Supplementary Material

Supplementary images and data
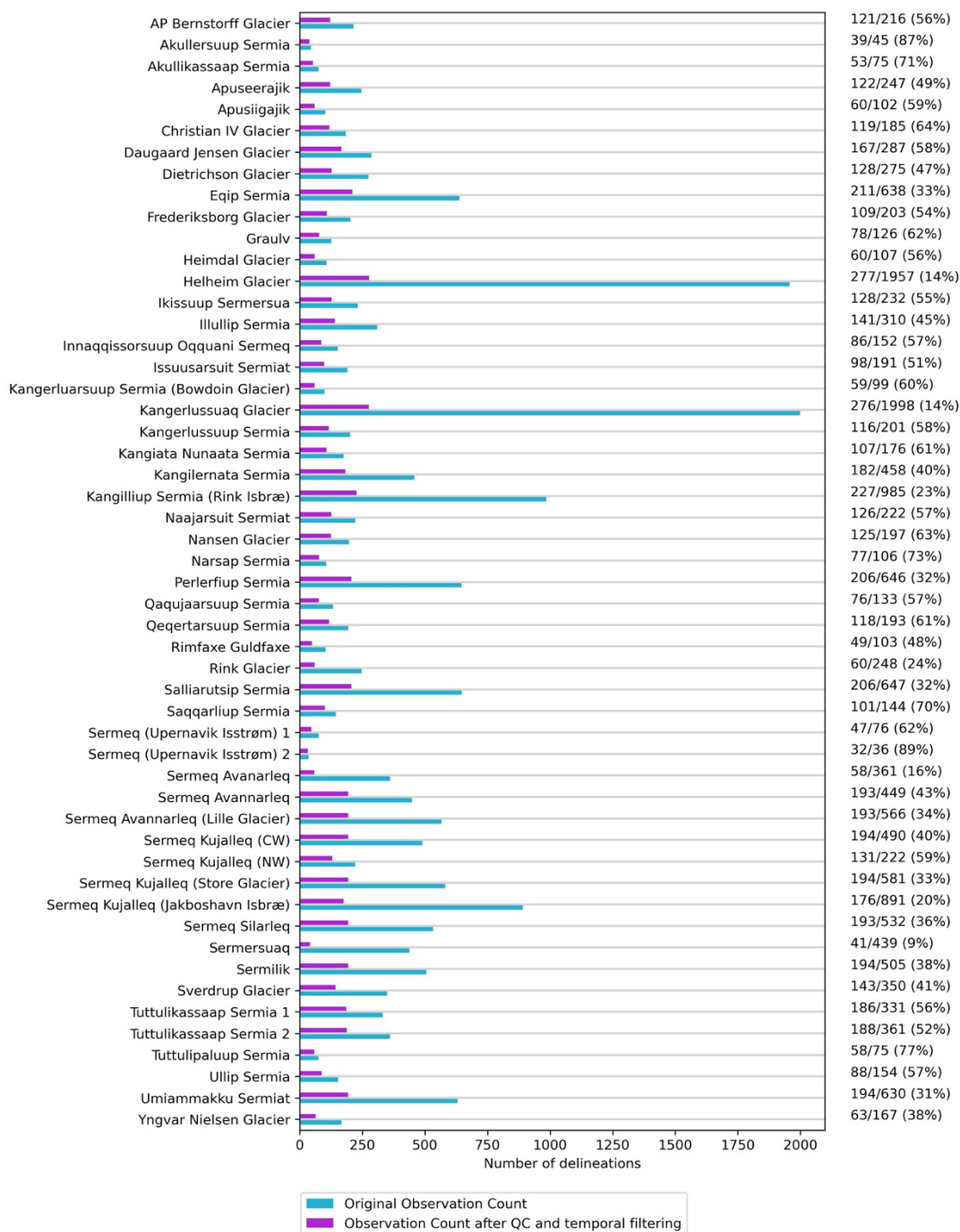
Figure S 1 | Number of terminus delineations before and after filtering

Overview of terminus delineations for each tidewater glacier before (blue) and after filtering (purple), with numbers indicating the number of filtered and all delineations, and the percentage of kept observations.

Table S 1: Spatio-temporal resolutions and uncertainties of input datasets

Spatial and temporal resolutions for each input dataset and uncertainties associated with them.

