

Review to Harp et al. “Effect of soil property uncertainties on permafrost thaw projections: a calibration-constrained analysis”

This manuscript shows the different uncertainties of soil properties and climate model structures on permafrost thaw depth simulations. It compares the parameter estimation uncertainty with model structural uncertainties for a single site in Arctic Alaskan coast and shows that parameter calibration of soil properties improves the accuracy of simulations however does not eliminate all problems. Using different models for the same experiment shows the higher uncertainty coming from individual model differences.

The manuscript is very well written and communicates a clear message. I am happy to accept it with minor revisions listed below.

Minor comments:

- Authors can add further references to introduction about recent model developments including surface vegetation insulation on soil thermal scheme: Chadburn et al. 2015; Ekici et al. 2014; Wania et al. 2009
- It would be better to include a site information section for Barrow. It can explain the site conditions in particular climate, snow distribution and vegetation cover as well as soil characteristics for the observational location.
- As I understand, the CESM outputs are used to drive the surface/subsurface model for calibration period (2013). Why not using the observed climate or at least showing the difference between observed and modeled atmospheric variables?
- What about the snow depth time series comparison? That would give important information on changes and timing of saturation as well as other metrics.
- Why did you choose to calibrate for a single year of observational data? Wouldn't it be more useful to include as much observation as possible to constrain the parameters? Are there no available observations from other years?
- Further discussion about other arctic sites considering the different landscape types and consequent importance of potentially different parameters can be added.
- Please describe the term S_i in Eq. 2, how do you calculate it?
- In section 7 you mention “different climate scenarios” (p3369, l22). do you mean different climate models? Since they all follow the same RCP8.5 scenario...
- I cannot see the pearson correlation coefficients on Figure 13

Technical corrections

p3361 l5: “their are” should be “there are”

p3364 l10: “above freezing” should be “above freezing temperature”

p3370 l6: “uncertianty” should be “uncertainty”

p3371 l13: “that” should be “than”

References:

Chadburn, S., Burke, E., Essery, R., Boike, J., Langer, M., Heikenfeld, M., Cox, P., and Friedlingstein, P.: An improved representation of physical permafrost dynamics in the JULES land-surface model, *Geosci. Model Dev.*, 8, 1493-1508, doi:10.5194/gmd-8-1493-2015, 2015.

Ekici, A., Beer, C., Hagemann, S., & Hauck, C. (2014). Simulating high-latitude permafrost regions by the JSBACH terrestrial ecosystem model. *Geoscientific Model Development*, 7, 631-647. doi:10.5194/gmd-7-631-2014.

Wania, R., I. Ross, and I. C. Prentice (2009), Integrating peatlands and permafrost into a dynamic global vegetation model: 1. Evaluation and sensitivity of physical land surface processes, *Global Biogeochem. Cycles*, 23, GB3014, doi:10.1029/2008GB003412.