

Black Text – original comment from reviewer (line #s correspond to previous draft)

Red Text – submitted response to review comment (line #s correspond to previous draft)

Blue Text – edits made to revised version of manuscript (line #s correspond to revised version of manuscript with tracked changes)

Reviewer 1

1. Regarding the 2011/238 event and the calculated runoff, have the authors look into if there are other factors to consider in their runoff estimate such as precipitation (rainfall) that occurred over this period to contribute to the larger velocity response?
 - Yes, it is likely that a precipitation event occurred around the 2011/238 event due to precipitation observations (Doyle et al., 2015; Loeb et al., 2022). A week of warm, wet cyclonic weather was observed in early September 2011, resulting in enhanced surface melt and rainfall (Doyle et al., 2015). However, Doyle et al. (2015) found the magnitude of runoff and precipitation to still be less than that during the mid-melt season. As a result, Doyle et al. highlighted the contribution of an inefficient subglacial drainage system to the acceleration of ice flow during the late season. We will clarify the role of precipitation in the 2011/238 event and add these key points and references to a revised version of the manuscript.
 - Added text on lines 428-432
 - Added Loeb et al., 2022 to references
2. L70: The following citation should be added in describing the limited role of conduit growth during lake drainages: Dow, C. F., Kulesa, B., Rutt, I. C., Tsai, V. C., Pimentel, S., Doyle, S. H., As, D. Van, Lindbäck, K., Pettersson, R., Jones, G. a., & Hubbard, A. L. (2015). Modeling of subglacial hydrological development following rapid supraglacial lake drainage. Journal of Geophysical Research : Earth Surface, 120, 1127–1147. <https://doi.org/10.1002/2014JF003333>
 - Thanks for pointing out this study. We will add the citation in a revised version of the manuscript
 - Added citation to L76
 - Added Dow et al., 2015 to references
3. L113: What is the ice thickness here?
 - ~980 m below North Lake (Das et al., 2008). We will add to L113 in a revised version of the manuscript.
 - Added to L131
4. L118: What is the baseline distance from KAGA?
 - ~55 km. We will add “KAGA base station on bedrock ~55 km away... (Bevis et al., 2012; Stevens et al., 2015).” to L118 in a revised version of the manuscript.
 - Added to L137
 - Added Bevis et al., 2012 to references
5. L122: Only 14 stations are shown in Fig 1, where is the 15th?
 - Station FL03 was inadvertently left off Fig 1; it is located on the western side of the array. We added its position to a revised version of Fig 1 in the pdf supplement of this comment response.
 - Added FL03 to revised Figure 1
6. L113-122: What is the uncertainty in the GPS station positions? (Horizontal and vertical)
 - Horizontal (vertical) 1-sigma errors are consistently +/-2 cm (+/-5 cm) across all stations and years (Stevens et al. 2015). We will add in a revised version of the manuscript.
 - Added to L138-139
7. L180: I suggest including the drainage basin outline in the study area figure.
 - Good suggestion. We added to a revised version of Figure 1 (pdf supplement).
 - Added to revised Figure 1