Dataset	Spatial resolution [m]	temporal resolution	uncertainty +/- [m]
TermPicks	30 15	1908 -2020	Landsat 4/5: 5.6 Landsat 7/8: 3.6
ArcticDEM	2	Glacier dependent	0.1
AeroDEM	25	Glacier dependent	6
BedMachine v4	150	2017	See Table S1 for mean error
Ice flux	N/A	1985-today (monthly to bi-weekly	Taken from Mankoff et al. (2020)
ITS_LIVE Velocities	240	1985-2019	Not need for processing (see raw data)

Table S 2 | Overview of location, mean bedrock topography error, and mean annual frontal ablation for each glacier.

Name, region, and latitude/longitude shown for each glacier as well as mean bedrock topography errors extracted along the centerline from BedMachine v4 (Morlighem et al., 2017, 2021)), and annual frontal ablation estimates for each tidewater glacier for the period 1987 – 2018 (period where observations are available for all tidewater glaciers).

Name	Region	Lat	Lon	Mean bedrock topography error (along centerline) [m]	Annual mean frontal ablation (1987-2018) [Gt/yr]
Akullersuup Sermia		64.38	-49.48	29.00	0.73
Kangiata Nunaata Sermia	SW	64.30	-49.61	57.50	5.65
Narsap Sermia		64.67	-49.86	45.22	2.16
Eqip Sermia		69.81	-50.19	41.33	0.83
Kangerlussuup Sermia		71.46	-51.31	44.83	1.86
Kangilernata Sermia		69.90	-50.34	13.87	0.83
Kangilliup Sermia (Rink Isbræ)		71.77	-51.50	53.33	12.78
Perlerfiup Sermia		70.99	-50.92	45.96	0.89
Saqqarliup Sermia		68.87	-50.28	18.61	0.38
Sermeq Avannarleq		70.09	-50.25	55.13	2.37
Sermeq Avannarleq (Lille Glacier)	CW	70.55	-50.49	21.85	0.17
Sermeq Kujalleq (CW)		70.00	-50.16	44.60	7.68
Sermeq Kujalleq (Jakobshavn Isbræ)		69.18	-49.80	73.93	42.15
Sermeq Kujalleq (Store Glacier)		70.41	-50.54	66.00	9.14
Sermeq Silarleq		70.83	-50.76	37.38	3.43
Sermilik		70.63	-50.62	43.79	0.99
Umiammakku Sermiat		71.81	-52.36	70.98	1.31
Dietrichson Glacier	NW	75.46	-58.06	32.98	1.89

Ikissuup Sermersua		74.23	-55.83	30.11	0.77
Illullip Sermia		74.42	-55.97	30.47	4.97
Innaqqissorsuup Oqquani Sermeq		76.38	-62.77	47.29	2.78
Issuusarsuit Sermiat		76.07	-60.63	17.63	1.11
Kangerluarsuup Sermia (Bowdoin Glacier)		77.69	-68.58	11.45	0.19
Naajarsuit Sermiat		73.25	-55.08	49.90	1.40
Nansen Glacier		75.78	-58.83	52.71	6.34
Qaqujaarsuup Sermia		77.52	-65.67	63.95	1.75
Qeqertarsuup Sermia		73.59	-55.53	21.48	0.73
Rink Glacier		76.22	-61.00	18.13	1.30
Salliarutsip Sermia		72.04	-52.61	37.12	0.96
Sermeq (Upernavik Isstrøm) 1		72.78	-54.25	27.02	2.97 } 3.16
Sermeq (Upernavik Isstrøm) 2		72.84	-54.28	57.66	0.19
Sermeq Avanarleq		73.94	-55.77	18.67	1.96
Sermeq Kujalleq (NW)		73.83	-55.58	52.17	2.17
Sermersuaq		75.32	-57.83	44.96	3.43
Sverdrup Glacier		75.62	-57.97	46.69	4.15
Tuttulikassaap Sermia 1		74.90	-56.90	25.15	6.67 } 13.35
Tuttulikassaap Sermia 2		74.96	-57.04	54.16	6.68
Tuttulipaluup Sermia		77.70	-66.23	46.44	0.57
Ullip Sermia		76.58	-67.63	25.70	0.94
Yngvar Nielsen Glacier		76.33	-64.08	79.64	0.88
Christian IV Glacier		68.70	-30.62	46.85	4.39
Daugaard Jensen Glacier	CE	71.75	-29.00	67.72	9.48
Frederiksborg Glacier		68.46	-31.66	24.30	0.28
Kangerlussuaq Glacier		68.67	-33.08	58.88	24.21
A.P. Bernstorff Glacier		63.88	-41.77	85.88	3.69
Apuseerajik		66.38	-37.54	75.03	2.70
Apusiigajik		63.29	-41.92	88.47	1.99
Graulv	SE	64.35	-41.57	90.98	4.78
Heimdal Glacier		62.91	-42.69	63.31	2.09
Helheim Glacier		66.37	-38.31	72.93	27.83
Rimfaxe/Guldfaxe		63.31	-42.37	45.34	1.59

