Reviewer 1 Comments:

Arthur et al. present a data set of long-term (2000-2020) remote sensing observations of lake extent, depth and volume on Shackleton ice shelf East Antarctica. They find that lakes predominantly form and exist in the ice shelf grounding zone, and that lake extent displays substantial seasonal and interannual variations. They do not find a clear connection between summer temperature or melt and lake extent, which suggests that lake formation is likely associated to episodic strong melt events. This is a well-written paper, and the methods and results (including uncertainties and limitations) are presented in a clear and coherent way. I think it is suitable for publication in The Cryosphere after some revisions, mainly clarifications and some extension of the discussion. I have highlighted some ideas below.

We would like to thank the Reviewer for their work on our manuscript and their encouraging comments.

L67: the ice shelf itself. . . Perhaps rewrite to: ‘the ice shelf surface flow has accelerated’ or ‘speed has increased’. . .

Amended: changed to ‘the ice shelf surface flow has accelerated’.

L170: we found a mean absolute error of 0.007 and a root mean square error of 0.029 between manually-digitised SGL areas and those derived from NDWI What are the units?

Amended: units added (square kilometres, km^2).

L178: just out of curiosity, would you expect variability in lake bottom albedo based on its proximity to rock outcrops, due to eolian deposition of dark material on the surface that is then collected in the lake?

Agreed, enhanced lake bottom albedo and surface ablation have been recorded in western Greenland (Tedesco et al., 2012) and is acknowledged to be an important process on McMurdo Ice Shelf (MacAyeal et al., 2019; Glasser et al., 2014, Banwell et al., 2017; 2019; Macdonald et al., 2020), which is heavily covered with fine debris due to sediment redistribution from medial moraine and rock outcrops. Whilst Shackleton Ice Shelf is mostly ‘clean’ blue ice or snow-covered, we do observe evidence of wind-blown material in meltwater adjacent to the Bunger Hills rock outcrop in our study area visible in Google Earth imagery, though this tends to be in very small ponds rather than the larger supraglacial lakes. We have added some additional sentences to reflect this in the second paragraph of Section 3.4.

L206: 0.25 degree in a regular grid translates to a much higher longitudinal resolution at high latitudes.

We agree that this is the case, and over Antarctica this equates to ~31 km (Tetzner et al., 2019).

L213: The routing analysis is useful, but is highly simplified since it does not allow for flow in the firn and subsequent storage. This should be clearly indicated here, and/or in the discussion.

Amended, sentence updated at Line 382: ‘This could have future implications for ice shelf stability, though we note that our routing analysis does not allow for water storage in the firn (Sect. 5.3).’

L251: likely because of its northerly location, allowing an earlier start of the melt season?

We agree that this is likely to be the case, and have added a sentence at Line 253: ‘We suggest the earlier onset of lake formation reflects an earlier start to the melt season due to the northerly location of this ice shelf.’

L275: in principle, lakes could also drain vertically via fractures. This is discussed later, but not mentioned here.

We have amended this sentence to ‘We observe lakes disappearing in three ways’, to clarify that these are the three mechanisms we observe in this study, while discussing vertical lake drainage in Section 5.2.

L407: The authors briefly discuss the poor correlation between lake extent and temperature and melt. I would agree that these results are not surprising, given the fact that ERA5 nor RACMO2 (at this resolution) cannot resolve the atmospheric phenomena around the grounding zone (katabatic winds, enhanced turbulent mixing around slope break from grounded to floating ice), and -at least as important- do not account for the presence of blue ice or outcrops and their low surface albedo. So, while lake formation might be more associated to episodic melt events – as the authors suggest, since the datasets used here do not even represent the climatology and spatial heterogeneity correctly, it is hard to proof either way. Perhaps it's worthwhile to extend this discussion somewhat.

This is a good point, which we have carefully considered. We used ERA5 in the absence of any long-term local meteorological observations within our 2000-2020 study period. ERA5 has been shown to be accurate in reproducing local climate variability on the Antarctic Peninsula, with only a small negative bias in near-surface air temperature (Tetzner et al., 2019). However, we acknowledge that the resolution of ERA5 cannot resolve these localised processes. Unfortunately, RACMO2 output is not yet available at the higher 5.5 km resolution over this region of East Antarctica, which could better resolve these localised processes. Nevertheless, to our knowledge this is the first time that seasonal supraglacial lake distributions are compared with regional climate model surface melt and (near)surface air temperature in East Antarctica. We think that the strong correspondence between peaks in supraglacial lake extents and peaks in RACMO surface melt is an important finding and indicates that episodic intense melt events are key on this ice shelf for lake formation and evolution. We have extended our discussion surrounding the correlation between lake extent, temperature and melt in Section 5.2.