



Supplement of

Seasonal drainage-system evolution beneath the Greenland Ice Sheet inferred from transient speed-up events

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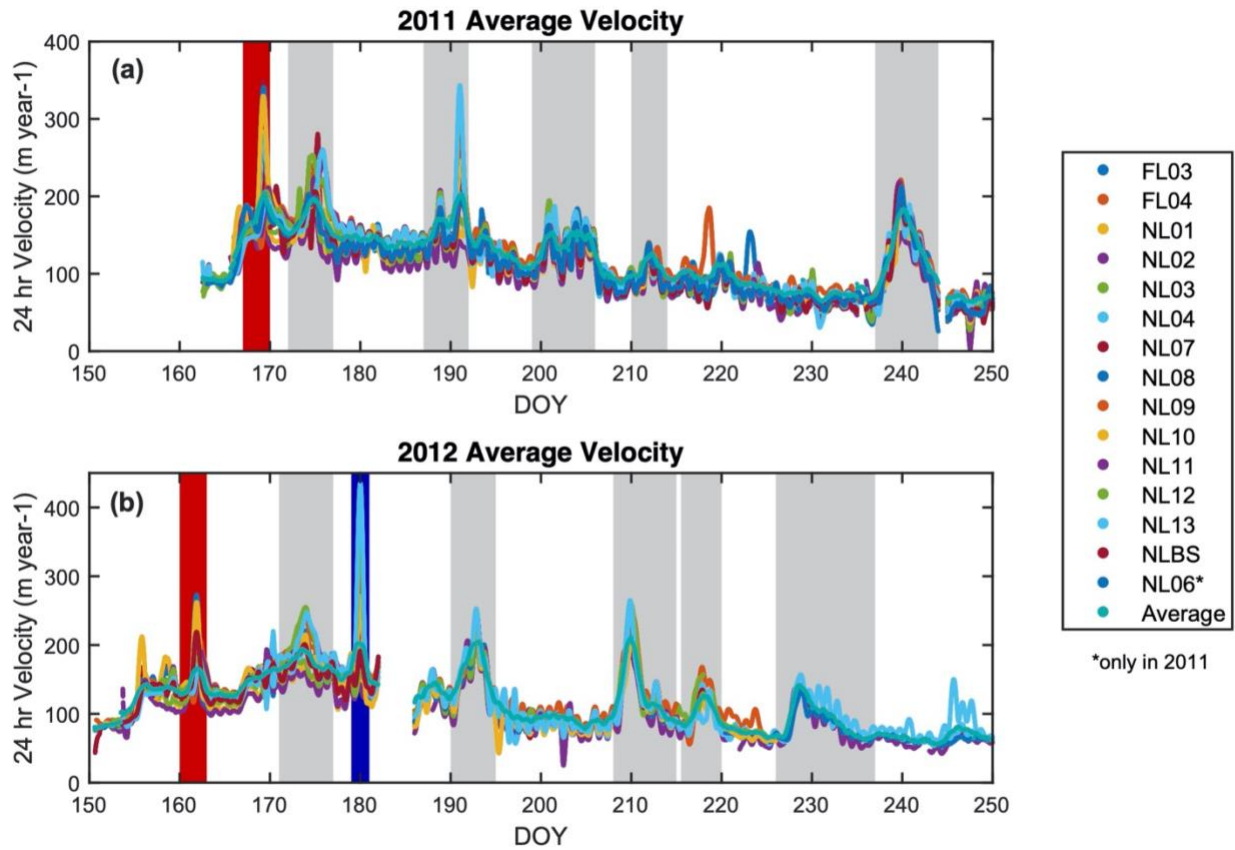


Figure S1. Smoothed 24-hour velocity versus day of year (DOY) per GPS station. Each color line represents the velocity record of an individual GPS station. Panels (a) and (b) show station velocity in 2011 and 2012, respectively. Grey bars denote time periods of the speed-up events, which were used to calculate event runoff. Red bars show North Lake drainage events via hydro-fracture in which there is additional input of 330 to 660 mm w.e. as described in the text. The blue bar represents a nearby lake drainage event as described in the text.

