Responses to referee's comments

Comment:
General Comments:

The research paper titled "A new approach to mapping permafrost and change incorporating uncertainties in ground conditions and climate projections" by Zhang et al., examines an intergraded approach to examining the distribution and change of permafrost in the present and into the future under low, medium and high levels of climate warming. This approach utilizes a commination of field-collected data with remote sensing and then models the permafrost distribution and active layer attributes using the NEST process-based model. I think this method provides a very novel way of examining how permafrost in the discontinuous zone is controlled in areas where elevation is not the dominant controlling factor such as those in mountain areas of the discontinuous zone. Overall I find this paper well written but more importantly well suited to addressing an important gap in the knowledge of permafrost distribution and evolution in the discontinuous zone. The paper also sheds light on the important influence ecosystem plays in the distribution of permafrost in this zone. One place were I do feel the paper is lacking is that I feel the paper has failed to reference some of the key conceptual material and studies that are reverent (listed below) as a result I feel that they must be added. Besides this I see no reason why the paper should not be published in TC pending the minor revisions that I will suggest on this review.

Specific comments:

1) I feel as if the title of the paper is a bit clumsy in its current form, I would consider shortening it and revising.

Response: The title is a bit long, but we cannot find a shorter and clearer way to covey the idea and content of the paper. Therefore we will just keep it that way.

Comment:
2) Throughout the paper degree days should be written as degree-days.

Responses: Corrected.

Comment:
3) On Page 1901, line 2; is the range of warming scenarios incorrect? 0.25 is mentioned twice.

Response: They are correct. The three numbers are for the probabilities of three representative climate scenarios.

Comment:

4) Page 1905, line 25, it is mentioned that for classes that were not measured in the field that data from an area near Tuktoyaktuk was used. This is very far away from the main study area, please comment more on any error that might have been introduced by this workaround.

Response: Agree. A sentence was added to indicate that "these observations may over-estimate the OLT in our study area, especially when bedrock is near the surface."

Comment:
5) Page 1907, line 3, please put in a reference to back up the statement that LAI would reach pre-burn levels in 50 years.

Responses: The paper of Bond-Lamberty et al. (2002) was added as a reference.

Comment:
6) I think a better justification needs do be used as to why two different modelling groups were used for the same A1B scenario for the medium and high climate warming scenarios. Why wasn't a scenario like A2 (which produces more warming by the end of the 21 century) used? If this is because A1B warms more than A2 by 2050 (which is the case based on the nature of the scenario) this should be stated. Otherwise I still feel justification is needed as to why CCCma's models were not used throughout.

Response: To select future climate scenarios, we first selected 18 climate projections of six climate models (CCCma, ECHAM, HadCM, GFDL, MIROC and NRCAR) under three greenhouse gas emissions scenarios (A2, A1B and B1), then we selected three climate change scenarios generated by CCCma (B1), CCCma (A1B) and MIROC (A1B) to represent low, medium and high warming scenarios based on their temperature projections (Fig. 4). We did not select CCCma (A2) because the projected air temperature is lower than several other projections and it is similar and sometimes lower than that of CCCma (A1B) before the 2050s. We added this information to the paragraph.

Comment:
7) In the paper both Mean Annual Air Temperature (MAAT) and Annual Mean Air Temperature (AMAT) were used to describe the same thing, this should be consistent throughout the paper.

Response: We checked these two terms in the paper. The three instances of "mean annual air temperature" describe averages over 30-year or longer. The two instances of "annual mean air temperature" refer to the average for one year. They are slightly different and the usages are correct.

Comment:
8) Page 1911, the subject heading for section 3.3 reads "Result validation" I strongly think this should be changed to "result verification". Although this is a good model addressing gaps in the field, it cannot be validated in the true sense but some verification can be done which is what is described here.

Response: Agree and revised.

Comment:
9) I feel that the maps presented in figures 3, 5 and 7 should use a classified colour scheme rather than a continuous graduated one. In the current format I find the maps difficult to read both printed and on screen. Consider adapting the same colour scheme used in other permafrost probability studies such that used in the references below.

Response: We tested the figure 5 using 10, 20 and 100 categories for permafrost probability (using ranges of 10%, 5% and 1% for each category, respectively). The difference among the figures is very small and the clarity does not improve much. So we will keep the current form.

Comment:
References I feel should be added to this paper:

Bonnaventure P.P. and Lewkowicz A.G. 2013. Impacts of mean annual air temperature change on a regional permafrost probability model for the southern Yukon and northern British Columbia, Canada. The Cryosphere, 7: 935-946. doi: 10.5194/tcd-6-4517-2012.

- This paper also uses climate change scenarios to examine how permafrost probability and spatial distribution changes in a discontinuous permafrost environment. Although the methods are not the same I think it should also be mentioned.

Response: Agree. Added and cited.

Comment:
Bonnaventure P.P. and Lamoureux S.F. 2013.The active layer: a conceptual review of monitoring, modelling techniques and changes in a warming climate. Progress in Physical Geography. 37: 352-376. doi: 10.1177/0309133313478314.

- Add this reference to speak about the type of active layer (e.g. page 1900 line 2, you are describing a Type 4 active layer); this reference also speaks about the evolution of changing active layers in different permafrost environments and ecosystems.

Response: Agree. Added and cited.

Comment:
Kremer M., Lewkowicz A.G., Bonnaventure P.P. and Sawada M.C. 2011. Utility of classification and regression tree analyses and vegetation in mountain permafrost distribution models, Yukon Territory, Canada. Permafrost and Periglacial Processes. 22: 163-178, doi:10.1002/ppp.719.

- There are very few examples where vegetation is incorporated into permafrost modelling however, this is one and it should be mentioned in the introduction.

Response: We cited three references about mapping permafrost directly using satellite images. The major idea is to show their advantages and limitations. Our reference list is already quite long so we will not include this one and some other papers, such as by Panda et al. (Remote sensing and field-based mapping of permafrost distribution along the Alaska Highway Corridor, interior Alaska, Permafrost and Periglac. Process. 21: 271–281, 2010).

Comment:

Jorgenson, M.T., Romanovsky, V., Harden, J., Shur, Y., O'Donnell, J., Schuur, E.A.G., Kanevskiy, M. and Marchenko, S. 2010. Resilience and vulnerability of permafrost to climate change. Canadian Journal of Forest Research, 40: 1219-1236.

Shur, Y. and Jorgenson, M.T. 2007. Patterns of Permafrost Formation and Degradation in Relation to Climate and Ecosystems. Permafrost and Periglacial Processes, 18: 7-19, DOI: 10.1002/ppp.582.

- The two above papers speak about how the distribution of permafrost and the nature of the ecosystem effect how it will be impacted by climate change giving a relative time frame. I really feel they should both be added, as the concepts are relevant to this paper.

Response: Agree. Added and cited.