Table S 3 | Comparison of decadal mean frontal ablation estimates

Comparison of mean frontal ablation estimates [GT/a] from Kochtitzky et al. (2023) and this study for the periods 2000-2010, and 2010- 2020. Only shows tidewater glaciers that are investigated in both studies. Colours indicate where estimates presented in this study are within the uncertainty boundaries of Kochtitzky et al. (2023).

Glacier names	Kochtitzky et al. (2023)		This study	
	Annual mean 2000-10	Annual mean 2010-20	Annual mean 2000-10	Annual mean 2010-20
Akullersuup Sermia	0.76±0.24	0.58±0.13	0.72±0.15	1.51±0.15
AP Bernstorff Glacier	4.98±0.11	4.63±0.08	4.31±2.16	4.49±2.6
Apuseerajik	2.36±0.08	2.97±0.06	2.53±1.10	3.54±1.10
Christian IV Glacier	3.96±0.26	3.57±0.19	4.13±0.78	4.73±0.78
Daugaard Jensen Glacier	8.12±0.12	8.77±0.10	9.24±2.60	9.93±2.60
Eqip Sermia	0.56±0.07	0.86±0.05	0.79±0.67	1.88±0.67
Frederiksborg Glacier	0.28±0.14	0.23±0.11	0.28±0.29	1.01±0.29
Graulv	4.82±0.08	4.29±0.05	5.01±1.21	5.26±1.21
Heimdal Glacier	1.34±0.05	1.24±0.04	1.56±0.21	3.12±0.21
Helheim Glacier	28.39±0.21	27.17±0.14	28.53±6.25	28.66±6.25
Ikissuup Sermersua	0.62±0.33	0.69±0.24	0.69±0.66	1.71±0.66
Illullip Sermia	5.46±0.39	5.67±0.22	5.16±0.95	6.03±0.95
Innaqqissorsuup Oqquani Sermeq	3.14±0.39	3.51±0.48	2.77±0.60	3.40±0.60
Issuusarsuit Sermiat	3.62±0.34	3.93±0.24	1.03±0.23	2.17±0.23
Kangerluarsuup Sermia (Bowdoin)	0.19±0.16	0.19±0.15	0.20±0.11	1.16±0.11
Kangerlussuaq Gletsjer	27.04±0.27	27.31±0.19	28.42±6.08	27.82±6.08
Kangerlussuup Sermia	1.62±0.11	1.59±0.08	1.92±0.77	2.51±0.77
Kangiata Nunaata Sermia	5.13±0.09	4.71±0.07	5.84±2.42	5.48±2.42
Kangilernata Sermia	1.21±0.13	1.96±0.08	0.84±0.45	1.87±0.45
Kangilliup Sermia (Rink Isbræ)	12.23±0.16	11.65±0.12	13.19±2.26	12.88±2.26
Naajarsuit Sermiat	1.17±0.13	0.96±0.09	1.37±0.35	1.85±0.35
Narsap Sermia	1.56±0.14	2.88±0.07	1.75±0.56	4.36±0.56
Qaqujaarsuup Sermia	1.71±0.18	1.76±0.12	1.73±1.47	2.49±1.47
Qeqertarsuup Sermia	0.70±0.11	0.81±0.08	0.82±0.18	1.59±0.18
Rimfaxe/Guldfaxe	1.79±0.10	1.74±0.08	1.75±0.26	1.75±0.26
Rink Glacier	1.23±0.38	1.18±0.23	1.49±0.60	1.79±0.60
Salliarutsip Sermia	0.84±0.10	1.94±0.06	0.85+0.68	2.12±0.68
Saqqarliup Sermia	0.06±0.31	0.14±0.33	0.21±0.32	1.06±0.32
Sermeq Avanarleq	1.83±0.25	1.82±0.17	1.93±0.36	2.62±0.36

