Supplementary Material for

Propagating speedups during quiescence escalate to the 2020-2021 surge of Sít' Kusá, southeast Alaska

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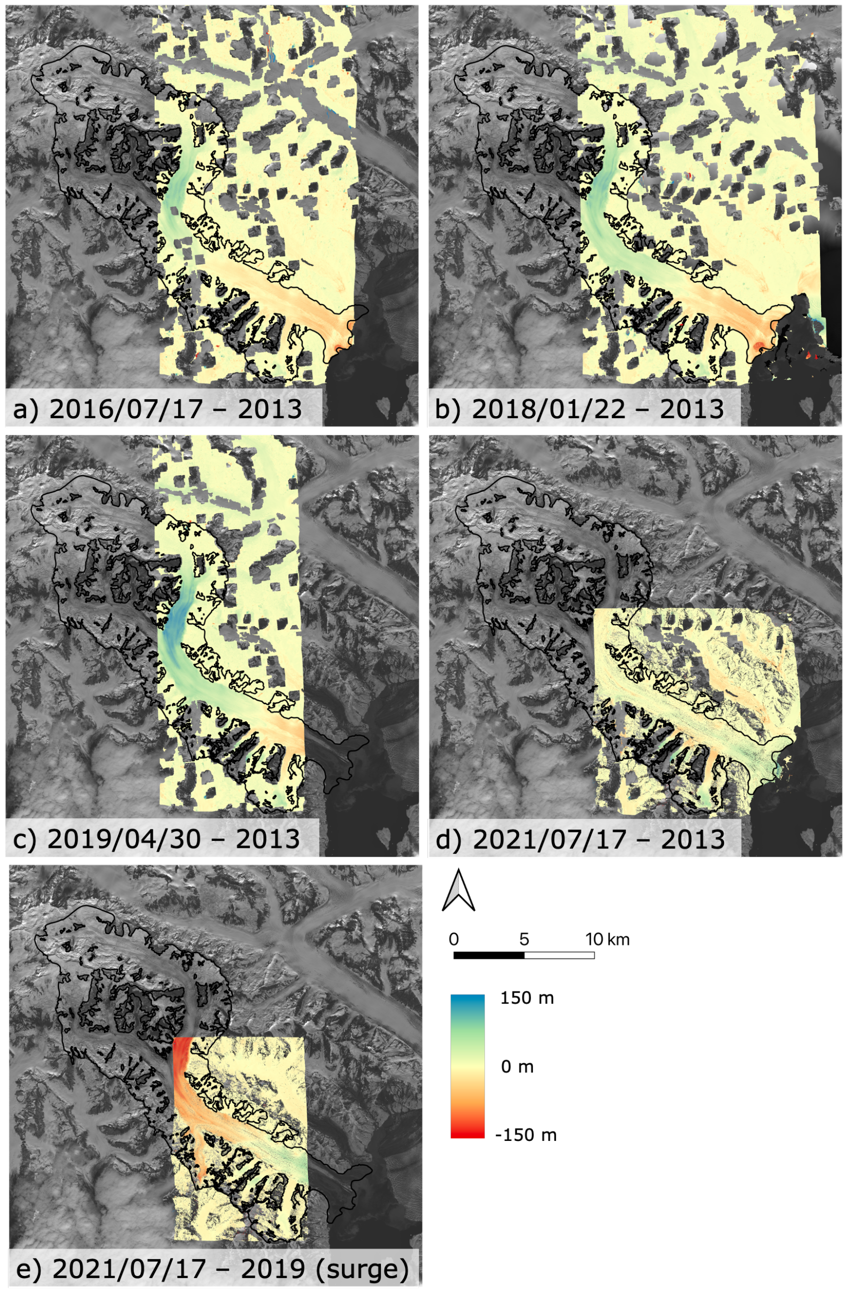

Figure 1: (a-d) Elevation change maps referenced to the post-surge geometry in 2013 (2013/12/07 DEM). Dates are reported as yyyy/mm/dd. (e) Elevation change from 2019/04/30 to 2021/07/17, throughout the surge

