note that at >10m, water does not exceed 15% seawater salinity, which implies freezing temperature quite close to that of fresh water. Also, the preservation of an FSI demonstrates that there was not much of groundwater flow since permafrost formation.

Minor comments:

Line 14: Replace „cheistry“ with „chemistry“ – **corrected (line 13)**

Lines 54-56: Please fix the structure of this sentence – **We changed it to:**

“Nevertheless, permafrost can occur beneath lagoons in association with taliks, as well as beneath bottom-fast ice in shallow water (Solomon et al., 2008).”

(Lines 52-53).

Line 73: What do you mean by “enhancing cryopegs?” i.e. providing the necessary conditions for their existence? **(we changed to “Flow may also provide the necessary conditions for the formation of cryopegs …” (line 71)**

Line 75: Replace “cryopegs was” with “cryopegs were” – **corrected (line 72)**

Line 408: Replace “and Thermal conductivity” with “and a thermal conductivity” – **sentence was erased**

Line 512: Replace “freezing rate” with “the freezing rate.” - **corrected line (483)**

Line 593: Replace “was rising” with “were rising”. **corrected line (552)**

Figures 5 and 6: Specify the thermal conductivity used. **no longer relevant; all simulation was conducted with 3W m^{-1} K^{-1}**