8. L245: Do you mean 168.85 is the end date for the pre-speed-up event? It looks like that date corresponds to the beginning of the orange bar in Figure 5. What is the start date for the pre-speed-up event velocity determination? It does not appear to be at the beginning of the x-axis shown in Figure 5 due to the location of the blue bars (calculated values) with respect to recorded velocities in that window (particularly at stations NL01, NL02, and NL06).
 - Correct, DOY 168.85 is the end date for the pre-speed-up event. The start date varies from 165 to 166 across the stations based on data availability at each sensor location. We will clarify this in a revised manuscript.
 - Revised L306 and revised Figure 5 x-axis
9. L290/Figure 7: Symbology on y-axis does not match text where the subplots are referred to as normalized
 - We will change reference in L290 from “(Fig. 7a and b)” to “(Fig. 7b)”
 - Revised L369
10. L318: Andrews et al., 2014 did not use in situ observations to show that channelization could account for decreasing velocities in the early melt season because they were only able to instrument moulins (to monitor the channelized system) during the middle of the melt season (between doy190-200 of each year) in mid-July.
 - Thank you for clarifying. We will revise L318 to “hypothesize” from “show.”
 - Revised L398
11. L323: weakly-connected cavities are not “low-water pressure” because the channelized drainage system operates at lower pressures than even drained or hydraulically connected cavities. I suggest rephrasing to something like “these dewatered cavities maintain lower pressures than isolated cavities” or similar.
 - We will revise L323 to “these dewatered cavities maintain lower pressures than isolated cavities.”
 - Revised L403
12. Fig 1: (a): The font size for the scale bar is too small to read. (b,d): What is the rationale for cutting off the x-axis bound on the date indicated? The last speed-up/melt event is close to that date so does it represent the end of the melt season or is there more variability after this point? (B,C) would benefit from the addition of the velocity at each individual station (in thin lines) that is then overlaid by the blue average line shown. This may be too visually cluttered and if so, I would appreciate a larger version in the supplement with this information as I am curious if some stations have a consistesntly lower amplitude or higher amplitude response to the melt events.
 - See revised Figure 1 (pdf supplement) with increased scale bar font. We cut off the x-axis when winter velocities were established and melt had ceased and will note this in a revised Figure 1 caption. We also made a new figure (pdf supplement) showing all station velocities plotted on top of the average velocity across the array. Small systematic variations above and below the average array velocity can be seen in this figure (which will be added as a supplement to a revised manuscript). Note that Figure 11(pdf supplement) also displays the variability at each station and shows that in general stations in the north have lower amplitude and stations in the south have consistently higher amplitude response to melt events.
 - Revised Figure 1 and added Figure S1
13. L183: Could other moulins not be identified from satellite imagery (or field observations) to remove this area from the drainage basin?
 - It is challenging to identify all moulins across the region. Further, the input of melt from nearby moulins is likely contributing to the melt-induced speed-ups recorded across the North Lake GPS array. Thus, we feel the most robust estimate for the potential melt contributing to the velocity response, is to consider the average runoff across all grid cells in the drainage basin.

14. L216: melt events should be labeled in Figure 1 (or colored to correspond with in-text citation), this would make it easier for the reader to reference the figures from within the text.
- Good suggestion. Please see the revised Figure 1 (pdf supplement), which shows the DOY 180 event in blue, representing a distal lake drainage (flood event). All other grey bars correspond with melt events.
 - Revised Figure 1
15. Figure 2: I suggest labeling the GPS stations to more easily compare with other figures (e.g., Figs 4,5). Also, this figure includes more stations than are included in the study area Figure 1.
- We will add station labels in revised version of Figure 2. As noted above, the revised Figure 1 now shows the missing sensor (FL03).
 - Revised Figure 2
16. Figure 3: It would be helpful to emphasize the longer duration of the x-axis in subplots b and d for event 2011/238 by making the axis length scale the same as in plot a. I understand the purpose of the plot is to compare the displacement magnitude, however, it could be misleading to readers. At minimum I would suggest adding in daily minor tick marks to the x-axis in b&d.
- We will add daily ticks to x-axis in subpanels b&d. Event duration of late season melt event is longer than the rapid lake drainage, so decreasing the duration shown on the x-axis would not capture the peak displacements.
 - Revised Figure 3 by adding daily ticks to panels b and d
17. Figure 4: The text within the figure is very difficult to read, consider increasing the font size and using a black rather than grey. (Same comment for Fig 5). I am not sure what stations or locations subplot label FL03 are referring to, a station with this name is not included in Figure 1 (maybe the 15th missing station?)
- We will make font larger in revised version of Fig 4, 5, and 9 by reorienting the figures to consist of 3 columns and 4-5 rows. See the revised version of Figure 1 (pdf supplement) for the addition of sensor FL03.
 - Revised Figures 4, 5, 10 (Figure 10 was formerly Figure 9)
18. Figure 5: What is the length of time used to determine V_{pre} in this figure? From the figure it appears that it is <1 day of data, however, I think it is longer considering the methodology. I suggest extending the x-axis to show the full velocity window used to determine the V_{pre} value. I am not sure what stations or locations subplot label FL03 are referring to.
- The time window varies station-to-station, most notably in the early season, when the sensors began collecting data over a range of days (between DOY 162 to 167) depending on their deployment. We will revise x-axis to a consistent start date of DOY 162; however, this will be prior to the collection of data for some stations. FL03 was added to a revised Figure 1.
 - Revised Figure 5
19. Figure 9: The axis for NL09 is different from the others, consider making them all uniform for an easy visual comparison of station response.
- We will revise the y-axis to match 0–450 m/year in revised version.
 - Revised Figure 10 (formerly Figure 9)
20. Figure 11: Great figure, I am glad this analysis and visualization was included in the manuscript.
- Thank you!