Sermeq Avannarleq	2.21±0.14	2.04±0.09	2.38±0.42	2.93±0.42
Sermeq Kujalleq (Jakobshavn Isbræ)	36.27±0.78	42.28±0.52	48.75±15.93	47.63±15.93
Sermeq Kujalleq (CW)	7.44±0.23	6.12±0.21	8.03±1.31	8.05±1.31
Sermeq Kujalleq (NW)	1.86±0.10	1.95±0.07	2.03±0.53	2.78±0.53
Sermeq Kujalleq (Store Glacier)	7.92±0.12	8.03±0.08	9.14±1.21	9.40±1.21
Sermeq(Upernavik_Isstrøm)1	0.33±0.16	0.33±0.11	3.12±0.88	3.21±0.88
Sermeq(Upernavik Isstrøm)2	7.74±0.28	9.19±0.19	0.16±0.87	0.97±0.87
Sermersuaq	5.15±0.62	6.81±0.637	3.57±2.56	4.80±2.56
Sverdrup Glacier	5.03±0.27	6.59±0.15	4.47±2.40	6.42±2.40
Ullip Sermia	0.99±0.48	0.81±0.28	0.96±0.66	1.66±0.66
Umiammakku Sermiat	3.50±0.16	4.24±0.10	1.60±1.19	2.10±1.19
Ullip Sermia	0.99±0.48	0.81±0.48	0.96±0.66	1.66±0.66
Umiammakku Sermiat	3.50±016	4.24±0.16	1.60±1.19	2.10±1.19
Yngvar Nielsen Glacier	0.54±0.13	1.07±0.13	0.63±2.04	1.56±2.04
Total	**210.71±9.64**	**224.34±7.26**	**217.11±68.64**	**245.59±68.64**
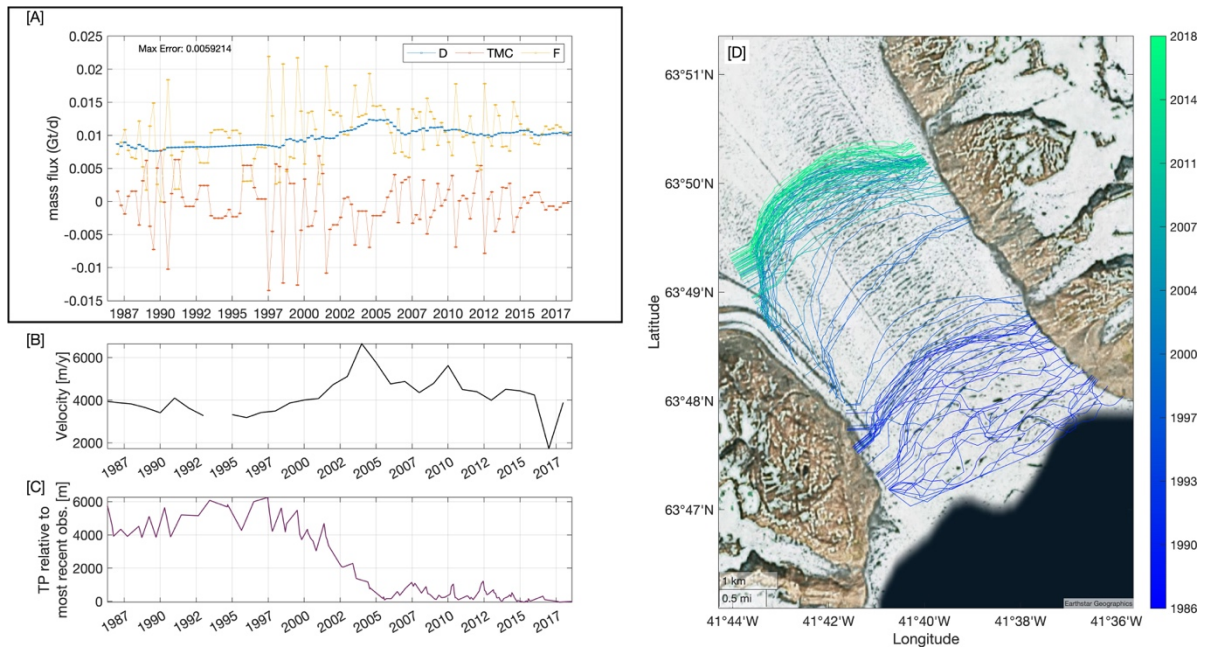
Figure S 2 | Results for A.P. Bernstorff Glacier

