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Interactive comment on "Nonlinear thermal and moisture dynamics of high Arctic wetland polygons following permafrost disturbance" *by* E. Godin et al.

Anonymous Referee #1

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The authors describe changes in temperature and moisture in a polygonal tundra landscape on Bylot Island (Canada). The paper focuses on the role of disturbances such as thermal erosion on permafrost polygons. In particular, the authors describe how polygons affected by thermo-erosion differ in key observables, such as, e. g., active layer thickness and soil moisture, as they compare observations in eroded polygons to reference observations in an intact polygon.

The paper is well structured and concise. The authors in the discussion also point out how the spread of thermo-erosion throughout the landscape can trigger larger scale change in the landscape, until the system could potentially reach a new equilibrium. In this paper the authors focus on measurements and observations on polygons in the

transition between those two equilibria.

I recommend this paper for publication, with minor revisions for clarity.

General questions to be discussed:

The authors investigate only the maximum active layer depth, and compare these values over different years in different polygons. No information is given on the timing of these values and on the persistence on the maxima. Would it be possible to investigate the dynamics of the TD for the observation period, analogously to what authors do for soil moisture in Fig. 5? If data are available for such an investigation, it would add value to the paper, highlighting the potential difference in TD dynamics and timing among intact and eroded polygons.

In the paper the authors rarely mention the issue of scales. What are the implications of these results at a landscape-scale? The transitions between different equilibria the authors talk about in the section 4.2 can be similar to a large scale transition due to thermo-erosion, such as the one theoretically highlighted by Cresto Aleina et al. (2013)?

What about time scales? Can the authors discuss the implications of their findings for potential future transitions in more detail? Is there enough evidence to suggest future rapid transitions between two different equilibria? Is the presence of gullies necessary to speed up the thermal erosion process?

How can your results influence the modeling of such a complex environment? Langner et al. (2013), for example, used a satellite-based approach to model the thermal dynamics in the polygonal tundra. Are there plans to scale up your fine-scale observations to a landscape-scale survey?

Minor comments:

Page 11801, line 11: Can you please define what you mean with "active" gully? Does it mean with water flowing through?

Page 11802, line 2: please substitute "onsite" with "on site"

Page 11802, lines 24-26: What do the authors mean with visually? Could you please specify the accuracy of this evaluation? Please, provide a more detailed description. Maybe a table with the scale description would be of help.

Page 11804, line 12: Please rephrase, the colon does not work well here. I would suggest: "with R..., and graphics..."

Page 11805, line 1: is it because of the wind action, or does the snow just fall due to gravity after accumulation?

Page 11806, line 26: What do the authors mean with "active layer depth variability within its grid"?

Page 11807, line 6: the n factor is a ratio in its definition, therefore I would omit this word now, in order not to generate confusion with the n_t factor (line 1, same page).

Page 11808: Please, move "anymore" at the end of the sentence.

Page 11811, line 5: It is rather the interaction, or the synergy of these condition, than the "sum".

Page 11811, line 16-17: This sentence is quite vague. Could you please describe this "lesser degree" better, maybe with some quantification?

Page 11813, line 6: Please, substitute "Further" with "Furthermore" or similar.

Figure 2: Probably a typo, but I guess the BYLPD should rather read BYLOTPD, I guess.

Refences:

Cresto Aleina, F., Brovkin, V., Muster, S., Boike, J., Kutzbach, L., Sachs, T., and Zuyev, S.: A stochastic model for the polygonal tundra based on Poisson–Voronoi diagrams, Earth Syst. Dynam., 4, 187-198, doi:10.5194/esd-4-187-2013, 2013.

Langer, M., Westermann, S., Heikenfeld, M., Dorn, W., and Boike, J.: Satellite-based modeling of permafrost temperatures in a tundra lowland landscape, Remote Sensing of Environment, Volume 135, August 2013, Pages 12-24, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2013.03.011.

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