Reviewer 2

1. Firstly, I think the analysis of the correlation between runoff and speed-up magnitude in Section 3.3 could be improved. It is unsurprising that there is no correlation between runoff magnitude and speed-up magnitude, as it is the preceding melt conditions which “define” how much runoff the subglacial drainage system can accommodate (e.g., Hoffman et al. 2011). Hence why we see large dynamic responses from “spring-events” or supraglacial lake drainages, as they provide a large input of meltwater relative to the preceding period. This has been well established (e.g., Bartholomew et al., 2010; Hoffman et al. 2011; Schoof 2010). A suggestion would be to shift the focus away from runoff magnitude (mean, max and total) and instead focussing on rate of change of runoff or runoff variations from preceding conditions to the melt event and/or estimated lake drainage meltwater volume. I believe this is especially important, as currently the lack of a relationship between runoff magnitude and speed-up magnitude is one of the main findings, and this is already well known/ established.
 - Excellent suggestion. We agree that the preceding melt conditions may play a role in determining how much runoff the subglacial drainage system can accommodate and should be considered when interpreting the velocity responses. To address this, we created a new figure, incorporating the rate of change of runoff (ΔR and ΔR_n) alongside speed-up (ΔV), relative speed-up (ΔV_n), and std. of ΔV and ΔV_n . We used the same methodology to estimate ΔR (max runoff – pre-event runoff) & ΔR_n (max runoff /pre-event runoff) as was used to determine ΔV & ΔV_n . We find that there is a positive correlation between ΔV & ΔV_n and ΔR & ΔR_n , similar to the relationship between ΔV & ΔV_n and day-of-year (DOY) (Figure 7). We also observe a negative correlation between the standard deviation of ΔV & ΔV_n and ΔR & ΔR_n . Both figures can be found in the pdf supplement of this comment response
 - The results shown in the Rate of Runoff Analysis 1 (pdf supplement) highlight the interplay between the velocity response, changes in runoff, and seasonal changes in the hydrologic system (e.g., subglacial drainage state and the number of open moulins). However, a complication in separating the main factors driving the velocity response is the positive correlation between ΔR & ΔR_n and DOY (Rate of Runoff Analysis 2, pdf supplement).
 - Because these variables are correlated with one another it is not surprising that they have similar relationships with ΔV & ΔV_n . However, masked in this relationship is the fact that ΔR & ΔR_n significantly underestimate the true runoff for the 3 rapid lake drainages (because the RACMO runoff estimates do not account for the meltwater stored in the lake basin). This implies that early season lake drainages have very large values of ΔR & ΔR_n , but small values of ΔV & ΔV_n , inconsistent with the correlations seen in the Rate of Runoff Analysis 1 figure. Thus, while we agree that changes in the rate of runoff may play a role in controlling the system response (particularly for runoff-driven events), we feel the temporal evolution of the melt system remains a key variable in the overall response of the ice sheet to meltwater forcing. We will address these issues more fully in a revised manuscript and propose including the figures above to highlight these points.
 - Added change in runoff figure, analysis, and discussion L450-494 (Figure 8, Figure S4).
2. In its current form, the novelty of the study is limited, as numerous previous studies have used GPS-derived ice velocities to infer changes in the subglacial drainage system as the melt season progresses. The data and methods have also been previously reported on, and I do not think this study provides new inferences about the subglacial drainage system evolution by applying the data, in the way that it does, to look at differences between melt-induced and lake drainage speed-up events. The main aspect of this the study which could provide new insights on the evolution of the subglacial drainage system compared to previous studies, is the use of a dense array of GPS