Example of output data for Helheim Glacier, SE Greenland shown in A) with three-monthly frontal ablation estimates shown in yellow, and discharge (blue) and terminus associated mass change (TMC, red) shown for comparison. Maximum error is also shown (for details see supplementary). B) Annual flow velocity in m/yr from NASA ITS_LIVE data B) Terminus position (TP) relative to most recent observation along the centerline. Panels B) and C) are only shown for validation purposes and are not part of the dataset. D) Terminus positions used to calculate frontal ablation estimates colour coded by date.
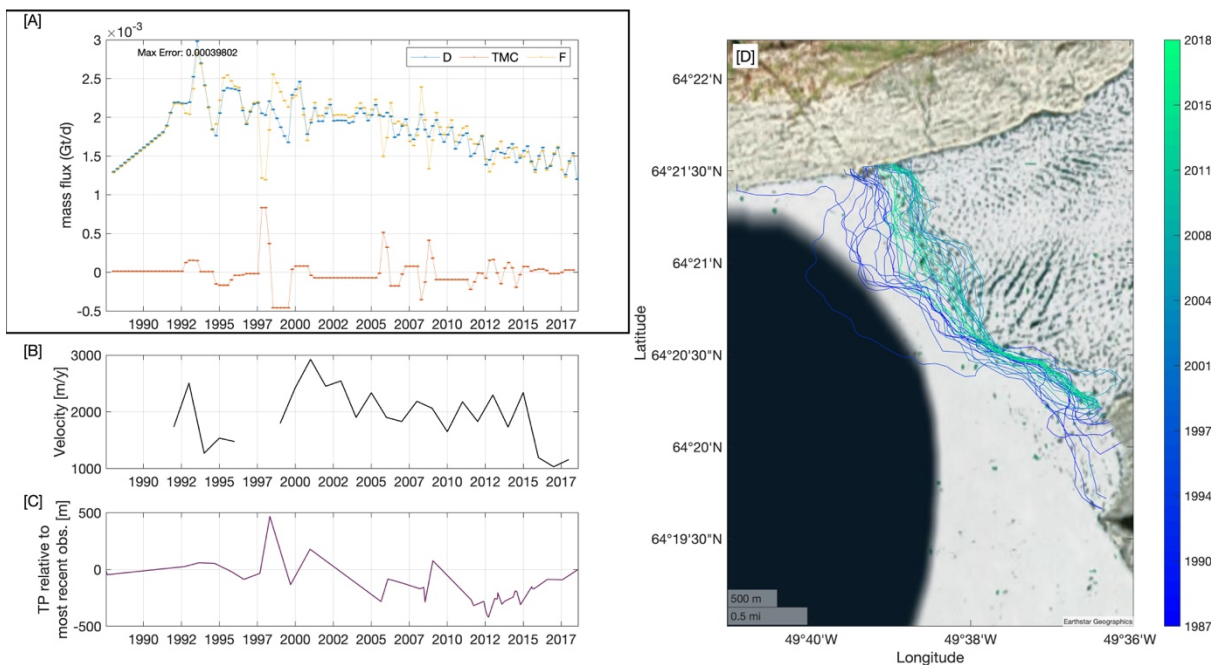
Figure S 3 | Results for Akullersuup Sermia

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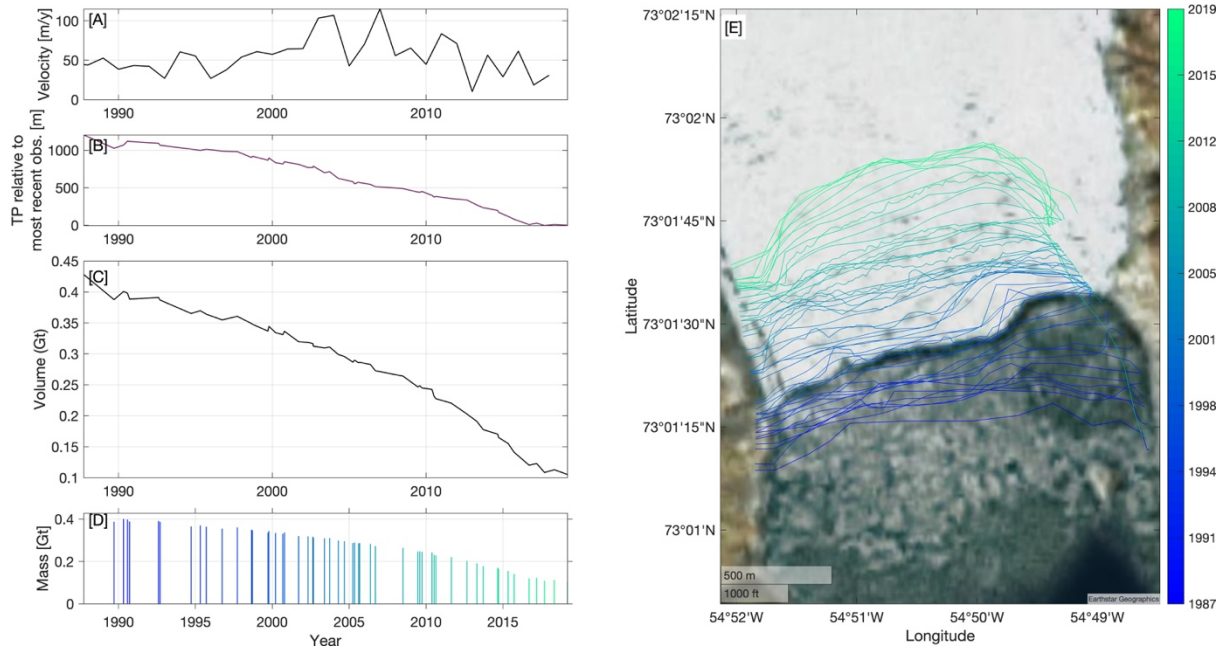
Figure S 4 | Results for Akullikassaap Sermia *Volume Only*

