

Supplementary Material for “Late-season flow recovery and trough-aligned subsidence reveal coexisting subglacial drainage components beneath the western Greenland Ice Sheet”

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Year	Track	Acquisition 1	Acquisition 2
2017	T090A	9 Feb 2017	15 Feb 2017
2017	T127D	12 Feb 2017	18 Feb 2017
2018	T090A	11 Jan 2018	17 Jan 2018
2018	T127D	14 Jan 2018	20 Jan 2018
2019	T090A	12 Jan 2019	18 Jan 2019
2019	T127D	15 Jan 2019	21 Jan 2019
2020	T090A	7 Mar 2020	13 Mar 2020
2020	T127D	10 Mar 2020	16 Mar 2020
2021	T090A	18 Feb 2021	24 Feb 2021
2021	T127D	15 Feb 2021	21 Feb 2021

Table S1–Sentinel-1 acquisition dates for winter references in DInSAR retrievals. Acquisition dates and track IDs for the winter reference pairs used in DInSAR retrievals. Note that the 2025 retrievals use the winter reference from 2021, since no 6-day pairs were available during the 2025 winter.

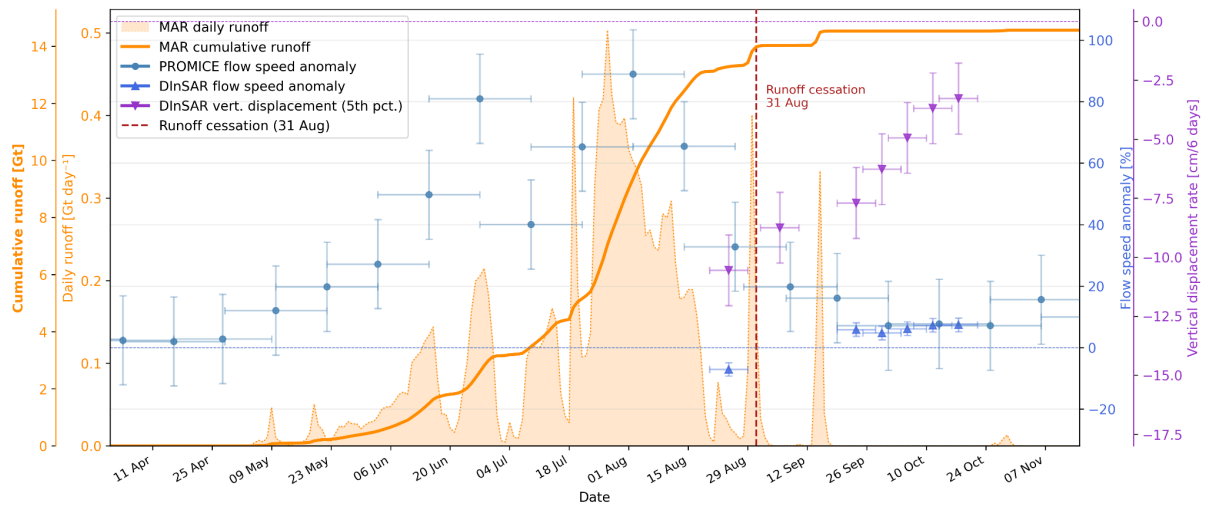


Figure S1–Time series of median late-season subsidence over troughs, regional flow speed anomaly, and runoff in 2017. Daily and cumulative runoff from MAR (orange line and shading; Mankoff et al., 2020), median relative flow speed anomaly (evaluated over the region indicated by the yellow line in Figure 1c) from PROMICE 24-day products (light blue circles) and DInSAR (dark blue triangles), and DInSAR-derived vertical displacement (lower 5th percentile) over manually identified subsidence events. Runoff is summed over all catchments intersecting the yellow boundary in Figure 1c, and the dashed red line indicates the runoff cessation date, defined as the date at which 96% of the season’s cumulative runoff is reached.