stakes. This setup enables the examination of spatial variability in the dynamic response to melt events, which has been looked at in this study. However, the analysis of this aspect is currently limited and could be expanded upon to make it the main purpose.

- We concur that the main focus of our study is how velocity varies across individual events throughout the melt season. However, our study also analyzes the spatial variabilities across the GPS array during individual events and throughout the melt season, which has not been previously reported. We document that local lake drainages tend to have greater variability than regional melt events (Figures 4,5, and 9). Additionally, the sensors in the southern half of the array tend to have greater velocities compared to the north throughout the year, corresponding to a bedrock basin (Figure 11, pdf supplement). We will further emphasize the spatial variability across the array in a revised version of the manuscript.
 - Furthermore, the novelty of this study comes from the characterization of a late season melt event at DOY 238. Although late season melt events have been previously observed, this study provides the first documented coherence of speed-up over the spatial scale of several lake basins. We also provide further constraint to the timing of hypothesized channel closure.
 - Added additional spatial variability discussion on L19-20 and L646-748
3. I don't quite follow how you have compared the magnitude of runoff from the late-season melt events to the magnitude of meltwater delivered to the bed from the lake drainage. The meltwater flowing through the system during the late-season melt event will be the runoff from the calculated surface catchment, plus all the runoff entering the subglacial system upstream of this (especially as you state the events last multiple days). The runoff is likely higher than you estimate, but still less instantaneous than the lake drainage. (L203)
 - The magnitude of meltwater delivered to the bed during the lake drainage was determined from the known volume of the North Lake basin and its inferred area of basal distribution. By dividing the volume of the lake basin by the area of the subglacial "blister," we were able to deduce a "effective thickness" (mm of w.e.) of melt at the bed. Further, to directly compare this value to daily RACMO data, we converted the 5-hour duration of the lake drainage to a 24-hr time period. In the middle-to-late season, we utilize RACMO runoff (mm of w.e. per day) to estimate the melt throughout the season. We calculate the average runoff across the drainage basin that North Lake resides in.
 - Additionally, as discussed above, we determined the rate of change in runoff using the same methodology to estimate velocity and relative response: ΔR (max runoff – pre-event runoff) & ΔR_n (max runoff / pre-event runoff). The pre-event runoff is an average daily runoff across the pre-event time period described in the manuscript.
 - New change in the rate of runoff methodology defined on L452-457
 4. The structure and coherence of the writing in the manuscript could be tighter. Currently, there is a lot of repetition of the main findings and introduction paragraphs throughout (e.g., L92-101, L309-306). To improve the readability and impact, the ideas presented in the discussion could be also be condensed.
 - Thank you for this suggestion to improve the clarity of the manuscript. We will condense text throughout Introduction, Results, and Discussion, notably in L92-101 and L306-309 in a revised version of manuscript.
 - We have streamlined manuscript and reduced repetition throughout the revised manuscript
 5. I am slightly confused how Section 4.2 in the discussion fits into the rest of the manuscript, as it seems to come out of nowhere.
 - We apologize for the abrupt transition. The latter half of Section 4.1 utilizes annual trends across the GPS array (Figure 7) to characterize and infer the timing of the distinct

phases subglacial drainage system. However, the DOY 180 event (described in Section 4.2) consistently has the largest variability, which diverges from the annual trends described in Section 4.1. Thus, the goal of this section was to further explore the origin of this variability, and in doing so we for the first time identify the response of a local GPS network to a distal lake drainage event. We will better motivate this discussion in a revised manuscript.

