Authors' point by point response to comments

We have substantially revised the manuscript and figures based on the constructive comments of the reviewers. The revisions can be seen as track changes in the accompanying Word file.

One of the key changes is the addition of a new co-author (Neil Ross, Newcastle University) who provided us with aerial photographs of the site on, or just before its formation January 2011. These photographs, and Neil Ross's observations at the time, helped us describe the mode of formation in much more detail than was possible from the earlier satellite images.

We respond to the reviewers' comments below:

Reviewer 1

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….

Response: We now have images of the site in January 2011 (Figs. 2a and b) which show the feature during, or just after the collapse event. It also shows surface deformation of the downstream ice revealing the path of the subglacial drainage channel. This latter feature was subsequently infilled by snow and is not visible in later imagery. The photograph shows the ice cliffs in the process of collapse into the subglacial cavity due to loss of structural support. Further blocks of ice have collapsed off the ice cliffs in subsequent years (Figs. 2d and 7).

2. 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.

Response: We have no data to separate meltwater inputs from the catchment, glacier surface, seepage through porous firn or a linked cavity network. However, the 1.18 m infill of the PICS between 22nd and 30th December 2019, at the same time as the catchment fell by 10 to >80 cm (Fig. 6), indicates a likely dominance of surface meltwater inputs to the infill. This coincides with the 32-year record-high surface melt in 2019/2020 recorded on the northern George VI Ice Shelf reported by Banwell et al., 2021. The Liang paper, and the Willis (2015) paper that it cites both provide useful analogues from Greenland which we have incorporated into the discussion.

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?

Response: Yes – this is possible. We have expanded on this in the revised text.

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…

Response: We have rewritten this section with a greater emphasis on surface meltwater getting to the bed of the ice sheet and influencing subglacial hydrological processes. We have also removed the circularity and separated the statements on the role of surface melt vs. ocean forcing.

5. Specific Comments

Response: We have addressed each of the specific comments and other minor observations. Notable ones include:

'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)'.

Response: This mechanism is unlikely now that we have evidence of the pathway of the outflow conduit (Figs. 2 a and b).

'Figures & Tables'

Response: Requested changes made to Figure 1. Figure 5 and Figure 9 have been redrawn as suggested.

Reviewer 2

1. Are there any accessible datasets which could be used to investigate the actual lake drainage prior to 2013?

Response: Yes - we now have images of the site in January 2011 (Figs. 2a and b) which show the feature during, or just after the collapse event. We have revised the site description and interpretations based on these new images. See response to Reviewer 1.

2. The Authors state that a southerly shift of subglacial lake appearance can be related to a changing glacier regime on the Antarctic Peninsula. This might be true, however, how can the Authors be sure that no subglacial lakes exist in these areas prior to 2013?

Response: We are careful to state that the drainage '*may* indicate the southward expression of this phase of glacier response to regional warming'; i.e., this is speculation. We have not observed similar drainage features elsewhere at these latitudes, but this may be due to under reporting. To address this, we add the sentence: ‘However, the presence of these features has not been systematically mapped and may therefore be underreported.’

3. Specific comments

Response: We have addressed these constructive observations in the revised version. The suggested additional references were really helpful and were used to strengthen the discussion. Notable comments include:

‘Are there any accessible datasets which could be used to investigate the actual lake drainage prior to 2013?’

Response: The best evidence we have found are the aerial photographs from 2011 presented in Figs. 2a and b.

‘L100-103: are there any rock outcrops covered by the LiDAR and/or DEM data that can be used for vertical and horizontal alignment and/or validation of the datasets?’

Response: yes – this has been carried out – see revised Figure 7.

‘Fig. 5: I think consecutive DEM differences would be more interesting than the single time steps shown here.’

Response: The Figure has been redrawn as suggested.

‘Are the REMA strips covering the hydrological catchment?

Response: Yes – those parts of the catchments that have good data are now represented in Fig. 5.