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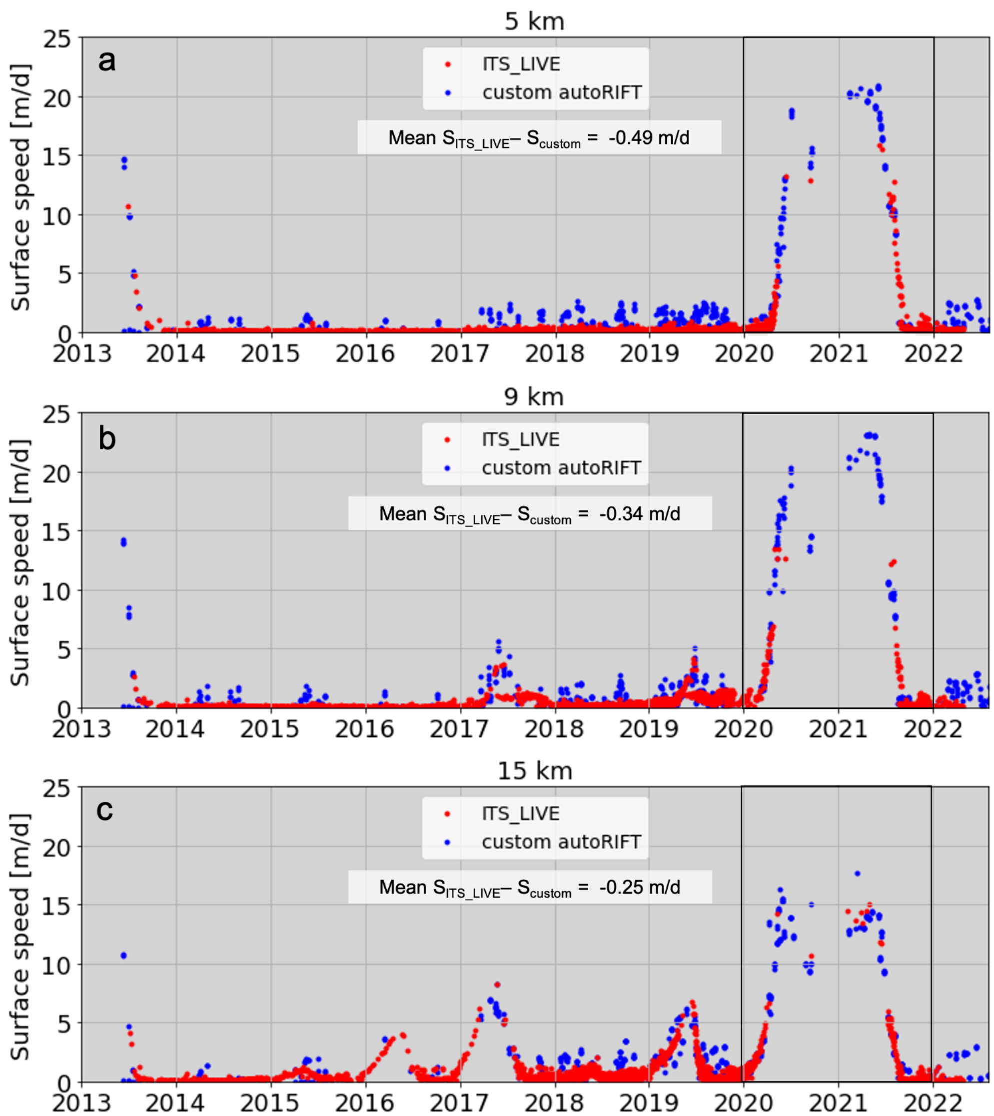

Figure 2: Comparison of the speed time series extracted from the 2022 ITS_LIVE velocity dataset versus the custom autoRIFT velocities for the points at (a) 5 km, (b) 9 km, and (c) 15 km from the glacier terminus. The custom autoRIFT results provide more data within the surge period (bounded by the black box).

Table S1. Summary information for all custom autoRIFT velocity maps generated from 2013-2022. Columns contain the dates for each image pair, temporal separation between each pair (days), image source (e.g., S1 = Sentinel-1, S2 = Sentinel-2, LS = Landsat 8), minimum chip size, percentage of data coverage over the glacier area, and mean velocity errors over stable surfaces (meters/day). The mean velocity errors for the Sentinel-1 velocity maps are the per-pixel speed errors provided through the ASF OnDemand autoRIFT.

