

***Interactive comment on* “Sensitivity of active layer freezing process to snow cover in Arctic Alaska” by Yonghong Yi et al.**

Anonymous Referee #1

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The manuscript presents a study on soil active layer dynamic sensitivity to snow cover from an improved remotes sensing driven permafrost model, which used several remote sensing information, including MODIS snow cover data. The modeled snow depth, soil freeze-up and zero-curtain period were calibrated and validated against in situ observations. The model was used to evaluate the sensitivity of active layer freezing to snow cover conditions.

The manuscript present interesting and valuable results on the relation between snow cover and active layer evolution. However, the manuscript is sometime difficult to read and some methodological section could be improve. The many supplement figure make the manuscript even harder to follow and I would suggest to lightening it. I recommend the publication of the manuscript following revisions:

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1. p1 - line 24 : “this was also consistent with findings based on the airborne radar $\dot{E}Z$ retrievals in 2014 and 2015” not clear in the context.
2. The introduction is very well written and interesting. However, at the last paragraph, it is not clear what the objectives of the paper is. Because there are many results and analysis in the manuscript, a clear definition of the objectives would help the reader.
3. p4 – l 3-4 : does the model as a name? (minor: sentence copy pasted from last paragraph)
4. p5 – Line 13 : At that point, it is not clear how SCE data can improve snow depth data? SCE is used to remove the snow where the model still simulate snow cover? It should be clarify at that point how you come to correct snow depth from binary information.
5. p8 – l13: At what frequency is $\dot{E}Z$. In addition, it would be important to clearly distinguish the $\dot{E}Z$ (SoilSCAPE) and $\dot{E}Z1$ (radar), and their frequency. Maybe use more precise acronym?
6. p9 – l6: How the model thermal properties were adjusted (changing the thermal conductivity of the soil or changing the amount of organic matter in the soil?)
7. 2.3.3 Airborne radar retrievals: The title is not clear. Maybe “Airborne radar permittivity retrievals”? The section is not very clear as well. 1) At this point it is not clear how the dielectric will help to analyse the relation between active layer freezing and snow cover. 2) What is the expected penetration depth with P-band (does it change with frozen vs unfrozen)? 3) L17 : define airborne land parameter. 4) “an iterative model inversion” .: what model (radar scattering model, but which one?). 5) p10 – l1 : does soil moisture variation can have an impact?
8. At the end, the usefulness of P-Band radar is not clear. The results obtain with P-Band radar are limited (Figure 6) but add to the complexity and the length of the manuscript.

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9. 3.1 Model Validation: “model parameterization and validation” would be more appropriate.

10. p12-28 : Have you done an inversion to get that number? Clarify how you calculated the 15%.

11. p15 – l13: Why higher elevation could impact the relationship? This point should be develop more. Is the elevation impact $\dot{E}Z1$ or MODIS SCF, or the soil thermal regime? At what point it is in opposition to the conclusion.

12. Fig S13: I do not see how Fig. S13 shows the effect of snow accumulation. Need more explanation.

13. 3.2.2 first paragraph: why considering only two years for this analysis? Does using many years would show that the mean snow onset is correlated to mean zero-curtain period? The results would be much stronger?

14. The model evaluation show some uncertainties in the model. At what point these uncertainties could influence the results and the conclusion?

Minor :

p19 – l5 : “information” instead of data?

Figure 1: The magenta and the red stars are very similar.

Figure 5 : (b) at 0.35 m?

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2018-170>, 2018.

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