A) Annual flow velocity in m/yr from NASA ITS_LIVE data B) Terminus position relative to most recent observation along the centerline. C) Volume change displayed only as no discharge data from Mankoff et al. (2020) available. D). Mass of each polygon that is associated with a terminus delineation, colours correspond to individual terminus position shown in E. E) Colour-coded terminus positions to correspond with frontal ablation data. Basemap from Earthstar Geogrpahics.
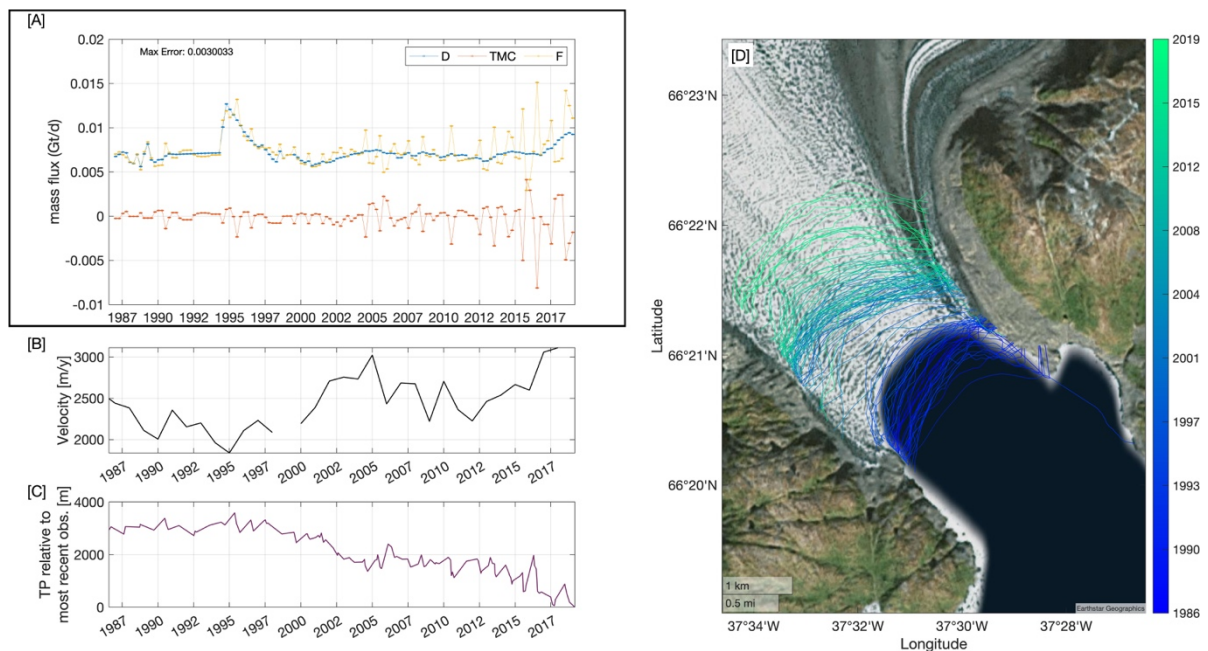
Figure S 5 | Results for Apuseerajik