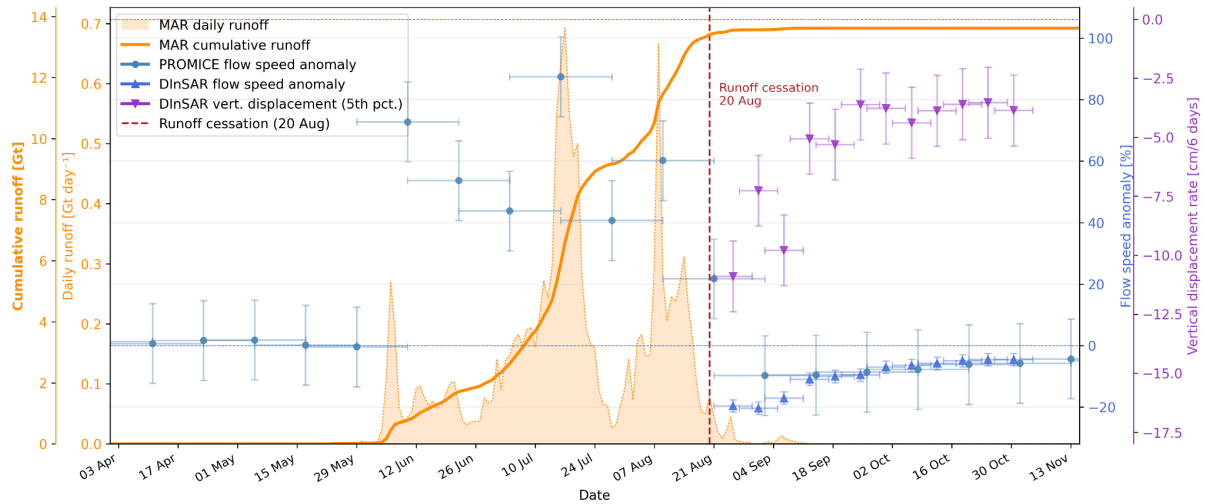


Figure S2—Time series of median late-season subsidence over troughs, regional flow speed anomaly, and runoff in 2018. Daily and cumulative runoff from MAR (orange line and shading; Mankoff et al., 2020), median relative flow speed anomaly (evaluated over the region indicated by the yellow line in Figure 1c) from PROMICE 24-day products (light blue circles) and DInSAR (dark blue triangles), and DInSAR-derived vertical displacement (lower 5th percentile) over manually identified subsidence events. Runoff is summed over all catchments intersecting the yellow boundary in Figure 1c, and the dashed red line indicates the runoff cessation date, defined as the date at which 98% of the season’s cumulative runoff is reached.

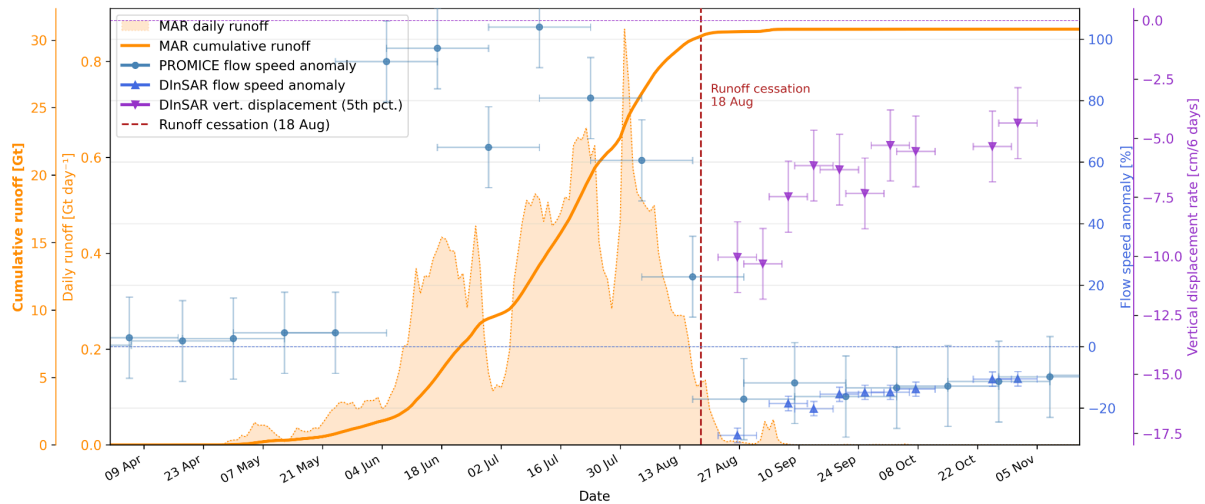


Figure S3—Time series of median late-season subsidence over troughs, regional flow speed anomaly, and runoff in 2019. Daily and cumulative runoff from MAR (orange line and shading; Mankoff et al., 2020), median relative flow speed anomaly (evaluated over the region indicated by the yellow line in Figure 1c) from PROMICE 24-day products (light blue circles) and DInSAR (dark blue triangles), and DInSAR-derived vertical displacement (lower 5th percentile) over manually identified subsidence events. Runoff is summed over all catchments intersecting the yellow boundary in Figure 1c, and the dashed red line indicates the runoff cessation date, defined as the date at which 98% of the season’s cumulative runoff is reached.