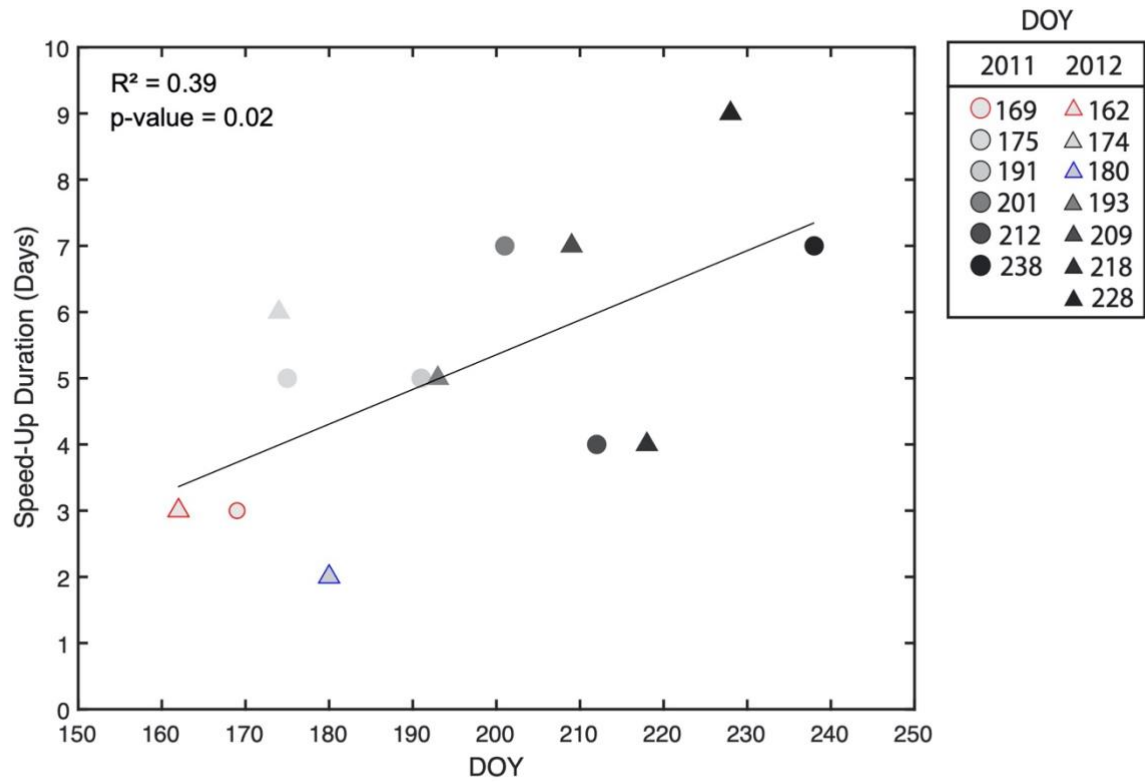


Figure S2. Speed-Up Event Duration versus day of year (DOY). Circles and triangles show events in 2011 and 2012, respectively. The red-outlined symbols show the North Lake drainage events. The blue-outline symbols show the neighboring lake drainage event on 2012/180. The median length of a speed-up event is 5 days.