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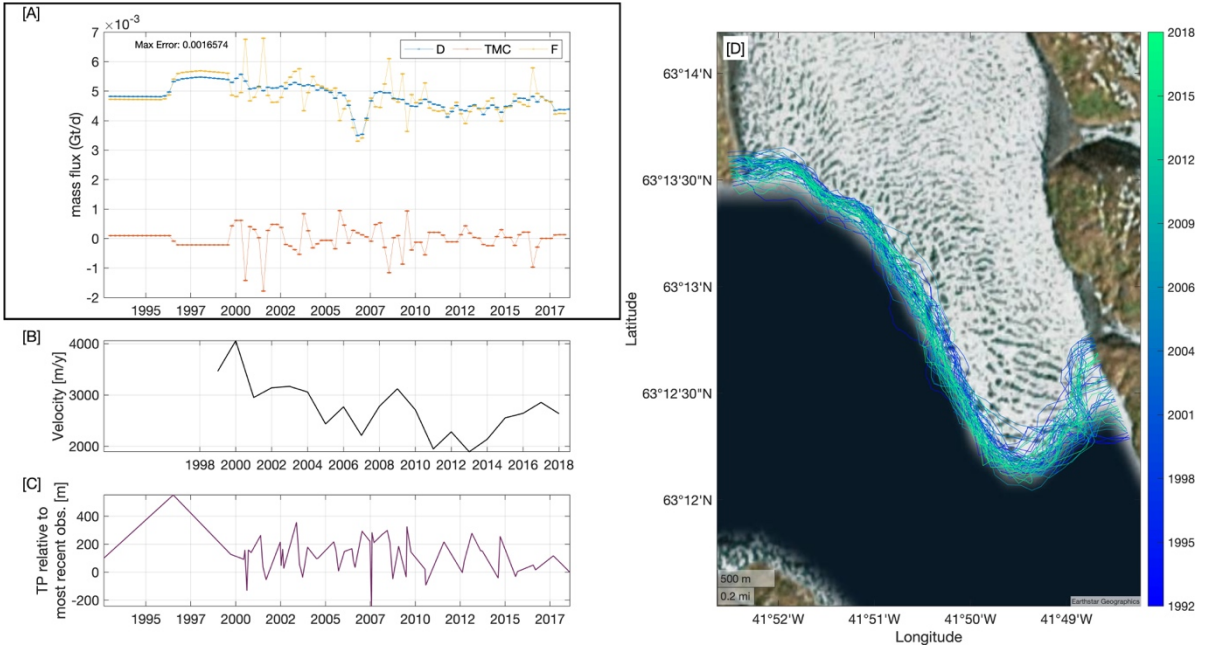
Figure S 6 | Results for Apusiigajik

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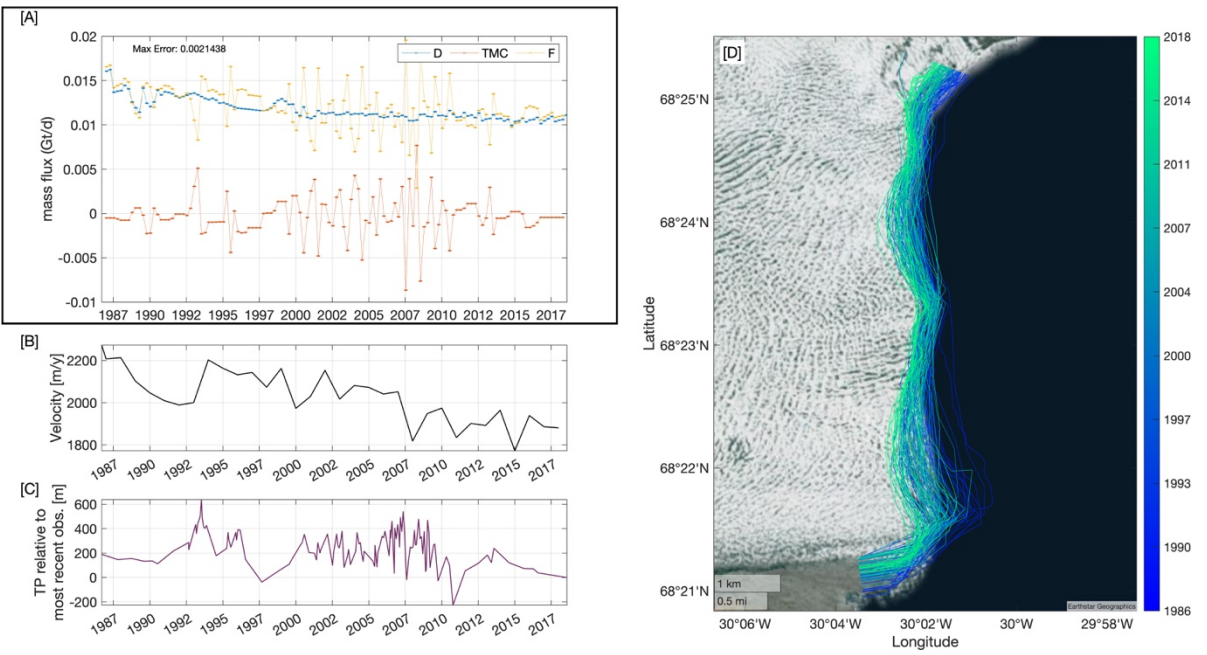
Figure S 7 | Results for Christian IV Glacier