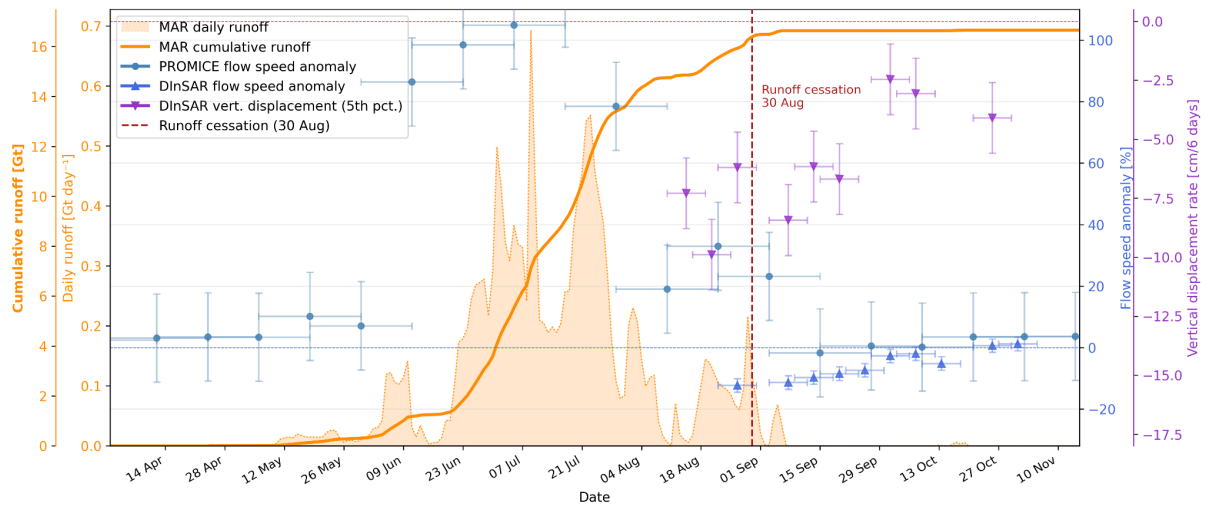


Figure S4—Time series of median late-season subsidence over troughs, regional flow speed anomaly, and runoff in 2020. Daily and cumulative runoff from MAR (orange line and shading; Mankoff et al., 2020), median relative flow speed anomaly (evaluated over the region indicated by the yellow line in Figure 1c) from PROMICE 24-day products (light blue circles) and DInSAR (dark blue triangles), and DInSAR-derived vertical displacement (lower 5th percentile) over manually identified subsidence events. Runoff is summed over all catchments intersecting the yellow boundary in Figure 1c, and the dashed red line indicates the runoff cessation date, defined as the date at which 98% of the season’s cumulative runoff is reached.

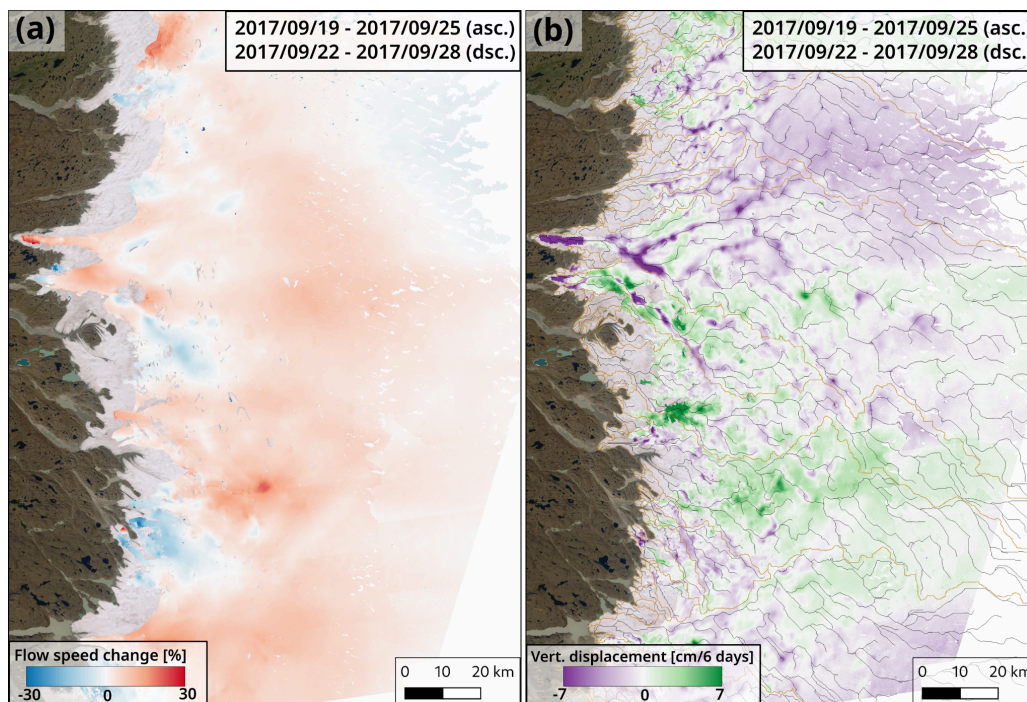


Figure S5—Example of DInSAR-derived flow speed and vertical displacement anomaly from September 2017. Flow-directed velocity anomaly (a) and vertical displacement anomaly (b) for a

mid-September DInSAR retrieval. Note the elevated flow speed (with respect to the 2017 mid-winter reference retrieval) and the presence of localized subsidence signals.

