

## Responses to referee's comments

### Comment:

This is an excellent manuscript and falls well within the scope of The Cryosphere. By integrating various ground-based and remote sensing-based information, the authors showcased a novel method to map the permafrost extent, types and the changes under future climate change scenarios. The methods and algorithms were well thought through and could be considered an improvement over the traditional empirical/statistical based permafrost mapping. The following are a few points this reviewer found impressive:

- 1) The extent of data integrated in this study was massive, especially in the permafrost regions where the accessibility is extremely poor.
- 2) The process-based NEST model served well in integrating all the available inputs.
- 3) The probabilistic algorithm used to quantify the uncertainty of ground cover types is novel. With further validations in other regions, it may provide a new method to address similar problems that are common in permafrost studies.

In general, this reviewer found this manuscript was well written. The objectives and methodology were stated clearly; results are very well presented and limitations of the current study were discussed. Therefore this reviewer recommends that this manuscript be accepted for publication with only very minor revisions as listed below:

- 1) Eq.(3), page 1901: Although it is stated that  $x_0$  was defined by satisfy the  $x$  and  $F(x)$ 's non-negative condition, the readers may wonder if there is any physical meaning to relate this term.

**Responses:** Agree. We added a sentence describing the physical meaning of  $x_0$  ( $x_0$  is the minimum organic layer thickness for a land cover type) and also reformulated the equations (1-3) by eliminating the intermediate variable 'a'.

### Comment:

- 2) Line 13-15, page 1904: could you add a few explanatory words to state why use 1971-2000 as climate normal period while more recent data are available?

**Responses:** The spatial thirty-year normals provided by McKenney et al. (2012) cover the period 1971 to 2000.

### Comment:

- 3) Line 24-25, Page 1908: I could not find in the paper that the lower simulation depth was specified, i.e. at which depth to apply this geothermal flux.

**Responses:** The lower simulation depth was 120 m. We added a sentence about this and slightly revised the last sentence accordingly.

### Comment:

- 4) Typos and minor corrections:

a) line 6 page 1900: “typ.”;

**Responses:** Corrected.

**Comment:**

b) line 19, page 1901: “nunit” maybe replaced by “dimensionless” or “unitless”;

**Responses:** This intermediate variable ‘ $a$ ’ was eliminated in the equations.

**Comment:**

c) Line 23 , page 1902 to line 1, page 1903: consider revising the sentence started with “permafrost conditions: : :.”. it was a hard read.

**Responses:** Revised. The long sentence was split and revised.