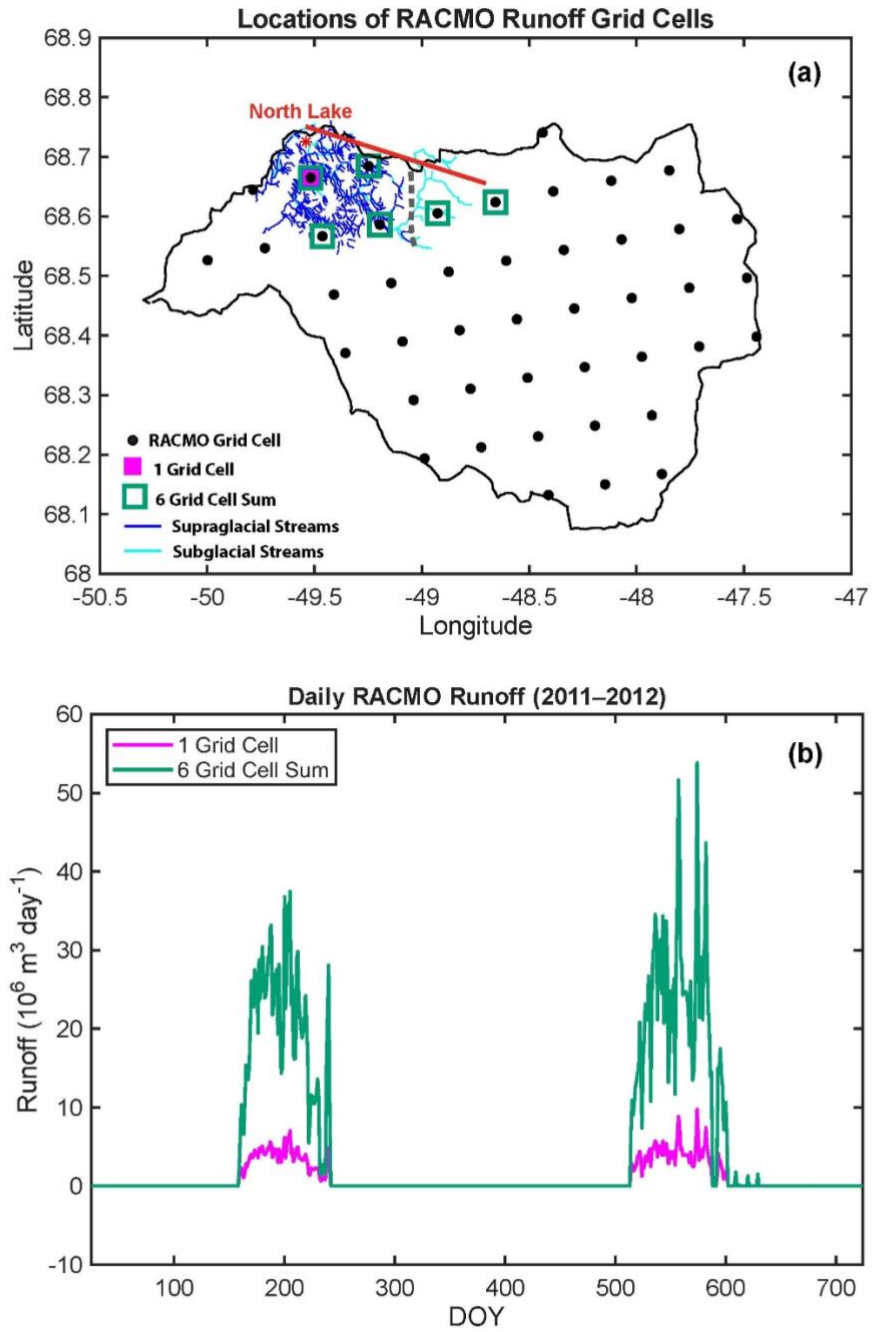


Figure S3. RACMO runoff grid cell locations (a) and runoff estimates (b) over the nearest grid cell (pink) and summed over six grid cells (green). Panel (a) shows the location of the RACMO 11 km by 11 km grid cells (black dots) used to estimate runoff within the surface catchment basin that contains North Lake (red star). Supraglacial ice streams within 43 km of North Lake are shown in dark blue (Joughin et al., 2013). The gray dotted line represents the upstream boundary of the supraglacial stream data, which extends ~30 km upstream of North Lake. The red line denotes the straight line upstream distance of 37.5 km from North Lake used to select RACMO grid cell for the 6-grid cell runoff summation. Subglacial ice streams within 43 km of North Lake are shown in cyan (Moon et al., 2023). The varying 1-point (magenta square) and 6-point (green box) are annotated correspondingly to their values shown in panel (b).

