Red Text – author response stating the edits made to revised version of manuscript (line #s correspond to revised version of manuscript with tracked changes)

Editor comment:
I have now also read through the revised manuscript and your response to the reviewer comments. Many thanks for your detailed replies and revisions in response to this. Although I am happy with most of these revisions, the key point raised by the reviewer around the runoff calculation has not been fully addressed - i.e. it is typical to sum the runoff values of the individual cells to get the total runoff. The application of a buffer to take account of the travel time of subglacial water makes sense and accounts for your point that not all the melt will be routed to North Lake on the timescales relevant to the observed speed-ups. But, given you now take account of this lag time, it is not clear why you still calculate an average, which then doesn't represent the actual amount of runoff. Please can you either provide stronger justification for calculating an average runoff in your revised methodology, or sum the runoff across the cells within the buffer(s) you use as suggested by the reviewer? Given this is a key part of the method I feel this point needs to be adequately addressed before I can accept the paper.

We acknowledge that our rationale for using an average instead of a summation of runoff feeding the North Lake hydrologic system was not clearly articulated and are happy to provide further clarification.

It is well established that the subglacial hydrologic system moves meltwater beneath an ice sheet following the hydraulic potential (Flowers 2015). During a speed-up event meltwater beneath the lake basin will enter the system both from the surface as well as from the up-stream parts of the subglacial system. Simultaneously meltwater will leave the system to the down-stream parts of the subglacial system. The balance between these fluxes will control the "excess" meltwater in subglacial system, leading to changes in basal effective pressure that modulate the ice sheet response.

This balance is seen clearly during lake drainage events, where a discrete pulse of meltwater from the surficial lake basin enters the subglacial system and then flows outward on timescales of hours to days (Stevens et al., 2015; Lai et al., 2021). As the meltwater pulse migrates away from the lake basin the dynamic response to the event decays. A similar balance occurs during runoff / melt events, where meltwater entering the system is balanced by meltwater moving away from the lake basin, down the hydraulic gradient toward the ice margin (Chandler et al., 2013). A key variable controlling this balance is the rate at which meltwater is supplied to the subglacial system relative to the rate it moves away (Schoof 2010; Hewitt 2013).

Our approach of averaging the runoff rates near the lake is designed to capture the best estimate for the rate of meltwater influx during the speed-up event. The reviewer's argument for integrating this runoff into a volume estimate would make sense only if all the meltwater in this region migrated beneath the lake basin and then remained there for the entire duration of the speed-up event. However, this is unlikely to be the case given that speed-up events last for several days, during which time meltwater will be constantly entering and exiting the hydrologic system below the lake basin. For example, during lake drainage events (when meltwater influx is focused beneath the lake basin on timescales of ~1 hour) there is a clear signal of outward migration of meltwater away from the primary drainage conduit on timescales < 1 day (Stevens et al., 2015). For this reason, we argue that looking at the runoff rate as a proxy for the rate meltwater enters the system is more important than the total volume of meltwater supplied over the speedup event. We take the average of a six grid-cell area because this provides a better representation of the region over which runoff changes will influence the rate meltwater enters the subglacial system beneath the North Lake GPS array.

We stress that in our previous revisions we adopted the reviewer's suggestion to quantify the speed-up signal relative to the rate of change in runoff compared to the pre-event time period. This was an excellent suggestion as it provides a better proxy for how the rate of inflow to the subglacial system is changing the inflow/outflow balance over the timescale of a speed-up event.

To better highlight out rationale we have modified lines 190–193 and 204–208 of the methods section. If you feel additional clarifications are needed, we would be welcome to suggestions for where to make additional changes to the text.