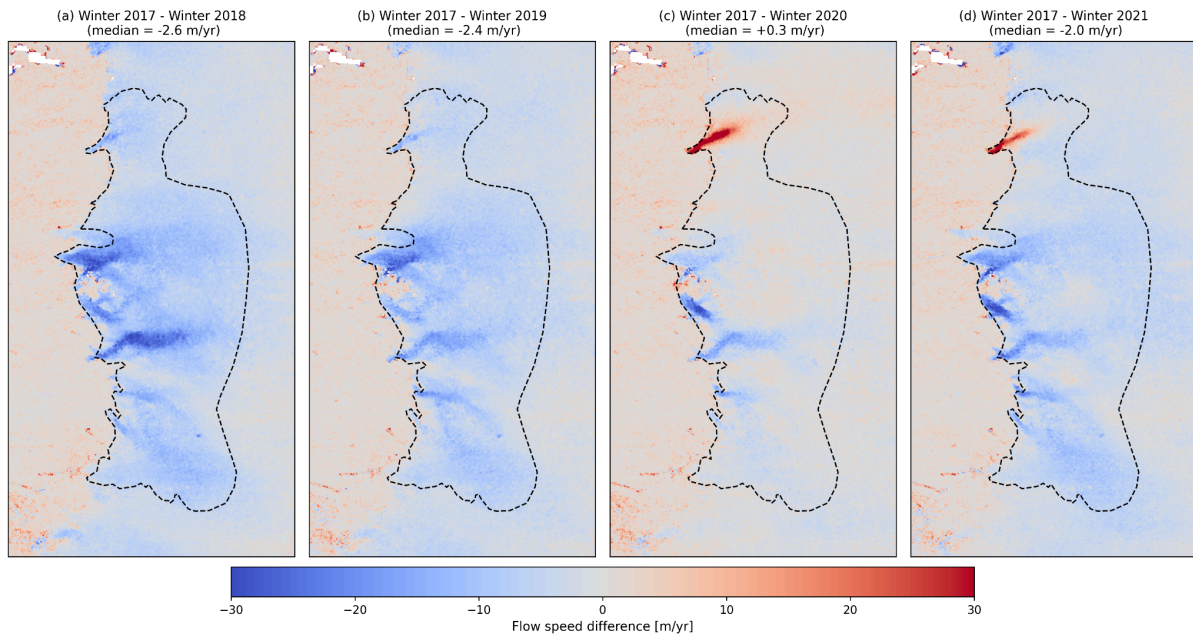


Figure S6—Inter-annual variability in winter ice flow speeds (December-March) across the study area, derived from PROMICE 24-day velocity products. Flow speed difference between winters of 2017 and (a) 2018, (b) 2019, (c) 2020, and (d) 2021. For each year, winter flow speed is computed as the temporal median between all PROMICE 24-day products within the December (previous year) to March period. The 2017 median winter flow is observed to be slower than all other winters (with the exception of 2020, which shows a marked deceleration at Inuppaat Quuat, but still shows faster flow at most other outlets).

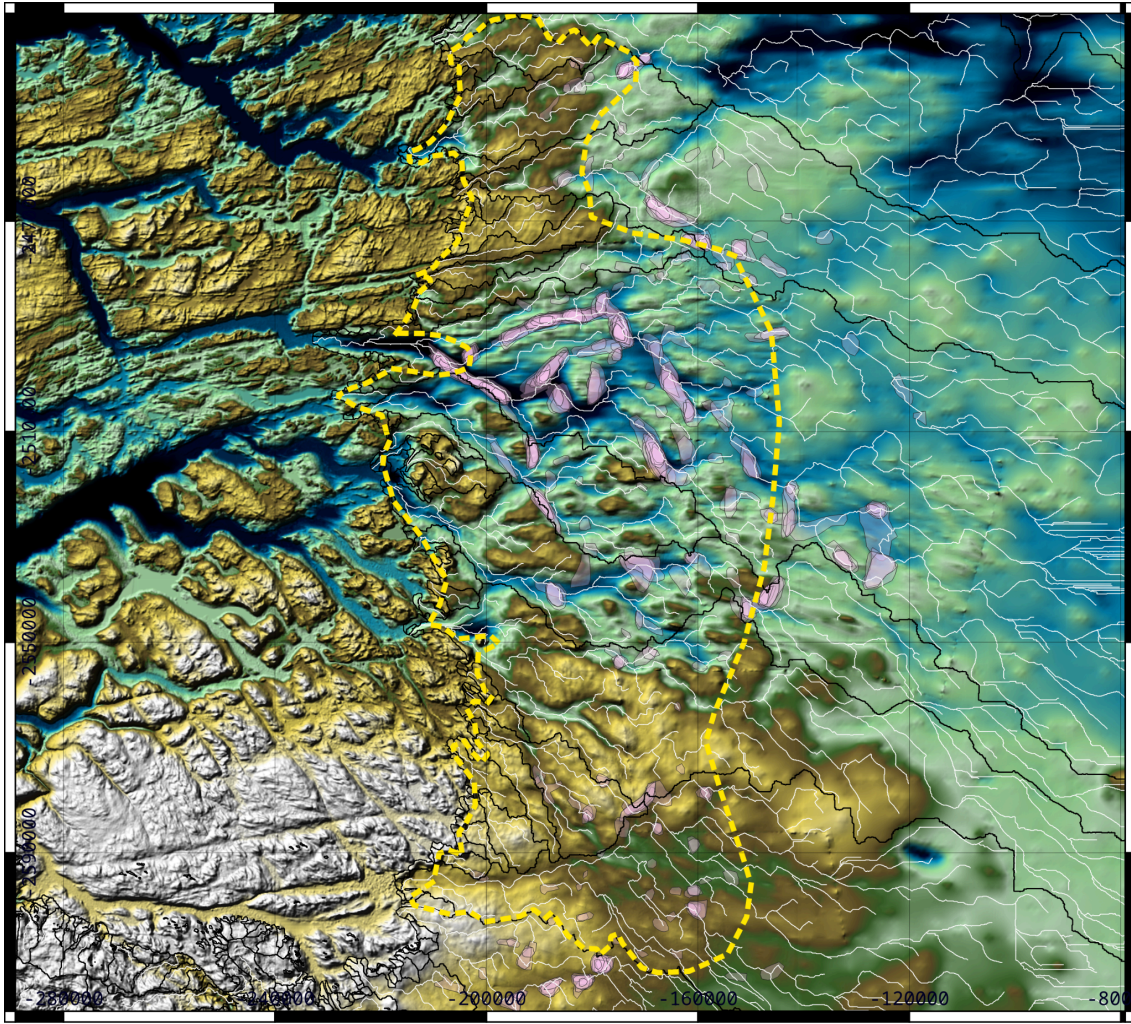


Figure S7—Subsidence events from 2021 DInSAR retrievals. Outlines of manually identified subsidence events from 2021 DInSAR retrievals (pink polygons), overlaid on bed topography from BedMachine v6 (Morlighem et al., 2026). The dashed yellow boundary is the same as in Figure 1c.

