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Supplement of

Brief Communication: Twelve-year cyclic surging episode at Donjek Glacier in Yukon, Canada

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1 **Supplementary material**

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5 This supplementary material documents the detailed processing method. After that, we show
6 the spatial patterns in ice velocity and the terminus area change at Donjek Glacier.

7 8 **1. Methodology**

9 We selected 64 pairs of the Landsat images and applied the CCF-O method to the band 4
10 images (30 m resolution) for Landsat 5 and the band 8 images (15 m resolution) for Landsat 7
11 and 8. After co-registration of the two images, we computed the cross-correlation coefficients
12 with a reference chip (30×30 pixels) and a search chip (50×50 pixels) on the orientation
13 images. The step number is set as 6×6 pixels. The distance between the maximum peaks of
14 the two images is regarded as a displacement of glacier.

15 After performing the CCF-O, the median filters about magnitude and flow direction are
16 performed in each result within areas of 3×3 or 5×5 pixels to reject the outliers and to
17 smooth the results. The mean error of ice speed is 0.28 m/d, which is estimated by the mean
18 speed of non-glacier area clipped by the Randolph Glacier Inventory version 4.0 glacial
19 masks (Pfeffer et al., 2014). We averaged the velocity data over the $450 \times 450\text{-m}^2$ area and
20 every 300 m intervals along the flow line set from the terminus (Fig. 1a).

21 We also examined the terminus area changes associated with the surging events using the
22 composite false images of bands 4–6 for the Landsat 1–3 MSS, 2–4 for the Landsat 4/5 MSS,
23 3–5 for the Landsat 5 TM and the Landsat 7 ETM+, and 4–6 for the Landsat 8 OLI. These
24 band combinations take advantage of the clear contrast between ice and rock (McNabb and
25 Hock, 2014).

29 **2. Spatial patterns in ice velocity**

30 Figure S1 shows some snapshots of spatial patterns in ice velocity at Donjek Glacier. The
31 speed patterns associated with three surging episodes in 1989, 2001, and 2013 are shown in
32 Figs. 2b, d, and f. The measured maximum speed is about 2 m/d, 4.5 m/d, and 3 m/d,
33 respectively. The others are in its quiescent phase, whose speeds are about 0.5 m/d or below.
34 The higher velocity area is limited to the ~20 km section from the terminus (Figs. 2b, d, and f),
35 which indicates it is associated with the geometry mentioned in the main text.

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37 **3. Terminus area change**

38 Figure S2 shows the spatial and temporal changes in the terminus area from 1975 to 2014 on
39 the Landsat 8 OLI band 8 image. The color line shows the terminus position in each image.
40 The secular decrease of the terminus area is shown in this figure.

