Response to RC 2:

(The reviewer comments appear in back, the responses are in blue and the proposed changes to manuscript are in ***bold italics***.)

The manuscript presents a time-series analysis from 2012-2021 of ice surface elevation change over a subglacial lake beneath the Flade Isblink ice cap. This analysis is a continuation of the initial study and identification of this subglacial lake by Willis et al. (2015), where the lake was identified via a collapsed ice surface indicating rapid lake drainage. Here, surface elevation data from the ArcticDEM and IceSat-2 is used to infer refilling and drainage of the subglacial lake. Ice surface elevation changes are compared to surface meltwater runoff from RACMO to infer the relative amount of surface meltwater input into the subglacial lake. Finally, a speedup of ice surface velocity downstream of the subglacial lake is linked to lake drainage in 2019.

General comments

This is well structured and generally well written manuscript that presents a new and extensive dataset revealing the filling/drainage cycle of a subglacial lake. The data is well presented and the scientific quality of the work is strong. The methods are mostly clear, however, could benefit from a few clarifications. While the manuscript does not represent novel concepts or methods itself, I believe that the observations can help address important scientific questions regarding subglacial lakes, and thus fits well within the scope of The Cryosphere. However, I find that a lot of details in the data/observations are presented, but not thoroughly discussed (for example the switch in surface meltwater drainage pattern after 2012 or the smaller lake drainage volumes in 2019 compared to 2011). This leaves me wondering about the "so what" question, and I believe that the manuscript could put a bit more emphasis on discussing the implications of the findings rather than mostly only presenting the data. Below are some specific points that I believe can be addressed with some minor revisions to improve the manuscript.

We thank the reviewer for detailed comments and suggestions.

- **Ice inflow**: The concept of surface elevation change due to ice inflow and how this was calculated is not clear. I understand that this is explained in Willis et al, 2015, but I think it would help the reader understand if is briefly explained here.

Thank you for pointing this out. We will add some text to explain more about the "inflow into the basin".

The text added/changed here will be:

"***Previous studies show that a reduction in the depth of the depression would result from the infow of the ice around the basin (Aðalgeirsdóttir et al., 2000; Willis et al., 2015). Therefore, we expect that the basin volume change here is mainly caused by ice inflow and subglacial lake filling. Assuming the subsidence that occurs around the basin outline in a 1500-m buffer region correspond to ice flowing into the basin, we calculate the inflow volume by integrating the surface elevation changes over the buffer area (Willis et al., 2015).***"

- **Ice surface velocity change**: It is unclear why and how this specific small area was chosen to evaluate changes in ice surface velocity. Is this based on where subglacial water routing is expected (e.g. from water routing models)? I believe that it would be better to include a larger area in the analysis, or present velocity time series from multiple locations downstream. Another idea would be to present an additional map (rather than time series) with the velocity difference between January 2019 and July 2019 to infer the velocity changes in the wider region.

Thank you for the suggestion. We do understand that more velocity variations analysis is desirable, and we would very much like to show the velocity change map or velocity change profile. But unfortunately, the coverage of the velocity product is poor in July and August 2019, due to few successful matching pixels in the summer when intense surface melting usually happened. Therefore, we are limited in where we can sample the velocity and choose to calculate the mean velocity from a region (800m*800m) located downstream of the collapse basin.

We will modify the text to clarify why this specific small area was chosen to evaluate changes in ice surface velocity.

"***Due to the limited coverage of the ice velocity product in the summer, a 800m*800m region that is located downstream of the collapse basin is chosen to evaluate changes in ice surface velocity (Figure 6c). We calculate the mean velocity within this region to estimate the velocity time series from 2018 to 2020.***"

- **Figure 2**: I generally like Figure 2 as one can clearly see the surface elevation rising from 2012-2019. However, the surface lowering in 2019 and uplift afterwards is difficult to see. I suggest separating this time period (2019-2021) into a different graph, maybe in another four subplots to the right? If this way the panels become too small, I suggest putting graph a) and the legend to the bottom of the plot.

Thank you for the suggestion. We will improve this figure accordingly.

- **Discussion of surface meltwater drainage change**: It would be great to add the location of the meltwater drainage through the crevasses from 2012 to Figure 5, so that the changes can be observed more clearly. If possible, I suggest marking the location of these crevasses on one of the panels in Figure 5 or adding a separate panel from 2012. I am also curious of why there is a change in supraglacial hydrology (e.g. changes in surface slope?), and how the different drainage locations (crevasses at the edge of basin versus drainage through moulin within the basin) would affect the subglacial lake and basin volume changes. I feel that this change in meltwater routing is presented, but then not fully discussed.