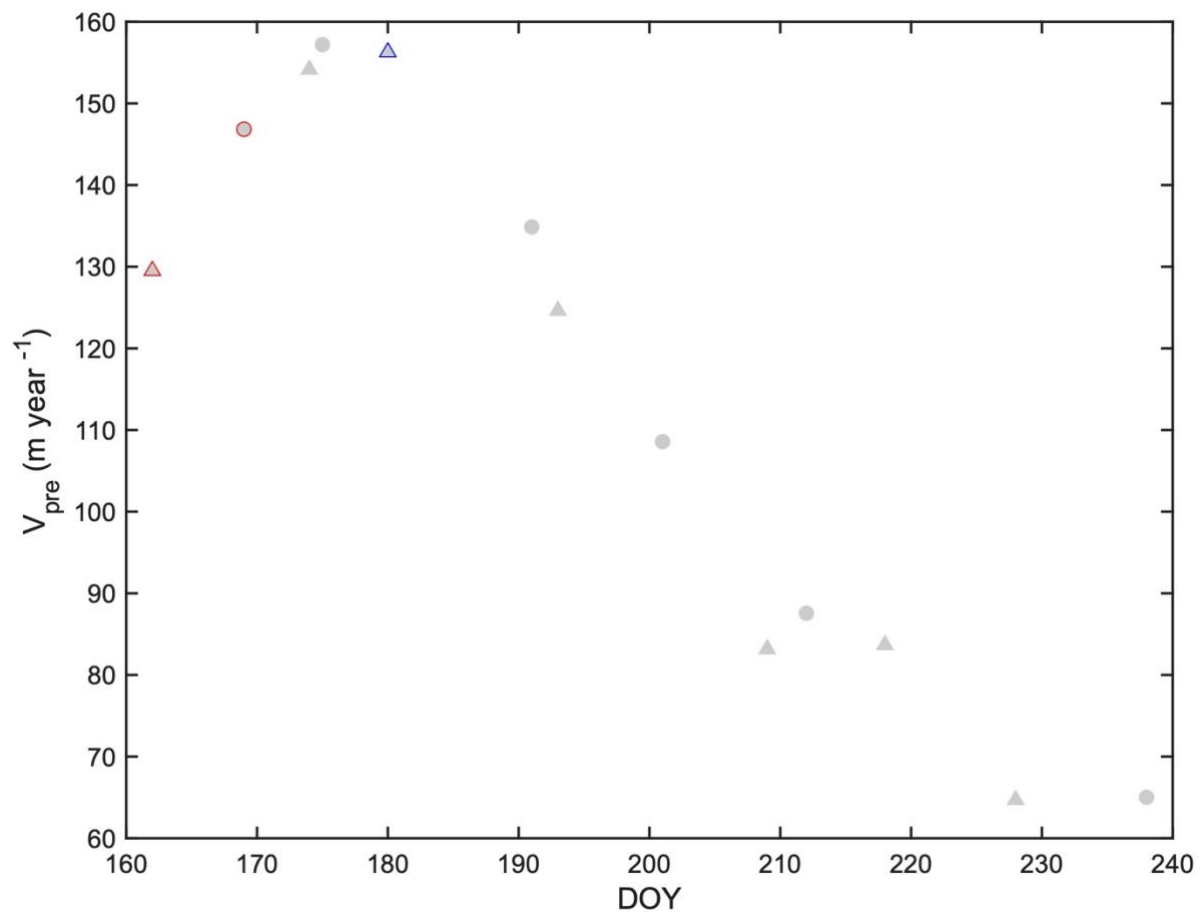


Figure S4. Pre-event velocity (V_{pre}) versus day of year (DOY). Circles and triangles show events in 2011 and 2012, respectively. The red-outlined symbols show the North Lake drainage events. The blue-outline symbols show the neighboring lake drainage event on 2012/180.

