Interactive comment on "Permafrost Variability over the Northern Hemisphere Based on the MERRA-2 Reanalysis" *by* Jing Tao et al.

Anonymous Referee #3

The authors compare model estimates (based on re-analyses data) of active layer thickness (ALT) with different data sources. This includes in situ measurements from an international database and an unpublished approach of airborne P-band estimation. The latter is available over Alaska. General evaluation is made for the northern hemisphere.
In addition, the model input is investigated for linear relationship with its output. The authors seek to find a simplified relationship to explain ALT change over time (driven by degree days, snow water equivalent etc).

General issues

The manuscript addresses an important topic, the modelling of active layer thickness over time. The presentation of the manuscript and setup of the experiment is however problematic.
1) The authors report 'reasonable' or 'good' results with limited and partially missing quantitative reasoning.
2) The results of the comparison to the unpublished airborne (AirMOSS) approach suggest that it actually does not work (AirMOSS values are all at the same level, not representing the in situ range, Figure 4). The comparison to this unpublished approach should be removed from the manuscript.
3) The stated objectives comprise issues regarding active layer thickness. The results section however does also cover permafrost extent.
4) In addition, common structure of methods, results and discussion is lacking. Methods are included in the introduction and mostly in the results section. The discussion is largely included in the results section. The 'approach' section mostly only includes the dataset description.
5) Some of the used datasets are not appropriately cited. See detailed comments below

6) A main weakness of the manuscript is that the results are not discussed with respect to already published material on permafrost related parameter modelling and on the parameters which are investigated for explanation as drivers of ALT change over time. The role of temperatures and snow water equivalent for active layer thickness is known (what is presented as one of the main results in the abstract). The novelty of the paper is not clear.

Detailed comments

Title: the title is misleading; the paper focuses on active layer thickness what should

be reflected in the title

Abstract:
Line 19: 'measurements demonstrates reasonable skill' – what is 'reasonable'? add numbers
Line 27: 'significant degradation, with ALT increasing up to 0.5 cm/year' – it should be noted that this cannot be confirmed with in situ observations

Page 5, line 9: NCSCDv2 – citation missing, follow instructions of https://bolin.su.se/data/ncscd/
Page 6, line 24: Brown et al. 2002: the reference is missing in the list

Page 7, line 30 following: this paragraph belongs to methods
Page 8, line 9: remove 'relatively'
Page 9, first paragraph: this belongs to discussion
Page 9, line 17 following: introduce this comparison in the methods section
Page 9, line 22: provide correlation analyses results as table
Page 9, line 23: which SOC value did you use? Is it representative for the upper soil layer?
Page 10, line 4-28: this all belongs to the methods section
Page 11, line 7: spell out LAI
Page 12, line 6-12: move to methods
Page 12, line 19: 'permafrost areas shown in Fig. 1b are well confined within the cold side ..' this cannot be seen. Add outlines to map
Page 13, up to line 7: to methods; what is the reasoning for the static time period approach?
Page 13 – move explanation of linear regression analyses to methods
Page 14, line 14: 'geographically thin disagreements' – quantify this

Page 14, line 28 following: this is methods
Page 14, line 18: this error may seem small in absolute numbers, but ALT is much thinner than for the Mongolian sites. The error is still relatively large.
Page 14, line 20-26: this belongs to discussion
Page 15, first two paragraphs of section 3.5 – this all belongs to methods
Page 17, 21: 'shows good general agreement' – this is not really the case, quantify the agreement and compare with other published results
Page 17, line 29: 'The simulated ALTs agree well with the in-situ observations' – not really, see my comment for page14, line18; how do your results compare to other published results?
Page 18, lines 1-2: 'retrievals from airborne remote sensing for 2015 and the corresponding simulated ALT exhibit reasonable accuracy vs. in situ measurements' – this is not clear from the material presented.
Figure 5: what is the red rectangle?
Figure 7: convert to table