Editor Review:
The third reviewer has now submitted their report. I tasked the reviewer with evaluating the following statement: it is typical to sum the runoff values of the individual cells to get the total runoff? You will see that overall, they agree with the initial reviewer comment and my concern about how you quantify the runoff. Therefore although I list as minor revisions as it relates just to this one point, I ask that you please better account for how the runoff is calculated following the suggestion(s) of this and the previous reviewer.

Following the third reviewer's suggestion, we revised the runoff methodology to integrate the total melt flux over the supraglacial drainage region feeding the North Lake basin. Specifically, we now calculate the runoff across six local 11-km x 11-km RACMO grid cells to North Lake within the ice-surface catchment basin. The cells included in this area summation were chosen to account for the runoff that makes it to the lake basin on the time scale of a single speed-up event (median event length is 5 days). Following the reviewer's suggestion, we take estimates of open channel supraglacial meltwater flow velocities to determine the spatial extent of the catchment feeding the lake basin. Assuming an open flow velocity of 0.1 m/s or 8,640 m/day (Yang et al., 2018), we calculate that during a single 5-day speed-up event, melt can flow up to distances of ~43 km through the supraglacial system.

To determine which RACMO cells contributed runoff we examined supraglacial streams mapped around North Lake (Joughin et al., 2013). However, these data only extend ~30 km upstream of North Lake (Fig. S3). To identify additional RACMO cells farther upstream that may contribute runoff to North Lake, we first calculated the average sinuosity of the local upstream supraglacial streams in the Joughin et al. (2013) dataset. Taking the ratio of stream length to the straight-line distance from the stream's start to end point we find an average sinuosity of 1.14. Using this value, we calculated the maximum straight-line distance of flow transport to be 37.5 km and included all upstream RACMO cells within this distance from North Lake (Fig. S3). This analysis indicates that six RACMO cells likely feed the North Lake basin on the timescale of single speed-up event. Summing the runoff across these six local grid cells provides an estimate of the total volume of runoff driving transient acceleration at this site (Fig 1d,e). We also estimated the maximum daily run-off rate experienced by the lake basin over the course of a speed up event. To calculate the maximum rate, we used the runoff over a single RACMO grid cell, which most closely corresponds to the distance meltwater can travel in a single day (Fig. S3).

We hope that this approach will address the issue of summing the runoff over the supraglacial drainage basin.

Referee #3 Review:
I am tasked with evaluating the following statement by the editor: it is typical to sum the runoff values of the individual cells to get the total runoff?

This is important to the main conclusions of the manuscript, which are (to borrow a reviewer's words) that "there is no relationship between the magnitude of runoff and amplitude of speed-up events" (also a central statement in the abstract). If this statement is to be accurately evaluated, it is important to accurately quantify the runoff driving these speed-ups. As the authors point out, "effective runoff" coming from lake drainages is accurately quantified by measuring the water volume in the lake and its drainage time. Perhaps counterintuitively, it's the day-to-day runoff that is more loosely quantified here, because there is a travel delay between the production time of the runoff and its arrival to the moulin / subglacial system.

The reviewer initially proposed an overestimate of the runoff reaching the moulin / subglacial system during the late-season event (summing all grid cells in the large catchment), which is too high because of delays in surface routing, as the authors point out. But the authors counter with an underestimate (averaging runoff, amounting to allowing input from only one grid cell, sized 11 x 11 km). This is too low because over a 5-

day* melt event, supposing 0.5 m/s flow velocity in a river, melt from ~50 km away could reach the moulin. Of course, much of the melt has to make its way _to_ a river first, which will slow the travel speed considerably. I think that the authors' decision to use the closest ~6 grid cells (travel distance of 20-30 km over 5 days*) is probably a reasonable compromise. I'd like to see some specific calculation of this distance using known or modeled supraglacial routing travel times or speeds to be sure.
See above response and lines 193–250 of the revised manuscript for a description of how we calculate supraglacial routing. Overall, the resulting catchment region is fully consistent with the reviewer's expectations.

I was confused by the authors' use of the _subglacial_ travel speed in their calculation for the distance over which they believe melt could reach the moulin (and thus the subglacial system) during the short runoff event. I can't see how the distance traveled by existing subglacial water would affect this. The authors make a (correct) point that it's the net flux in the subglacial system (output minus input) that's key during an event; however, with the base subglacial outflow assumed to be steady, the only dynamic term here is the surface input. So it's really the _supraglacial_ travel speed that should be considered, as I described above.
Following the reviewer's suggestion, we have revised the manuscript to focus on supraglacial flow velocities; however, we note that open channel flow in both supra- and sub- glacial systems have been estimated to be on the same order of magnitude (O 10^{-1} m/s).

I have reviewed the manuscript in its evolving versions and each review/response. It is still not clear to me why the authors _average_ the RACMO input across cells rather than _summing_ it across all cells that would be likely to contribute over a ~5-day event. I have to agree with the reviewer that using an average like this is _not_ standard practice and that a more careful accounting is necessary. Ideally, this would involve a supraglacial routing routine. This would help the authors avoid another potential pitfall, which is ignoring the runoff in the distant reaches of the catchment produced several days before the event in question, which will be reaching the moulin during the event. I do not think this is large compared to the local runoff generated during the event, but I do think it's likely to be substantial (10-30%).
Here again, we have revised our methodology following the reviewer's recommendation to sum the runoff over the 6 RACMO grid cell area (described above). However, we feel the implementation of a full supraglacial routing algorithm to generate a hydrograph for the North Lake moulin is beyond the scope of this study, as it requires a higher resolution DEM than is available for the 2011 & 2012 melt seasons and a runoff model with higher spatial and temporal resolution.

Since the manuscript's conclusions rely foundationally on the relationship (or lack thereof) between velocity response and runoff, I think the authors need to do a better job quantifying the runoff.

Some other notes I had while reading these materials:

The authors argue that the difference between which cells are included is small, citing Figure S2. However, that figure clearly shows (by my visual estimate) that the 44-cell average method yields runoff about 20%+ larger than the 1- or 6-cell average method. This is not trivial if we are talking about correlations between runoff and velocity response. For comparison, the reviewer's suggestion of the 44-cell sum would be much, much larger than this - 4300%. And a 6-cell total would be 500% larger.
After implementing the reviewer's approach for integrating melt (described above), this issue is no longer relevant in the revised manuscript.

*I had trouble in the manuscript learning the approximate duration of the runoff events. I found the reviews referring to 5-day events, but I would like to see this timescale reported in the manuscript. Even additional x-ticks in the Figure 1 panels would be helpful.
We have added a supplemental figure (S2) illustrating the duration (days) of each event.