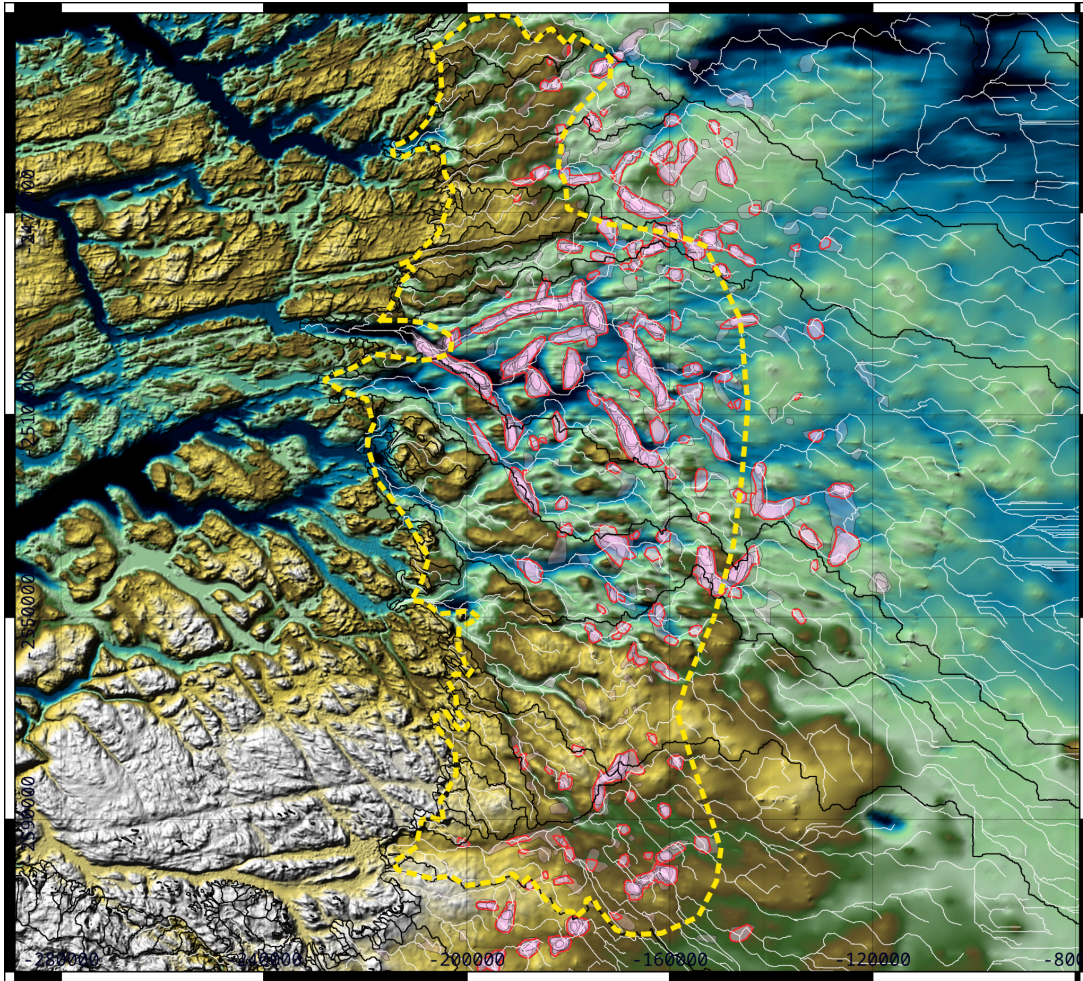


Figure S8—Subsidence events from 2017-2021 DInSAR retrievals. Outlines of manually identified subsidence events from all 2017-2021 DInSAR retrievals (pink polygons), overlaid on bed topography from BedMachine v6 (Morlighem et al., 2026). The dashed yellow boundary is the same as in Figure 1c. Red boundaries outline all areas that are covered by 2 or more individual subsidence events. These red polygons are interpreted as a rough, ‘lower-bound outline’ of the well-connected drainage system components, with the remaining ablation zone area assumed to predominantly consist of weakly connected cavities.

