The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2018-211-RC1, 2018

The Cryosphere Discussions
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Interactive comment on "Pathways of ice-wedge degradation in polygonal tundra under different hydrological conditions" *by* Jan Nitzbon et al.

Anonymous Referee #1

Received and published: 14 December 2018

Nitzbon et al. develop and test a new ice-wedge polygon model to represent thermokarst in polygonal tundra. The paper is very well written, convincingly argued, and balanced. I also think the topic is very important (permafrost degradation) and relevant to ongoing analyses in many groups. I appreciate their creative approach to representing a very spatially heterogeneous system with a geometric scaling approach and their analyses of the sensitivity of their results to the assumptions of their approach.

However, I think the authors could strengthen the paper by considering the following suggestions:

1. The validation runs are worthwhile, and do not appear to result in large discrepancies in moisture or temperature. However, I expect larger variation from uncertainty in soil parameters, and so suggest that such a sensitivity analysis be performed. Pa-

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rameters in Tables 2, 3, and D1 are all uncertain, so I would like to see an analysis of which are dominant for the system responses you are studying, and then an uncertainty quantification of your main results associated with variation in the dominant parameters. 2. The hydrology model structure described in Appendix A is somewhat disappointing, given advances made over the past few decades in implementing more sophisticated approaches. However, the proof's in the pudding, and Figure E2 appears to show good comparisons. It is probably worth mentioning in the main text that the model systematically underestimates water content in the rims. That problem may be from setting the porosity to 0.5, but it's not easy to tell. a. Are there no observations at other depths, for both moisture and temperature? Report R2 against observations for temperature and moisture. b. You should describe the model time step and numerical methods for solution. c. Discuss in the main text motivation for your choice of using a simple hydrology model, and what possible implications are. d. Discuss the role of vegetation changes that might be expected during degradation. Currently you set the vegetation parameters at the beginning of the simulation, and I think they remain constant. But, e.g., a drying system should expect to see a transition to plants less adapted to saturated conditions, and that will affect ET. e. It's difficult to see how well the model is doing in Figure 6. Change the y-axis range to -0.2 to 0.3, and report R2 from the average of the 8 simulations, or some combination of those simulations. 3. I am confused about what is being compared in Figure 7. How can an ECOR measurement separate out centers and rims (wet and dry)? Seems impossible, so it's not clear what is being compared. a. Put a 'wet tundra' label above the gray part, and a 'dry tundra' label above the RHS part. And, describe what these terms mean in the context of an ECOR measurement. 4. Line 15 of Page 19, where you use the word "realistic" for your ice-wedge degradation approach. I think you should move the text from lines 12-17 on page 20 up here to show that your results are reasonable, even though you have not made any direct comparisons with degradation. Otherwise, as written, on page 19 I did not see how your representation was reasonable for degradation. 5. In Figure 2, label the colors of the features with a legend.

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