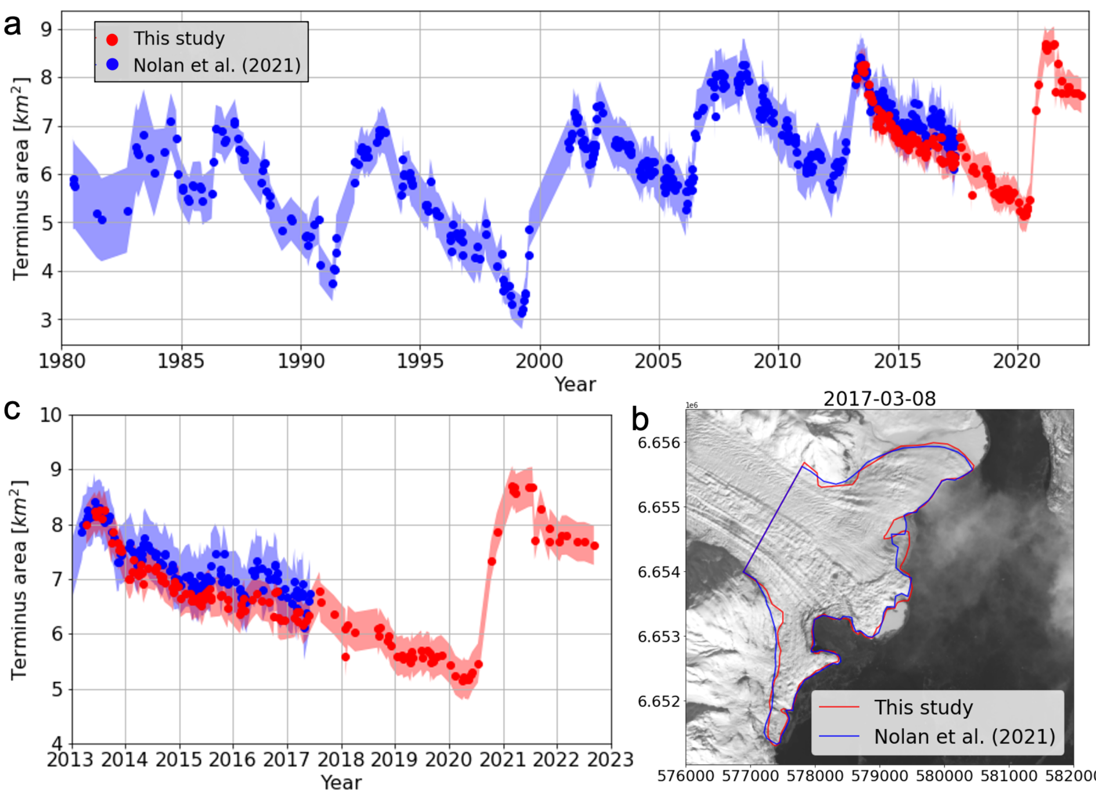

Figure 3: Comparison of terminus areas traced in this study using 15-m resolution Landsat 8 panchromatic images versus Nolan and others (2021) using 30-m resolution Landsat 8 and 7 false color composites. Comparison of terminus area time series from 2013-2022 (this study) versus 1980-2017 (Nolan and others, 2021): (a) from 1980-2022 and (b) from 2013-2022. The terminus area uncertainties correspond to the uncertainty from mixed-pixels (Nolan and others, 2021) and mean 2013-2017 inter-study area differences of ± 0.36 km^2 (this study). (c) Comparison of terminus area traced on 2017-03-08; background is the 15-m Landsat 8 panchromatic image.

Video S1. Time series of velocity maps throughout the entire 2013-2021 surge cycle showing seasonal pulses of high velocity propagating down-glacier from the upper northern tributary throughout quiescence (2013-2019) and the 2020-2021 surge progression.