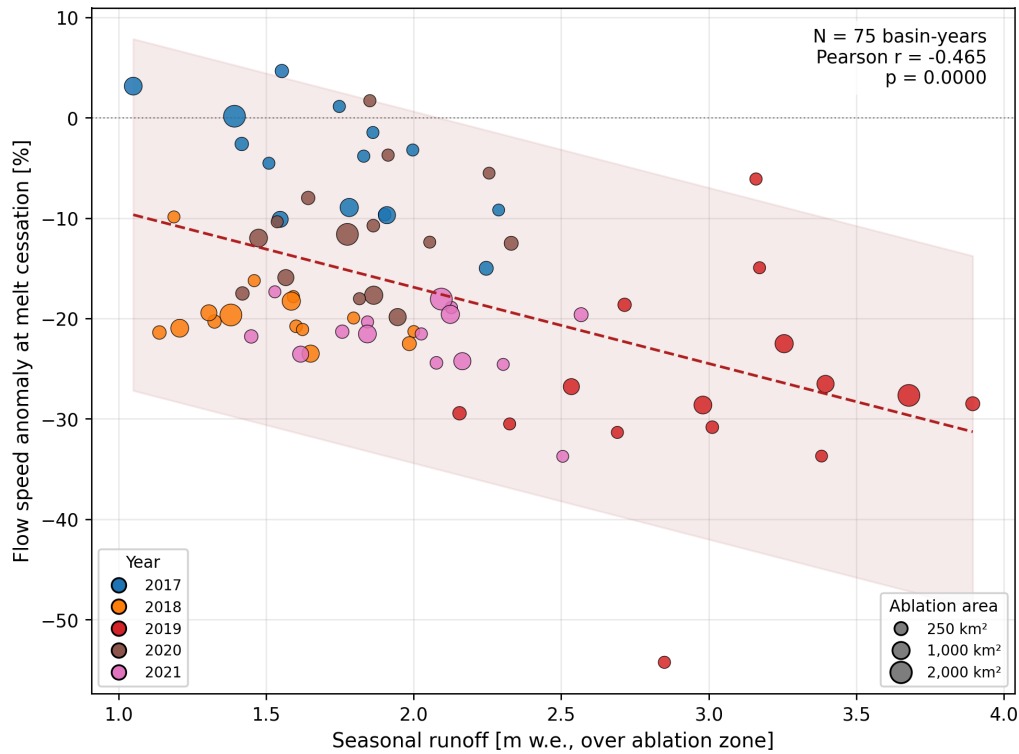


Figure S9—Flow speed anomaly at melt cessation vs. seasonal runoff across study years. For each subglacial drainage basin (Mankoff et al., 2020) within the study area (yellow boundary in Figure 1c) and each study year (2017–2021), the flow speed anomaly at time of melt cessation (cumulative runoff >98% of total seasonal runoff) was obtained by extrapolating a linear fit through the per-retrieval flow speed anomalies (as in Figure 6a) to day zero, providing an estimate of the initial late-season deceleration magnitude (*Methods*). Seasonal runoff is computed as the total cumulative runoff from each subglacial catchment (based on MAR model output; Mankoff et al., 2020), normalized by the area of the basin within the ablation zone used for estimating flow speed anomaly (yellow boundary in Figure 1c), yielding a basin-averaged metric (*Methods*). Each point corresponds to a single basin-year combination, with color denoting year and point size corresponding to the ablation zone area over which flow speeds are computed. The dashed red line and shading shows the linear regression through all points and the associated ± 1.96 standard deviation prediction interval. A statistically significant negative correlation is observed ($r = -0.47$, $p < 0.0001$), supporting the interpretation that years with greater melt input produce larger initial regional flow deceleration at the time of melt cessation. Note the limited number of years and the variable DInSAR temporal coverage between years (potentially leading to an uneven sampling of the annual velocity curve), which limits the strength of this analysis.

