

Response to RC1 for tc-2020-351

RC1 – black text; Response – blue text

In the present paper the authors investigate a novel analytical model which conceptualizes the hydrological drainage dynamics of inundated ice-wedge polygon centers in Arctic lowlands. I have already reviewed an earlier submission of this manuscript with TC (<https://tc.copernicus.org/preprints/tc-2020-100/tc-2020-100-RC1.pdf>). One of my major concerns with the previous submission was, that the article by Zlotnik et al. (2020) which introduces the analytical model had not undergone peer-review at the time of the initial submission. This point is now obsolete, as the model description and validation article has been published in a peer-reviewed journal (<http://www.mdpi.com/2073-4441/12/12/3376>).

The present article is well-written, well-presented, and certainly of interest to the readers of TC as the topic is important and timely. In particular, I have seen that the authors addressed almost all major and minor points which I raised when reviewing the first submission of this article. Hence, I support publication of this article in TC after addressing some minor, mostly technical, points which I noticed during reading.

We thank Dr. Nitzbon for taking the time to review our manuscript for a second time. We are glad that Dr. Nitzbon feels that we adequately addressed most major and minor points from his first review. We found his first review extremely helpful and constructive in improving our manuscript. Please find our responses below indicating how we have further revised the manuscript based on Dr. Nitzbon's additional comments.

### **Specific comments**

- The introduction of the article is quite long and should be shortened and streamlined. For instance, I would suggest to shorten on detailed descriptions and justifications which should rather be presented in the Methods or Discussions sections, respectively (e.g. lines 84-87, lines 107-110, lines 112f).

We agree and have removed the indicated lines. The Robin boundary condition discussion (lines 84-87) has been integrated into "Section 2.1 Model overview" and the precipitation/evaporation discussion (lines 107-110) has been moved to "Section 2.2 Model parameterizations". The material in lines 112f is covered adequately elsewhere (such as in "Section 4.2 Model limitations"), so has simply been removed.

- In the abstract (l. 7) the authors state to investigate "inter-annual increases" in active layer thickness. While I understand that this is only done indirectly via the variation of aspect ratios, it would be nice to provide a discussion of the effect of active-layer deepening, similar to what is done for the seasonal thaw-depth increase in lines 323ff.

We agree that tying back into the "inter-annual increases in active layer thickness" was missing from the Discussion Section. As Dr. Nitzbon indicates, we use aspect ratio to evaluate both the effects of seasonal thaw depth and inter-annual active-layer thickness changes. Therefore, the

discussion in 323ff applies to both as well. To make this more apparent, we have added the following text:

“Inter-annual deepening of the active layer will lead to even more dramatic evolution in drainage patterns described above during the thaw season as the range of thaw depths encountered increases.”

We also point this out to the reader concerning advective heat transport towards ice-wedge tops:

“Similarly, increasing seasonal thaw depth and inter-annual active layer thickness will lead to polygons with less focused advective heat transport towards ice-wedge tops, potentially providing a negative feedback on ice-wedge degradation.”

Concerning pond depletion rate, we have added the following text:

“Concerning temporal changes during the thaw season, polygon pond depletion will slow down as the thaw depth increases, and this reduction will become more dramatic over the thaw season as inter-annual active-layer thickness increases. This implies that a thickening active layer due to warming trends may result in slower pond depletion.”

These additions to the discussion help guide the reader to the implications of our results, and we thank Dr. Nitzbon for prompting them.

### **Technical corrections**

- 1. 2: I think “transitions from methane to carbon dioxide dominated emissions” would describe the implication of polygon drainage better.

We completely agree and have revised the text.

- 1. 68: “ice-wedge surface hydrology” might be a confusing terminology. Maybe rephrase this to “(ice-wedge) polygon surface hydrology” or “polygonal tundra surface hydrology”.

Dr. Nitzbon is exactly correct that the wording was confusing and imprecise. We have used his suggestion and changed this to “polygonal tundra surface hydrology”.

- 1. 319: Do you mean “affecting”?

Yes! We thank Dr. Nitzbon for pointing this out. It has been fixed.

- 1. 345: Do you mean Abolt et al. (2020) (JGR: Earth Surface), which I suggested to discuss in the first review? To my understanding Abolt et al. (2018) do not discuss the effect of trough geometry.

We agree that Abolt et al. (2020) is a very appropriate reference here. We thank Dr. Nitzbon for pointing out that oversight and apologize for not catching that suggestion in his first review.

- l. 385: should be "that" instead of "this"

This has been fixed.

- The references Atchley et al. (2015) and Harp et al. (2015) are for the Discussion papers, but not for the final revised articles. You probably want to change this.

We thank Dr. Nitzbon for catching this. The references have been updated to the final articles.

- Fig. 5 and 8: Consider leaving away the decimal points (.000) at the contour line labels.

Yes, the ".000"s were completely unnecessary and we have removed them. We appreciate Dr. Nitzbon pointing this out.