Thank you for the suggestion. We will mark the location of these crevasses in Figure 5. In the revised version, we will also try to discuss the reason of supraglacial hydrology changes and how these changes affect the subglacial lake and basin volume changes during 2014-2016.

- **Discussion of lake drainage 2011 vs. 2019**: The lake drainage in 2019 is briefly discussed, however, I think that there could be a bit more discussion on the difference in water release between 2011 and 2019. For example, the possibility that the lake is behind a bedrock ridge is mentioned (L238-240), but why would there be a release of all water in 2011 and not in 2019? And are there other observations of partial lake drainage elsewhere? Similarly, it would be interesting to compare the volume/time of water increase/drainage to other subglacial lakes, e.g. using the inventory by Livingstone et al, (2022). And finally, what implications could the remaining water in the subglacial lake have? E.g. would we expect another lake drainage in a few years, and would this cause a speedup or potentially a GLOF?

Livingstone, S. J., Li, Y., Rutishauser, A., Sanderson, R. J., Winter, K., Mikucki, J. A., et al. (2022). Subglacial lakes and their changing role in a warming climate. Nature Reviews Earth & Environment, 1–19. https://doi.org/10.1038/s43017-021-00246-9

Thank you for the suggestion. We agree that the initial version did not sufficiently discuss the lake drainage in 2019. In the revised version, we will add a comparison on the water drainage time and volume, and give more discussion about the partial lake drainage and the future evolution of the subglacial lake.

- **Language/grammar**: The manuscript is mostly clear and concisely written, however, there are a few instances where the grammar/language would benefit from some minor editing. I've added a few suggestions in the specific comments, but I probably didn't catch everything.

We regret there were problems with the English. In the revised version, the manuscript will be carefully checked by a native English speaker to make sure the grammar is correct.

Specific comments

L20: I suggest replacing "e.g." with "such as"

Agreed. We will correct this.

L24: I suggest changing to "..,which need to be further quantified"

Agreed. We will correct this.

L38-43, 185: I suggest adding a link to the most recent subglacial lake inventory: Livingstone, S. J., Li, Y., Rutishauser, A., Sanderson, R. J., Winter, K., Mikucki, J. A., et al. (2022). Subglacial lakes and their changing role in a warming climate. Nature Reviews Earth & Environment, 1–19. https://doi.org/10.1038/s43017-021-00246-9

Agreed. We will cite this inventory in the proper place.

L45: Previously the abbreviation GrIS is used with "the" GrIS, I suggest making this consistent throughout the text.

Thank you for catching this. We will use "the GrIS" throughout the text for consistency.

L50-54: The figure caption misses a few articles, e.g. “Background is a Landsat-8…”, “The black box shows the location of b”
Thank you for catching this. We will correct this.

L53: I believe that “Blue lines” be replaced with “Black lines” in the text (Figure 2b).
Thank you for catching this. We will correct this.

L58: I suggest changing to “as supraglacial meltwater was transported to the ice base, refilling the subglacial lake.”
Agreed. We will correct this.

L59: The sentence structure is a bit misleading; the similar glacial setting of the Flade Isblink ice cap subglacial lake to the GrIS is probably not the “main reason” to study this lake. But studying the Flade Isblink subglacial lake can lead to important improvements in our understanding of subglacial lakes beneath the GrIS. I suggest changing the sentence structure to be more clear.
Agreed. We will modify the sentence to improve clarity.
“***Although this subglacial lake is located under the ice cap which is not directly connected to the wider GrIS, its glacial setting is similar to that of GrIS. It is important to investigate its behavior and influence, as it can lead to improvements in our understanding of subglacial lakes beneath the GrIS.***”

L75: I suggest outlining the 1500 m buffer zone for the ArcticDEM co-registration to Figure 1b, so that is more clear where this zone is.
Thank you for the suggestion. We will show this buffer zone in Figure 2.

L84: I suggest deleting “accurate”
Agreed. We will correct this.

L90: add “…(4 pairs) that pass through…”
Agreed. We will correct this.

L91: I suggest changing “pass” to “passing”
Agreed. We will correct this.

