Drainage and refill of an Antarctic Peninsula subglacial lake reveals and active subglacial hydrological network. Hodgson et al. 2022. TCD

General Comments

I enjoyed reading this paper. It is well written with excellent supporting figures and provides an important contribution to our understanding of smaller active subglacial lakes in the Antarctic Peninsula, and further support that surface meltwater is reaching the bed above the grounding line. The paper uses remote sensing and aerogeophysical platforms to characterise the ice collapse structure and the slow refill of the lake. Further examples of ice collapse structures are identified around the Peninsula suggesting these lakes are rare but not isolated phenomena. I am therefore in favour of this being published. However, I do have some general comments/ questions summarised below and more specific line-by-line edits and comments:

1. **Constraining/ inferring rapid subglacial lake drainage.** The rapidity of drainage seems to be largely inferred from the steep ice walls. Could this also be a result of other glaciological factors (e.g., ice thickness, crevassing …)? Some discussion or further support for rapid drainage would really help the paper. In particular, could you use the satellite archive to look for evidence of when the lake drained, and over what time-span? This would really strengthen the argument. Out of interest, the surface collapse pattern reminds me of the drainage of englacial Lake Dålk (see Fig. 2 – of Boronina et al., 2021), which also drained rapidly but with a thin ice lid.
2. **Supraglacial meltwater inputs.** There might not be the resolution to do so, but I wonder if there is a simple back-of-the envelope calculation that could be done to evaluate the contribution of surface meltwater to the uplift rates based on cumulative modelled catchment runoff between 2013-2019? There is a nice study by Liang et al. (2022 – TC) who correlate lake recharge with surface melt inputs in Greenland.
3. **Lake drainage trigger?** Just a thought, but if the ice is relatively thin, could the lake have been trapped by cold based ice? Subsequent cryohydrological warming by surface water getting to the bed, might then be impacting these seals around the Peninsula?
4. **Wider implications.** I like the idea that these subglacial lake drainages might be the result of climate warming, even though it is a bit speculative. And certainly, I buy the idea that surface melt getting to the bed could start to trigger subglacial lake drainage and activate hydrological networks, which is consistent with, for example the Tuckett et al. (2019) paper, and some of the ideas in Bowling et al., (2019) for Greenland (i.e. that lake could activate as the ELA rises). But there is some circularity in your argument as written, as you use the Boxall et al. (2022) paper to support the idea of subglacial hydrological networks (L255) but then suggest the identification of active subglacial hydrological networks supports the Boxall et al. (2022) results. I think the argument would be stronger if you used your data as evidence for surface meltwater getting to the bed of the ice sheet and influencing subglacial hydrological processes; and then use that to support the idea that the seasonality in ice flow that has been observed can be explained by surface melt above the grounding line and not ocean forcing.

Boronina, A., Popov, S., Pryakhina, G., Chetverova, A., Ryzhova, E. and Grigoreva, S., 2021. Formation of a large ice depression on Dålk Glacier (Larsemann Hills, East Antarctica) caused by the rapid drainage of an englacial cavity. Journal of Glaciology, 67(266), pp.1121-1136.

Bowling, J.S., Livingstone, S.J., Sole, A.J. and Chu, W., 2019. Distribution and dynamics of Greenland subglacial lakes. Nature communications, 10(1), pp.1-11.

Liang, Q., Xiao, W., Howat, I., Cheng, X., Hui, F., Chen, Z., Jiang, M. and Zheng, L., 2022. Filling and drainage of a subglacial lake beneath the Flade Isblink ice cap, northeast Greenland. The Cryosphere Discussions, pp.1-17.

- Stephen Livingstone

Specific Comments

L6-7 – I am not sure this is strictly true because the sample size of ice velocity measurements in response to lake drainages is still so small. Certainly, a lot more is known about the hydrological activity of subglacial lakes, so could just remove the dynamic part of the sentence.

L9 – You certainly infer a rapid drainage, but I am not sure you describe it as you only know it occurred pre-2013. I would suggest rephrasing slightly (or see general comment).

L20 – I would suggest modifying to: “including short-term accelerations in ice flow” for this reference as it focuses on seasonal patterns.

L21 – it sounds a bit odd to refer to airborne radio-echo sounding here when talking about ice surface elevation changes.

L33-36 – could cite Kingslake et al. (2017) to support this statement:

Kingslake, J., Ely, J.C., Das, I. and Bell, R.E., 2017. Widespread movement of meltwater onto and across Antarctic ice shelves. Nature, 544(7650), pp.349-352.

L38 – ice shelf – two words.

L41 – Lai et al. look specifically at the vulnerability of ice shelves rather than specific collapses. Might be better to cite a study that has looked at collapse of an Antarctic Peninsula ice shelf and the influence of meltwater, e.g., van den Broeke (2005).

van den Broeke, M., 2005. Strong surface melting preceded collapse of Antarctic Peninsula ice shelf. Geophysical Research Letters, 32(12).

L73 – can you state the resolution you gridded the data at here?

L80 – Do you mean “could not be carried out”, given the “However” at the start of the next sentence?

L101 – Is this fixed surface elevation based on bedrock outcrops? It would be useful to clarify how you did this.

L122 – Would help if this depression was mentioned in the caption or annotated in Figure 3a.

L141 – Can you rule out the reflector being the bed based on the depth of the PICS in 2013 (i.e., an extra ~30 m below the 2019 LiDAR data)?

L157 – Could some of the variation between the northern and southern cliff sections be associated with ice flow?

L164 – I found it confusing that you talk about a decrease in basin depth in one sentence and then elevation increase in the other. You could be consistent across terms here. A space is also needed between 1.18 and m.

L180 – "This suggests either that drainage…"

L191 – The flotation of the ice dam could also have caused an initial sheet flood that then developed into channels, as suggested for some Icelandic subglacial lake drainages based on the hydrographs and modelling – e.g., Flowers et al. (2004)

Flowers, G.E., Björnsson, H., Pálsson, F. and Clarke, G.K., 2004. A coupled sheet-conduit mechanism for jökulhlaup propagation. Geophysical research letters, 31(5).

L228 – It is not clear what "subsequent observations" you are referring to here? Could do with a citation or link to a figure.

L247-250 – This is a long sentence and the final part is poorly phrased. Maybe end as: "… while Prince Gustav Ice Shelf, which they formerly discharged into, has disappeared…"

L254 – Delete "of"

L255 – I find this sentence to be rather misleading – it is a ~15% austral summer speed-up relative to background, and not an increase through time (I am not sure if there is the temporal resolution to determine whether this seasonal velocity response has been happening over a longer time period). And although it could well be surface melt, the Boxall paper also suggest that these changes could be forced by the ocean.

L255-256 – This sentence seems a bit out of place to me. It could be misleading in suggesting you equate your lake drainages with the seasonal speed-up.

Figures & Tables

Figure 1 – I struggle to see most of the yellow dots in panel a. Maybe need a black ring or a colour change. The colour is also a bit confusing against the elevation scale bar (all looks very low elevation). Maybe a simple outline would help with both the above points?

Figure 2 – these are amazing images!

Figure 5 – I am not sure the elevation colour scale helps here as the depression just looks black, with variations induced by the hillshade (I think?). Perhaps remove the hillshade, and consider changing the colour scale to better identify changes. Or you could produce difference maps relative to the 2013 result for 2014, 2016 and 2017.

Figure 9 – It would be helpful to have a dotted line showing the rough outline of the depression; I struggled to place it in panel (a).