- The transition to Section 4.2 is on L381-384. After describing the general trends of Figure 7, we point out the outlier on 2012/180, which we state will be discussed further in Section 4.2. This is an appropriate transition as it is prior to the discussion, and after the anomaly event is identified in the results.
6. Title: For consistency with the manuscript and other literature, perhaps “subglacial hydrologic system” can be changed to “subglacial drainage system”.
 - We will update in a revised version of the manuscript.
 - Revised to subglacial drainage system throughout manuscript.
 7. L19: Change “transients” to “transient speed-up events” or similar
 - We will update in a revised version of the manuscript.
 - Revised velocity transients to transient speed-ups throughout manuscript.
 8. L23: I’m not sure I follow what you mean by “basal transmissivity” here, can you instead say “increasing basal friction” or similar. Also, the reason for the large magnitude speed-up during this time of year, is the reduced capacity of the subglacial drainage system to “handle” this sudden extra melt, not the fact that an increase in basal friction has led to lower ice velocities. Perhaps these sentences could be rephrased to make this clearer.
 - “Basal transmissivity” (or “basal hydrologic transmissivity”) refers to “the ability of the meltwater to move through the basal hydrologic system” (L57) and is formally defined as the hydrologic conductivity multiplied by the saturated layer thickness (Lai et al., 2021). Thus, “basal transmissivity” does not refer to basal friction and a decrease in basal transmissivity is consistent with the understanding that in the late-season the subglacial system has a reduced capacity to handle a sudden influx of extra melt. We will add the formal definition to a revised version of the manuscript to clarify this concept.
 - Added formal definition to L62-64
 9. L45: Change “ice-sheet” to “basal”?
 - We will update in a revised version of the manuscript.
 - Revised L46
 10. L46: Here and multiple other times you use “basal/subglacial” “drainage/hydrologic” interchangeably. Can you please stick to just one? I suggest just using “subglacial drainage system”.
 - We will update to “subglacial drainage system” in a revised version of the manuscript.
 - Revised to subglacial drainage system throughout
 11. L56-60: This sentence is quite long and hard to read, can it be rephrased?
 - Agreed. We will revise to “These observations suggest that the hydraulic transmissivity (i.e., the ability of the meltwater to move through the basal hydrologic system) becomes more efficient beneath the lake as the melt season progresses (Lai et al., 2021). Furthermore, these findings are consistent with model predictions (Schoof, 2010) and observations (Chandler et al., 2013; Andrews et al. 2014; Andrews et al. 2018) premised on a seasonal evolution towards a more channelized subglacial meltwater system with increasing meltwater input (e.g., Schoof, 2010).”
 - Revised L62-66
 12. L70: Could you provide a timescale for creep closure of subglacial channel closure (e.g., from Chandler et al., 2013)? It will help with the interpretation in your discussions