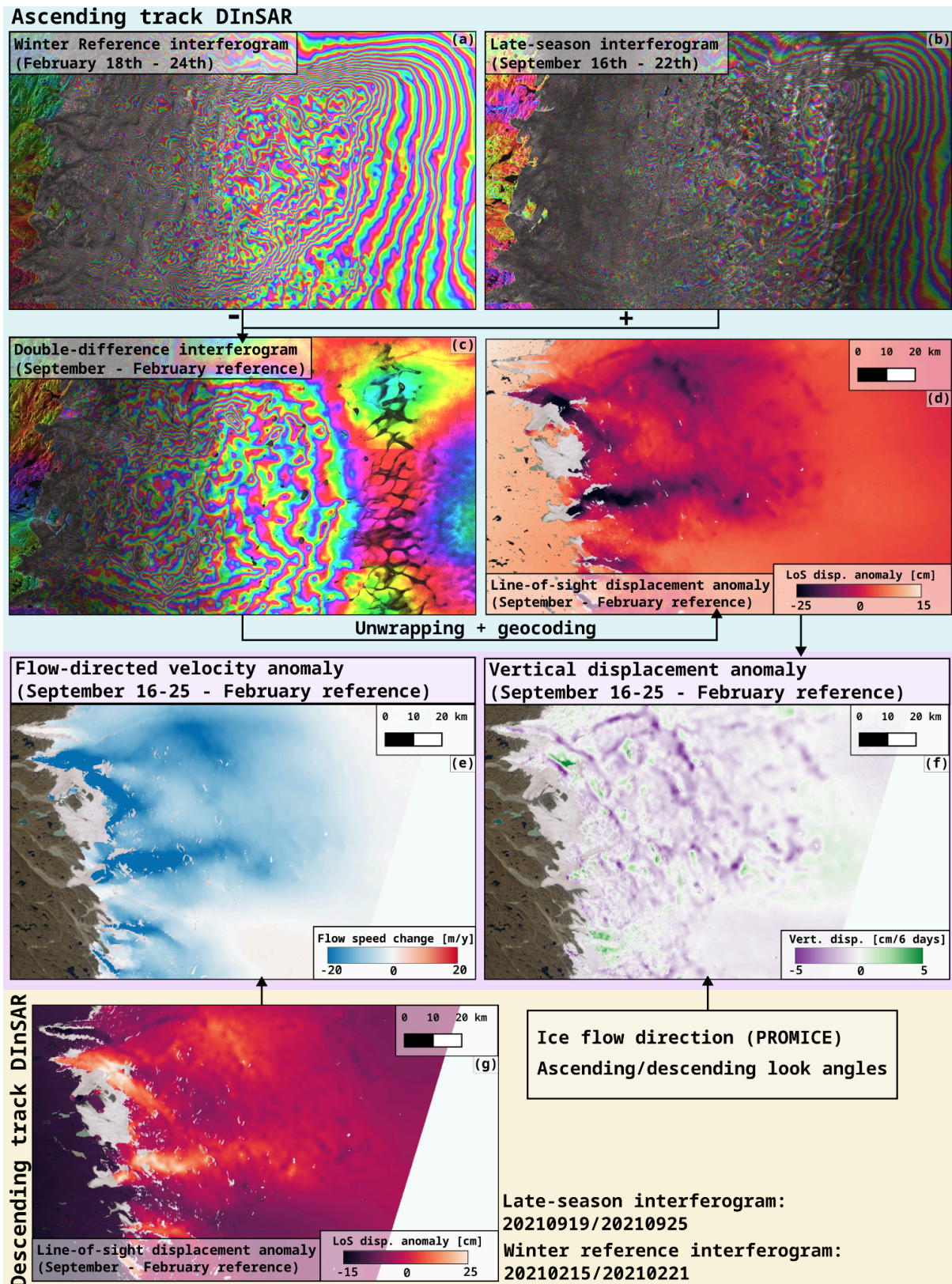


Figure S10—Overview of DInSAR methodology. (a-d) DInSAR workflow, demonstrated for the ascending Sentinel-1 track. A winter reference interferogram (a) is selected for each year and subtracted from a late-season interferogram (b), producing a double-difference interferogram (c). After unwrapping and geocoding, this yields a line-of-sight (LoS) displacement anomaly map (d) representing motion relative to the winter baseline. A corresponding LoS anomaly map from the

descending track is shown in panel (g), based on the same procedure. These ascending and descending anomaly maps are combined (panels (e)-(f)) using a geometric inversion to isolate displacement anomalies in the vertical and flow-parallel directions (subsequently scaled to velocities/rates). The inversion incorporates the local ice flow direction (from a PROMICE multi-year velocity product) and ascending/descending radar look angles. All anomaly maps represent changes over 6-day intervals with respect to nominal winter flow conditions.