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43 **4. References**

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Figures and captions

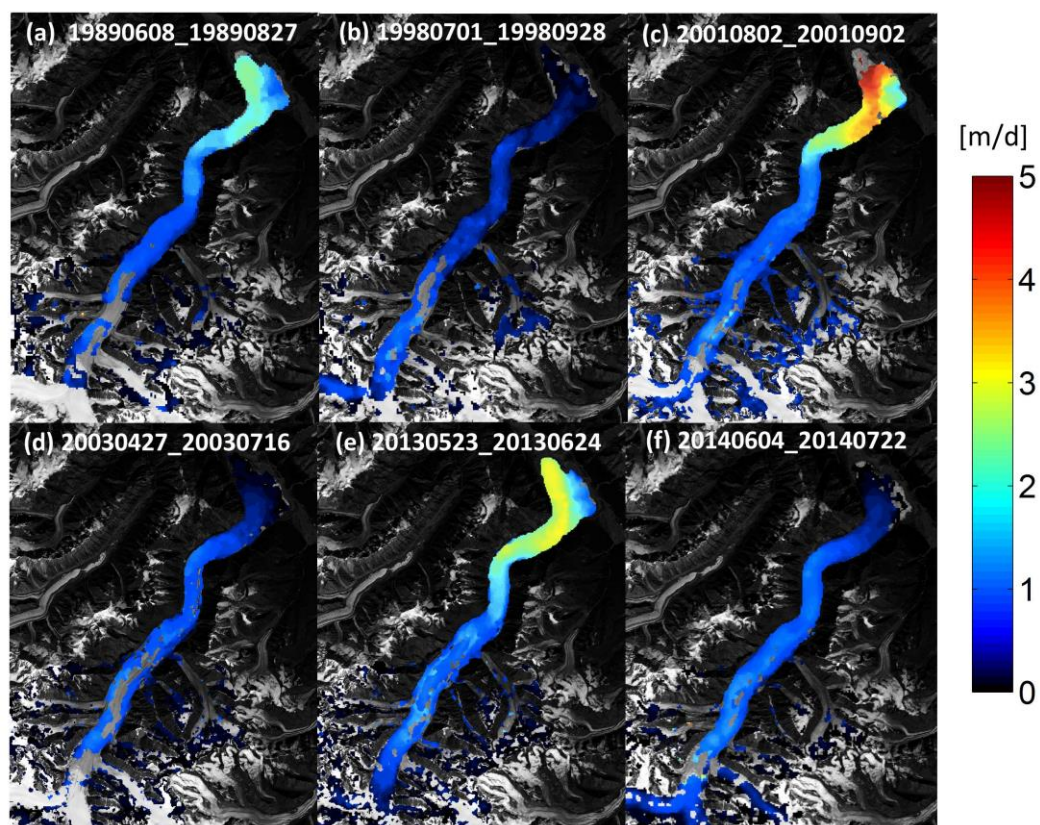


Figure S1. Some examples of spatial patterns in the ice speed. The color scale is shown in linear scale.

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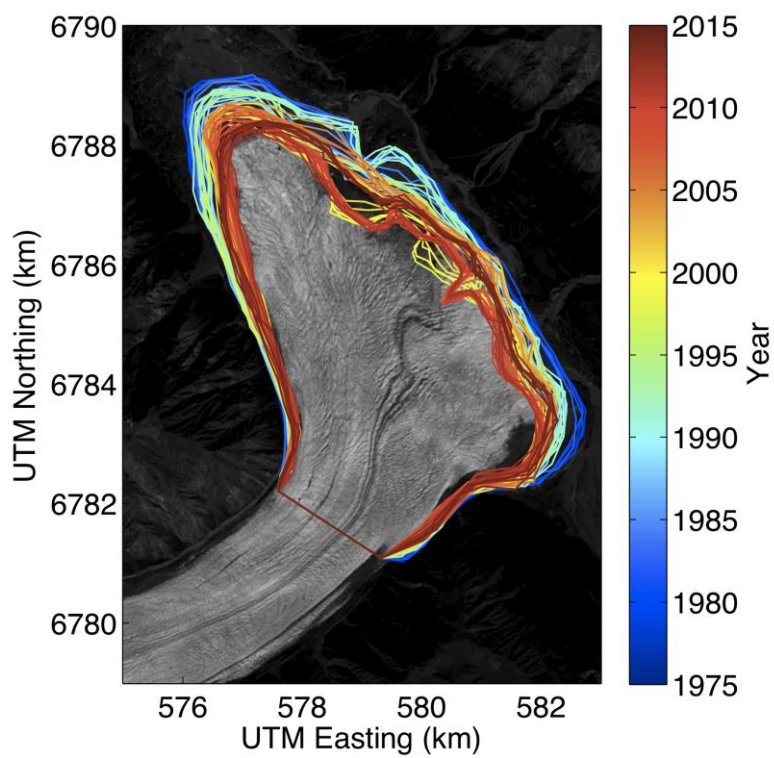


Figure S2. Spatial and temporal changes in the terminus area.