- We will add “on timescales of hours to days (Chandler et al., 2013)” in a revised version of the manuscript.
 - Revised on L76
13. L78: With no evidence, you can’t be sure they are an “order-of-magnitude smaller” so perhaps remove. The main differences are the rate of meltwater delivery between the two.
- The reviewer is correct that the rate of meltwater delivery between the two is the main difference. However, this line is referring to the volume of melt difference between the melt stored in the North Lake basin and the magnitude of melt reaching the bed from a regional melt event. We will revise to “smaller” as this discrepancy is not always an order-of-magnitude, depending on if you consider the maximum, mean, or integrated melt “thickness” (proxy for volume). See below for these reference values; also shown on Figure 6 of the manuscript.
 - Lake Drainage Effective Runoff (mm of w.e./day): 1650-3000 (Max), 110-200 (Mean), 330-600 (Integrated)
 - Regional Melt Events Runoff (mm of w.e./day): 13.9-60.1 (Max), 7.6 to 40.3 (Mean), 70.8 to 273.8 (Integrated)
 - *We correct for the difference in the rate of delivery by converting all runoff to daily timescales.
 - Revised to “smaller” from “order-of-magnitude smaller” on L100
14. L89: Can you state the distance from the terminus?
- ~25 km. We will add in a revised version of the manuscript.
 - Added distance on L113
15. L91: I know that the NIF is described in the methods, but because it is not a commonly used method, perhaps brief detail on what it does could be added here, e.g., “we use a NIF to infer basal slip...”
- Good point. We will add details on our use of the NIF in this paper, such as, “we use a Network Inversion Filter (NIF) (Stevens et al., 2015) to infer the basal slip and basal uplift of a late-season, transient speed-up event and compare to an early-season lake drainages at the same location.”
 - Revised L114-116
16. L97: Rephrase “ice-response indicators”
- We will update in a revised version of the manuscript.
 - Revised to “values” on L118
17. L101: This sentence is largely a repeat of what has previously been said in this paragraph. I wonder if this paragraph can be cut down, and instead changed to focus on what your objectives are. L92-101 currently reads more like a conclusion.
- We will remove L93-95 and L97-100 to shift focus from findings to objectives. L101 refers to our hypothetical model construction, which has not yet been mentioned in the paragraph.
 - Removed findings from paragraph L118-126 so that it only describes the objectives
18. L101: The literature review provided in the introduction is clear, but I would suggest also referencing Schmidt et al. 2023 and Hoffman et al. 2011, which are currently not in the reference list but are two very relevant papers to this study.
- Thank you for this suggestion. We will incorporate references in a revised version of the manuscript.
 - Added Hoffman et al 2011 to references and L56, L58, L64-65, L390, L446
 - Added Schmid et al 2023 to references and L44, L65, L103-104
19. L175: What is the timestep of the RACMO data, hourly or daily?
- Daily, we will state the timestep in the revised manuscript.

- Added “daily” to L223
20. L181: Change “points” to “grid cells”
- We will update in a revised version of the manuscript.
 - Revised L226-227
21. L181: Surely you need to calculate the sum of all grid cells in the catchment to get a measure of the total runoff entering the subglacial system?
- Yes, we sum all grid cells in the catchment then divide by the number of cells. This average across the catchment basin is significantly smaller than the runoff collected in the North Lake basin that rapidly drains during a lake drainage event. As part of the revisions described above, we use this approximation to determine the pre-event runoff by averaging the daily runoff across the time-period preceding the speed-up event. We found the maximum event runoff during the speed-up event. The maximum runoff and pre-event runoff were used to determine the rate of runoff (as described above).
22. L190: Change “total” to “integrated” to keep consistent with your plots, or vice-versa
- We will update to “integrated” in a revised version of the manuscript.
 - Revised L235
23. L218: The phrase “plotted relative to the onset of the speed-up event” is confusing as it sounds like you have plotted basal slip relative to the timing of the speed-up onset. I believe you have actually plotted it relative to the basal slip before the event? Although in the caption for figure 2 you state that it is the maximum basal slip of each event? Please can you improve the clarity of this sentence and the caption of Figure 2.
- Sorry for this confusion. A pre-speed-up event time period is needed to define the background ice speed and direction for the NIF. Figure 2 then shows the maximum extra basal slip relative to this background ice velocity (Stevens et al., 2015). In other words, if the ice were to continue to move at exactly the same rate as during the pre-speed-up event period, the NIF would report no "extra basal slip". This will be clarified in a revised manuscript.
 - Revised L268-269
24. L261-268: This paragraph is a repeat of the previous two and could be omitted
- Good suggestion. This paragraph will be removed as it is expanded upon in the discussion as well.
 - Removed paragraph on L321-328
25. L276: Can you just say “average delta V” here and throughout to make it easier for the reader to follow? And perhaps rephrase “does not exceed” as you are referring to an average not individual data points.
- $\overline{\Delta V}$ is a standard notation for average that is also used in Figure 11 when we define $\overline{\Delta V}_{\text{array}}$.
26. L311: Delete “Recently,”
- We will update in a revised version of the manuscript.
 - Removed word on L391
27. L336: I am not sure you can be confident the volume of meltwater is less, just that the delivery is less instantaneous than during a hydro-fracture lake drainage.
- See L78 response (#13). The delivery is less instantaneous; however, we also provide an approximation of the melt volume delivered to the bed at a lake drainage and a melt event. We adjust for rate of delivery by converting to daily timescales, including the rapid lake drainage. Specifically, the DOY 238 event has notably less melt than the lake drainage as shown by the “thickness” of melt at a lake drainage and as averaged across the drainage (i.e. at any given grid cell across the catchment basin):