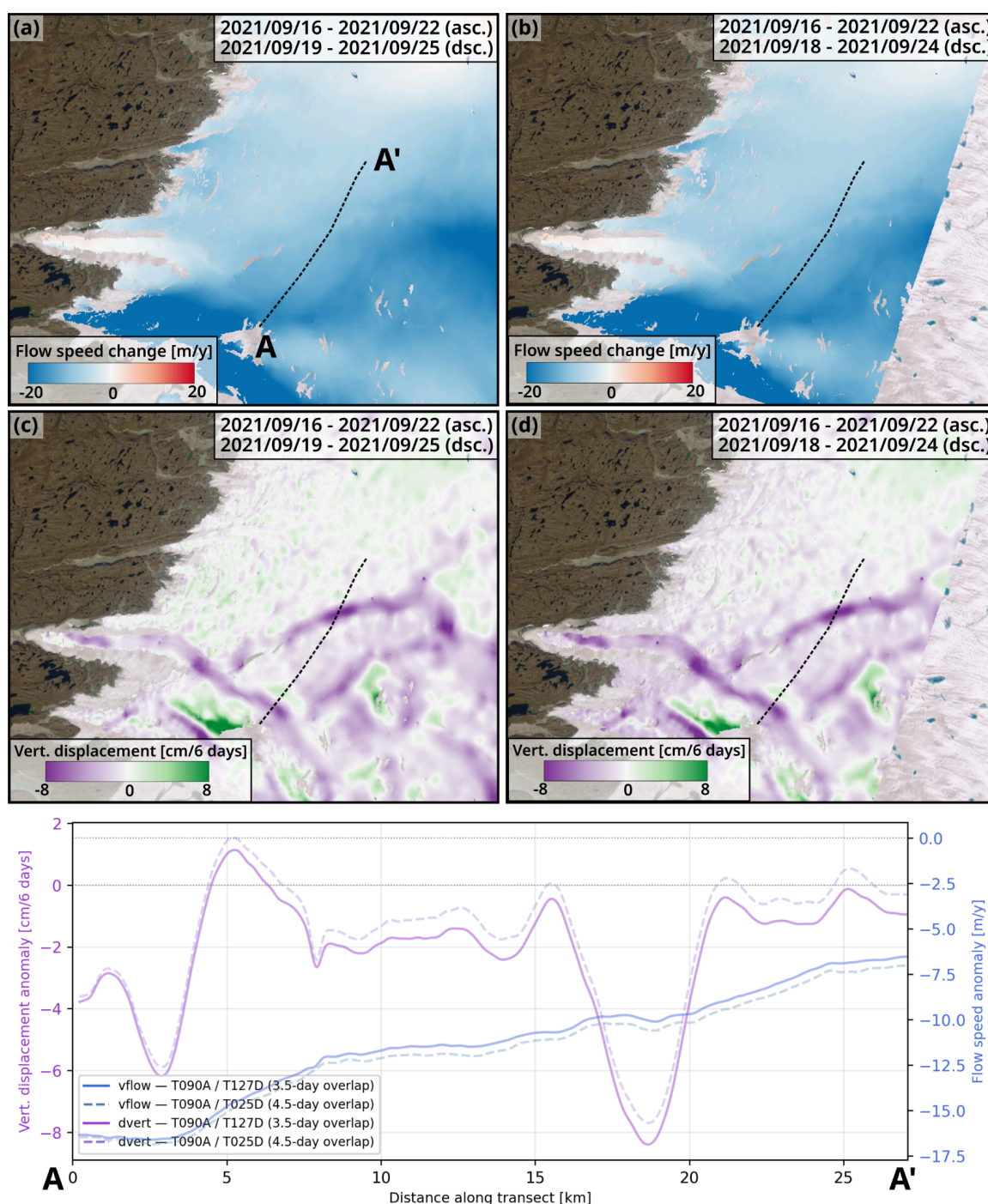


Figure S11—Comparison between DInSAR results using two different descending tracks. (a)-(b) flow-directed velocity anomaly using DInSAR acquisitions from tracks T090A and T127D (yielding a 3.5 day overlap out of the 6-day temporal baseline) and using acquisitions from T090A and T025D (yielding a 4.5 day overlap out of the 6-day temporal baseline), respectively. Note that T025D covers only a smaller part of the study area. (c)-(d) Vertical displacement anomaly from the T090A/T127D and T090A/T025D acquisitions, respectively. (e) transect plot of flow-directed and vertical anomalies, computed along the dashed line in panels (a)-(d). Note that the same relative spatial pattern is observed in the signals, with only relatively modest differences in magnitudes (<1 cm/6 days for vertical displacement anomalies and <0.5 m/y for flow speed anomalies), suggesting a relatively small effect of the temporal offset between ascending and descending acquisitions.

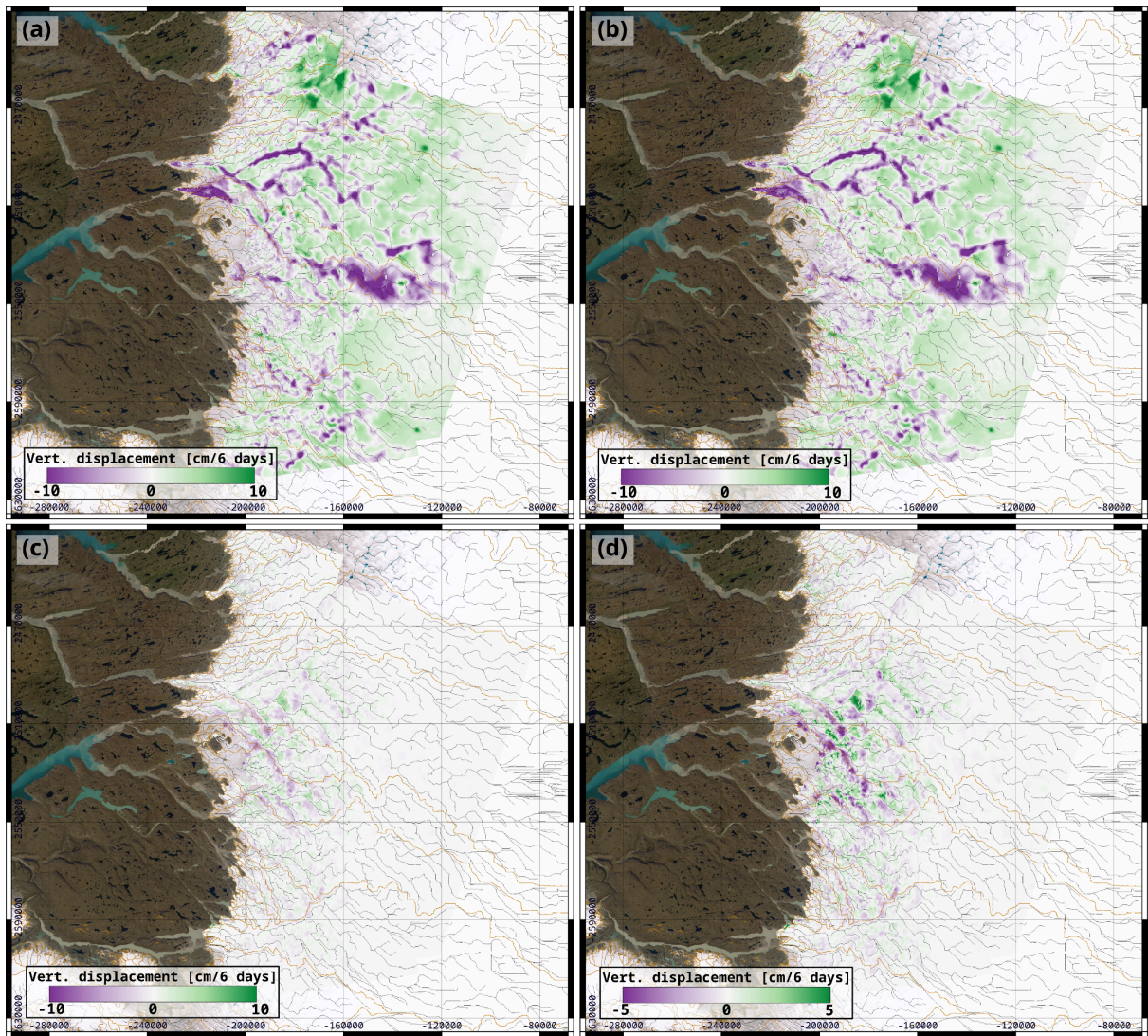


Figure S12—Estimating bed-parallel vertical motion contributions. (a) Original DInSAR-derived vertical displacement anomaly field for a single retrieval (acquisition dates listed in the top right corner) prior to correcting for bed-parallel motion. (b) Vertical displacement anomaly field obtained after subtracting the estimated bed-parallel motion component. (c) Bed-parallel vertical motion anomaly for the same product, computed as the product of horizontal flow speed anomaly and bed slope along the flow direction. Note the much smaller magnitude of the bed-parallel motion component in (c) relative to the observed displacement signals, as well as the alternating sign arising from reversals in the bed slope along the flow direction, which contrasts with the trough-aligned subsidence features in (a) that are generally independent of the relative geometry between the horizontal flow vector and bed slope. Panel (d) is the same as panel (c), but on a tighter color scale, to better show details of the lower magnitude signal.