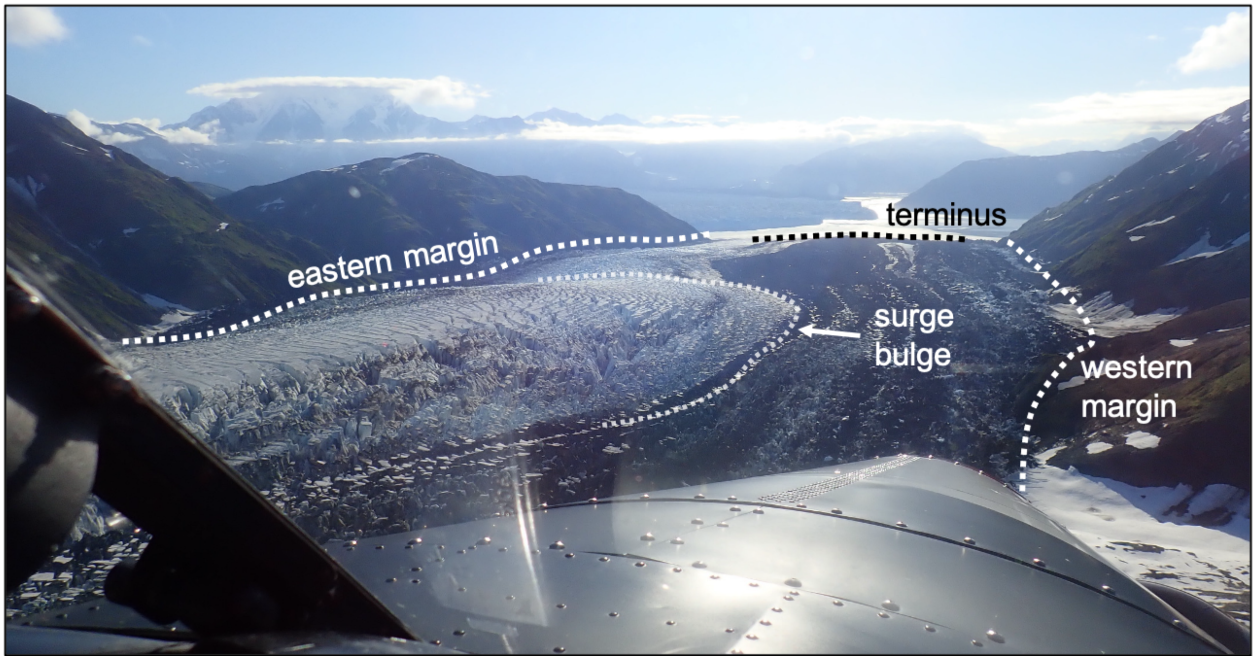

Figure 4: Annotated photo of Sít' Kusá taken late August 2020 showing the surge front (i.e., bulge) nearing the glacier terminus.