- Lake Drainage Effective Runoff (mm of w.e. per day): 1650-3000 (Max), 110-200 (Mean), 330-600 (Integrated)
 - DOY 238 Runoff (mm of w.e. per day): 29.5 (Max), 8.8 (Mean), 70.8 (Integrated)
28. L337: Again, I think it is the variation in meltwater delivery to the bed that is important here, not the total runoff/drainage volume
- See discussion above regarding our new analysis of the sensitivity of the ice sheet velocity response to changes in the rate of meltwater delivery.
29. L344: It would be good here to give a measure of the amount of runoff in the preceding period before the speed-up event, as this is the most important factor in inducing the dynamic response. Additionally, do you have an estimate for the ice thickness under the GPS array – it would be helpful to add this information to your introduction.
30. Important to highlight that the runoff drops close to zero for a prolonged period before the late-season melt event. Basically, a spring event but with an established supraglacial drainage system.
- We will address runoff preceding speed-up with the revised rate of runoff figures (pdf supplement) and will add ice thickness (~980 m below North Lake (Das et al., 2008) to introduction in a revised version of the manuscript.
 - ~980 m ice thickness added to L131
 - Runoff methodology, discussion, and figure added (per RC2 revision #1)
31. L347: I would argue that the subglacial drainage efficiency is a result of the preceding runoff magnitude. Please provide a reference(s) for the hypothesis you are referring to.
- We will add Schoof (2010), Hoffman (2011), and Hewitt (2013) references, which emphasize the role of the subglacial system in describing sliding behavior.
 - Added references to L445-446
32. L354: Can you clarify what you mean by the “style” of runoff delivery? Is this supraglacial lake drainage vs normal runoff routing through moulins?
- Sorry for the confusion, but your understanding is correct. Here “style” refers to a rapid supraglacial lake drainage injecting a large volume of melt to the basal system in a few hours versus the mid-late melt season events, which consist of normal runoff routing through moulins on longer timescales. We will clarify this in a revised manuscript.
 - Revised L497
33. L340: Change “basal” to “subglacial”
- We will update in a revised version of the manuscript.
 - Replaced on L436
34. L385: This study does not report on annual ice motion at North Lake
- We will revise “as noted” to “similarly.” We calculate the displacement contribution of the late season melt event to annual ice motion at North Lake to directly compare our results at North Lake to the Ing et al. (2024) findings regarding the relatively small impact of late-season speed-ups on annual ice discharge in western Greenland.
 - Revised L434
35. L391-407: The conceptual model presented here is largely a repeat of models that have already been established (e.g., Hoffman et al. 2016; Davison et al. 2019), so I question whether this paragraph and Fig. 8 provides anything new and is necessary?
- Our model emphasizes the role of many open moulins in the late season, and couples this with the closure of channels. Thus, we emphasize the role of a small melt volume allowing for significantly larger, yet uniform, velocity response in the late season.
36. L392: Change Figure 8 to Fig. 8?
- We will update in a revised version of the manuscript.
 - Revised on L542 (now Fig. 9)
37. L402: Remove “ice sheet” as the processes you are describing here are specific to your site (lake drainages)