L97-98: It is not clear to me what is meant by “original elevations”, please specify.
“original elevations” here means the elevation value directly extracted from the ICESat-2 data. We will modify this sentence for clarify.
“***… and comparing to the original elevations that extracted from the ICESat-2 data for the two adjacent measurements.***”

L110: It is not entirely clear how the elevation change due to ice inflow is derived. I think adding a brief section to explain the concept and how this was calculated would help the reader better understand.

Agreed. We will add some text to explain more about the “inflow into the basin”. The text added/changed here will be:

“***Previous studies show that a reduction in the depth of the depression would result from the infow of the ice around the basin (Aðalgeirsdóttir et al., 2000; Willis et al., 2015). Therefore, we expect that the basin volume change here is mainly caused by ice inflow and subglacial lake filling. Assuming the subsidence that occurs around the basin outline in a 1500-m buffer region correspond to ice flowing into the basin, we calculate the inflow volume by integrating the surface elevation changes over the buffer area (Willis et al., 2015).***”

L120: add “… runoff within the catchment…”
Thank you for catching this. We will correct this.

L123: add “acquired during the 2014-202…”
Thank you for catching this. We will correct this.

L145: change to km^2
Thank you for catching this. We will correct this.

L156: change to …“at a rate of …”
Thank you for catching this. We will correct this.

L169: It is not entirely clear to me what the volume of the collapse basin contains; Is it the volume between the pre-collapse ice surface and the post-collapse (and rising) ice surface, e.g. filled with air? Or is it the combination of the subglacial lake water and the ice column above? It might be good to clarify this. From the explanation of “decreasing basin volume”, I assume it is the basin volume filled with air. It might also be good to then specify on Figure 4 that the Basin volume change is a volume loss, whereas the ice flow and subglacial lake volume change is a volume gain.
Thank you for the suggestion. Indeed, here the volume of the collapse basin means the volume between the pre-collapse ice surface and the post-collapse ice surface. We will add a sentence to clarify this and modify the description of the volume change in Figure 4.

“***We define the volume of the collapse basin to be the volume between the pre-collapse ice surface and the post-collapse ice surface.***”

L200: It would be great to show the drainage pattern in 2012 as compared to 2014-16.
Thank you for the suggestion. We will mark the location of the crevasses where meltwater mainly drained in 2012 in Figure 5.

L255-257: I appreciate the speculation about the “missing” surface meltwater, but is there any evidence for firn aquifers or ice slabs in this area? From a quick check, it looks like there are some ice slabs marked on the Flade Isblink ice cap by MacFerrin et al. (2019) (dataset here:

https://figshare.com/articles/dataset/Greenland_Ice_Slabs_Data/8309777), but it could be worth checking with the exact subglacial lake coordinates.

MacFerrin, M., Machguth, H., As, D. van, Charalampidis, C., Stevens, C. M., Heilig, A., et al. (2019). Rapid expansion of Greenland's low-permeability ice slabs. Nature, 573(7774), 403–407. https://doi.org/10.1038/s41586-019-1550-3

Alternatively, could surface meltwater be routed to the bed through moulins/crevasses at other locations, and then flow somewhere else and not into the subglacial lake? Could other supraglacial lake drainage routes to the bed be observed on satellite imagery?

Thank you for the suggestion. We carefully check the data and find that the ice slabs exist around the collapse basin area, though not exactly under the collapse basin. We agree with the reviewer that cannot rule out the possibility that meltwater flow somewhere else and not into the subglacial lake. While we include the entire catchment area to calculate the total runoff, so no other supraglacial lake would drain into this lake. We will modify text to clarify this.

"***As firn aquifers and ice slabs exist around the collapse basin area (MacFerrin et al., 2019; Miller et al., 2022), part of the meltwater may also stored in the firn aquifers (Forster et al., 2014; Kuipers Munneke et al., 2014) or be restricted to flow within the firn above ice slabs (MacFerrin et al., 2019). Moreover, we cannot rule out the possibility that the surface meltwater flow somewhere else and not into the subglacial lake.***"

L271: This last sentence seems a bit blunt and out of context. I suggest rephrasing to emphasize that the new satellite data has great potential in detecting and monitoring active subglacial lakes beneath the GrIS.

Thank you for the suggestion. We will modify this sentence to

"***We have also shown that the new ICESat-2 data has great potential in detecting and monitoring active subglacial lakes beneath the GrIS.***"