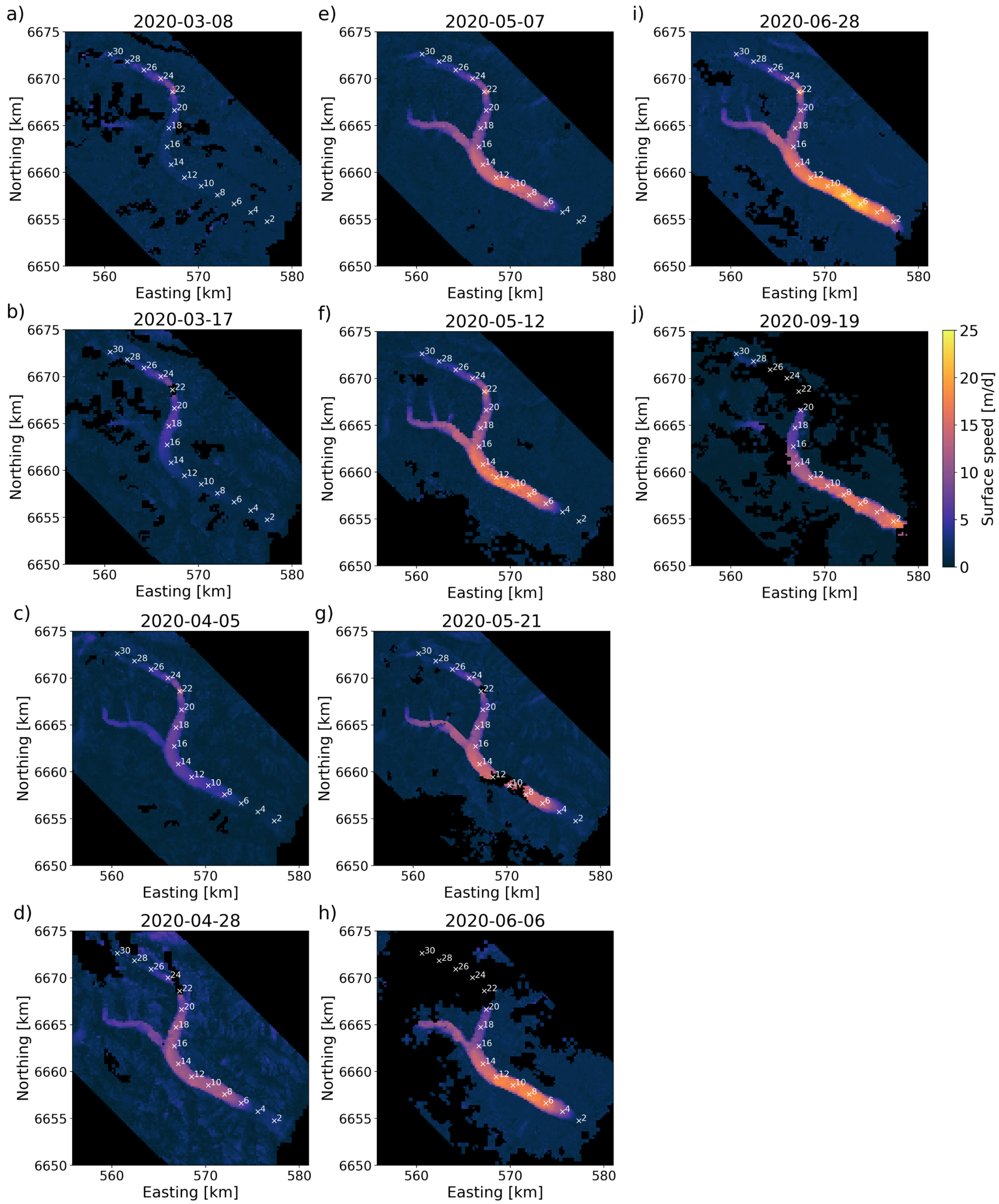

Figure 5: Velocity maps labelled by the image pair mid-date showing propagation of the surge front speed anomaly down-glacier throughout 2020. White Xs mark every 2 km from the glacier terminus along the northern centerline. All velocity maps use the same color scale as in panel j.

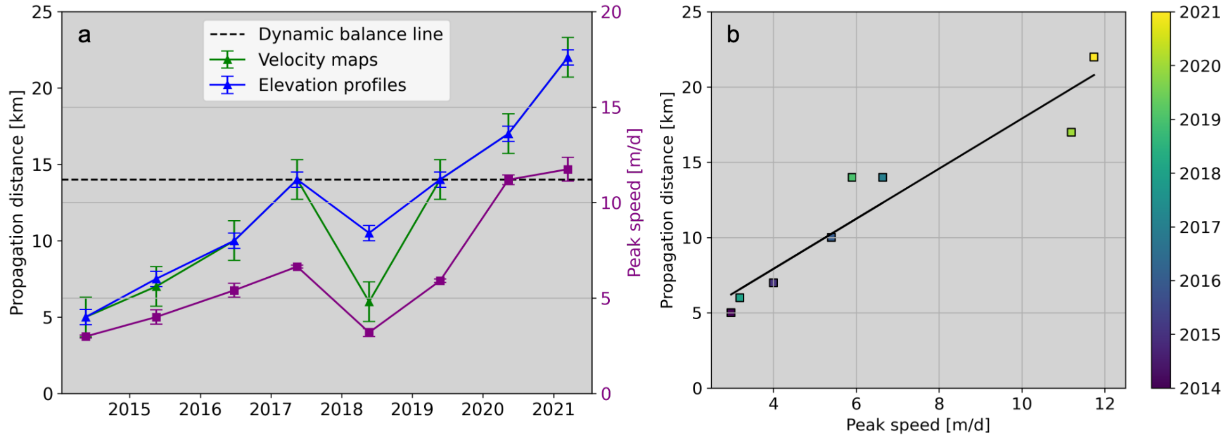

Figure 6: (a) Propagation distance of the annual speedups as measured in the velocity maps and the surface elevation profiles plotted alongside peak speed. Peak speed from the two surge years, 2020 and 2021, are also included. (b) Cross-plot of the propagation distance and peak speed indicate an approximately linearly proportional relationship between the two.

Text S1. The temperature and snowfall data used to calculate the surface mass balance throughout Sít' Kusá's quiescent period (2013-2019) are processed from the high resolution down-scaled climate data for southeast Alaska product available through Amazon Web Services (SNAP, 2023). We extracted the daily temperature and snowfall from Weather Research and Forecast (WRF) model forced with Climate Forecast System Reanalysis (CFSR) historical data, down-scaled to 4 km spatial resolution, and calculated monthly average values. Following the procedure outlined in Eisen and others (2001), we calculated the April to October total snowfall and the May to September average temperature as input to the empirical relationship between the climatic variables and the annual balance measured at Variegated Glacier over a 10-year period. The cumulative sum of the total annual balance from 2013-2019 was equivalent to 35 meters.