- We will update in a revised version of the manuscript.
 - Removed on L552
38. L409-413: I'm not sure if there is anything novel added here.
- We are describing our results in the context of the ideas of Andrews et al. (2014) and Hoffman et al. (2016) and defending our reasoning for the closure of channels around DOY 238. Evidence of the closure of channels in this region has not been previously described.
39. L460: I'm not sure these results provide "preliminary insights", with many previous studies reporting on the evolution of the subglacial drainage system in this area.
- Previous studies in this area do not describe the subglacial drainage system beyond DOY 210. We provide preliminary insights of the drainage system beyond that observable via a lake drainage study.
40. L461-463: This sentence is hard to read at present, can it be rephrased?
- We will revise to "We find enhanced ice-flow sensitivity to melt input in the form of longer, more uniform, velocity responses during late-season melt events compared to early- to mid-season lake drainage or melt events."
 - Revised on L633-635
41. L471: Isn't this just because there are more of them?
- No, this was determined considering individual events. Each individual melt event, generally, has a longer duration and greater velocity response amplitude (seen in Fig. 7a and b).
42. L680 (Figure 2): It is difficult to distinguish the black GPS triangles from the black arrows, perhaps you could use a different colour?
- We will change GPS triangles to grey.
 - Revised Figure 2
43. Figure 1: Please add lat/lon coordinates to the border of (a) and other figures where appropriate. Change y-axis of (d and e) to Daily runoff (mm w.e.). Change units in (b) and (c) to m year⁻¹. This and for all figures change "a)" to "(a)".
- Please see the revised version of Figure 1 (pdf supplement). We added lat/lon coordinates to the border of panel (a), changed the y-axis (d,e) to "Daily runoff (mm w.e.)," and "m year⁻¹," and revised labels to "(a)." We will implement similar changes to Figures 10 and 11.
 - Revised Figure 1
44. Figure 6: I find Figure 6 somewhat hard to interpret. I believe the point of this figure is to relate change in velocity of speed-up events to the mean runoff of the event, the maximum runoff of the event and the total runoff of the event. All of which show little or no correlation. I wonder whether comparing the change in velocity to all of the mean, total and max runoff is necessary. What seems lacking is the comparison to the change in runoff, as this is the main factor that causes the speed-up (see Hoffman et al. 2011)
- Your understanding is correct, we find little or no correlation between change in velocity and various measurements of event runoff. We address the change in the rate of runoff in a revised version of Figure 6 (pdf supplement).
 - Added Figure 8
45. Figure 8: Can you make the figure labels (a, b, etc) bigger, they are currently hard to read.
- We will make figure labels larger in a revised version of Figure 8.
 - Revised Figure 9 (formerly Figure 8)
46. Figure 10: Here and throughout change "m/year" to m year⁻¹ or m yr⁻¹. Please add coordinates to map border.
- We will revise to m year⁻¹ and add coordinates to map borders in a revised version of Figure 10 (similar to revised Figure 1 and Figure 11).

- Revised Figure 1, 11, 12 (formerly Figures 10 & 11)
47. Figure 11: Please increase font size of figure labels, scale bar and legend in b. Please can you move the figure labels to the left of each plot.
- We increased font size of figure labels, scale bar, and legend (b), and moved the (a) and (b) labels to the left side of the plots in a revised version of Figure 11 (pdf supplement).
 - Revised Figure 12 (formerly Figure 11)