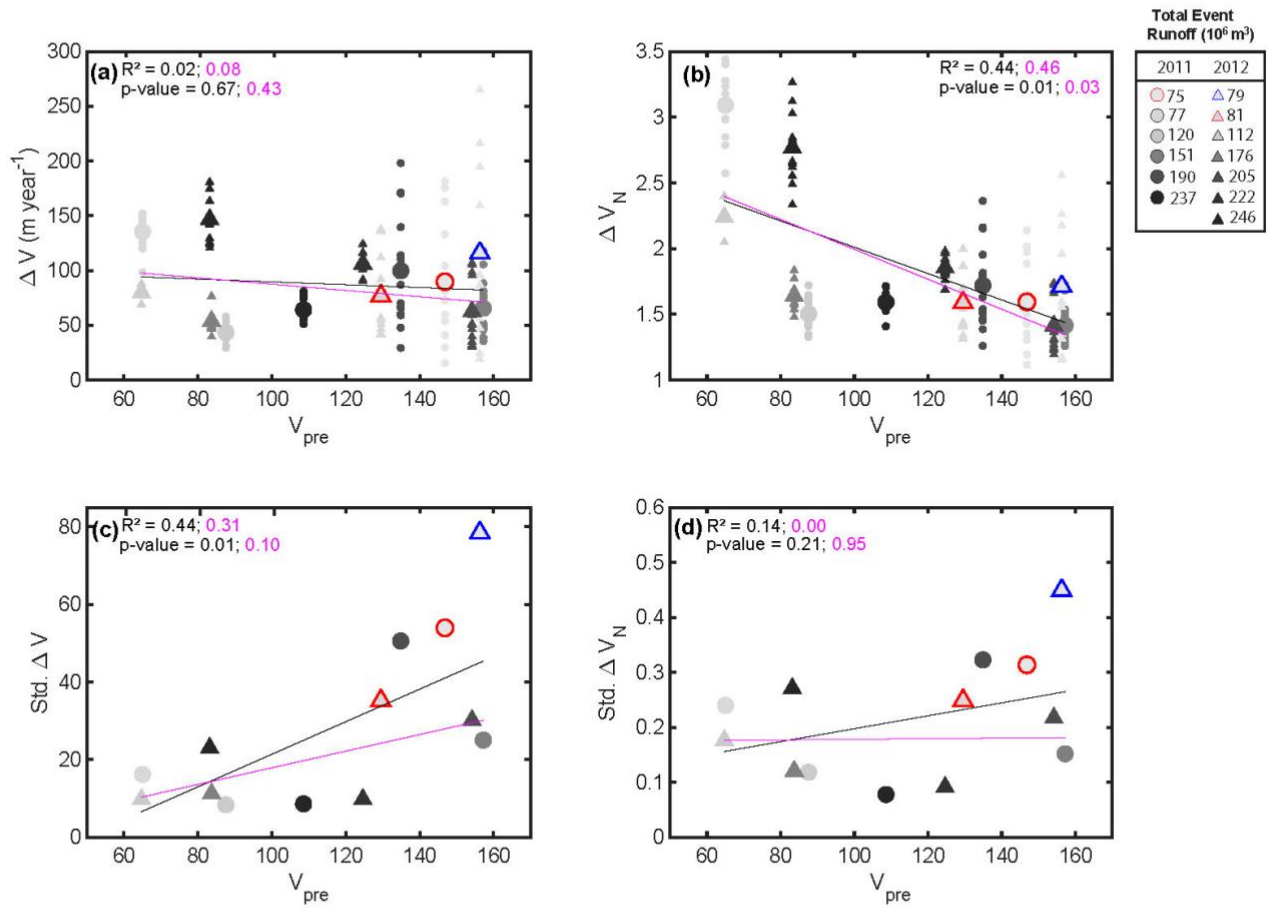


Figure S5. Velocity response (a) ΔV and (b) ΔV_N , as a function of V_{pre} . Circles and triangles show events in 2011 and 2012, respectively. Individual, smaller symbols in panels a and b show individual GPS stations. Larger symbols show the average value across all stations per event. Colors darken with integrated event runoff (mm) the lightest grey color indicating less runoff and the darkest black color representing the greatest runoff. The red-outlined symbols show the North Lake drainage events. The blue-outline symbols show the neighboring lake drainage event on 2012/180. Standard deviation of (c) ΔV and (d) ΔV_N , as a function of V_{pre} . Linear fits of all events (black lines) and regional events only (magenta lines) are displayed for all panels, with associated R-squared and p-values shown in panel corners. Note the trend similarity to Figure 7.

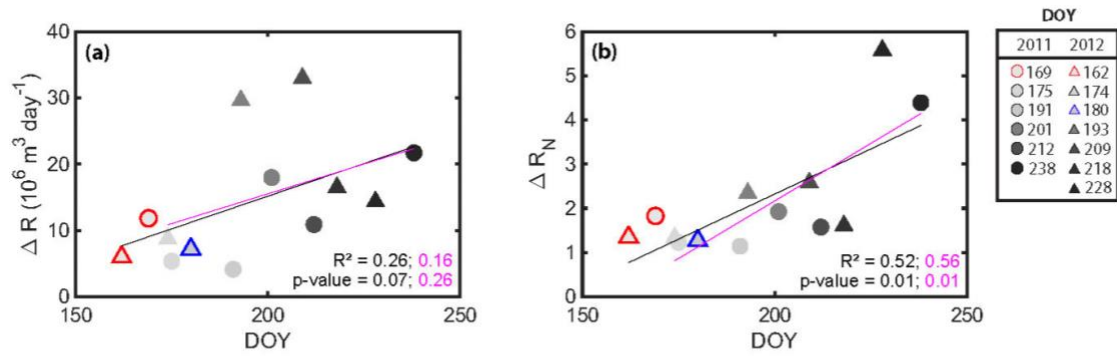


Figure S6. Runoff response **(a)** ΔR and **(b)** ΔR_N , as a function of DOY. Circles and triangles show events in 2011 and 2012, respectively. The red-outlined symbols show the North Lake drainage events. The blue-outline symbols show the neighboring lake drainage event on 2012/180. Linear fits of all events (black lines) and regional events only (magenta lines) are displayed for all panels, with associated R-squared and p-values shown in panel corners. Note the trend similarity to Figure 7.

References

Joughin, I., Das, S. B., Flowers, G. E., Behn, M. D., Alley, R. B., King, M. A., Smith, B. E., Bamber, J. L., van den Broeke, M. R., and Van Angelen, J. H.: Influence of ice-sheet geometry and supraglacial lakes on seasonal ice-flow variability, *The Cryosphere*, 7, 1185–1192, <https://doi.org/10.5194/tc-7-1185-2013>, 2013.

Moon, T. A., Fisher, M., Stafford, T., and Thurber, A.: QGreenland Ice Streams (v3), National Snow and Ice Data Center [data set], <https://doi.org/10.5281/zenodo.12823307>, 2023.