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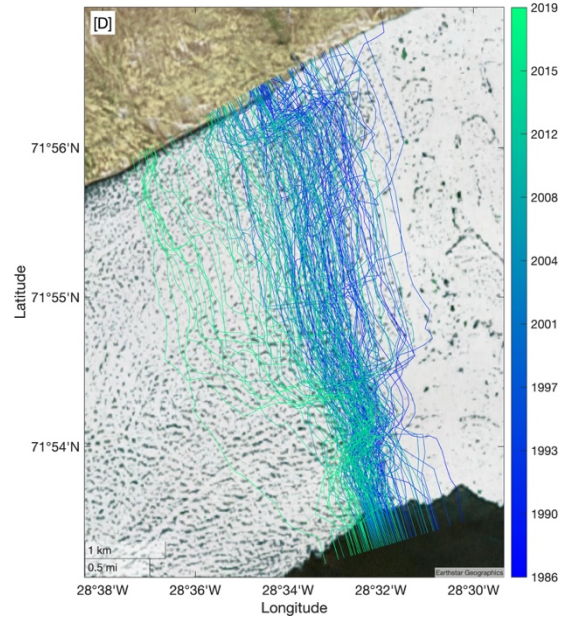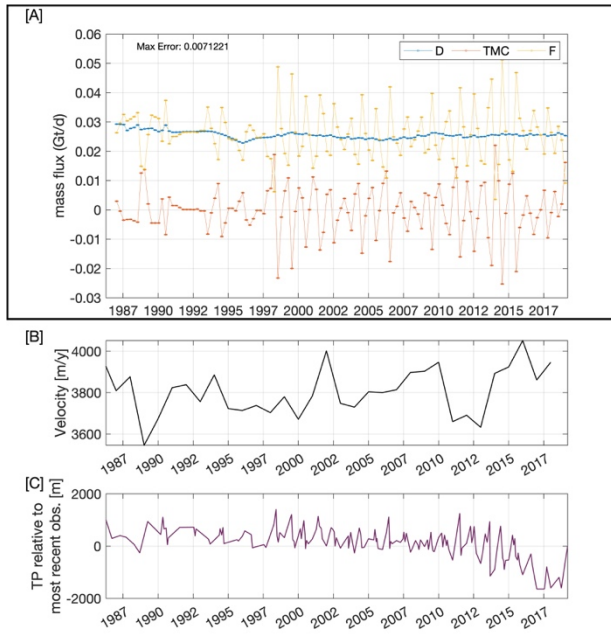
Figure S 8 | Results for Daugaard Jensen Glacier

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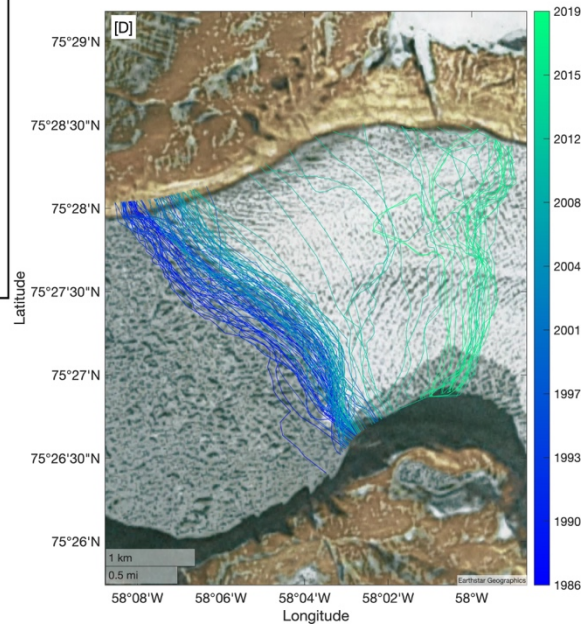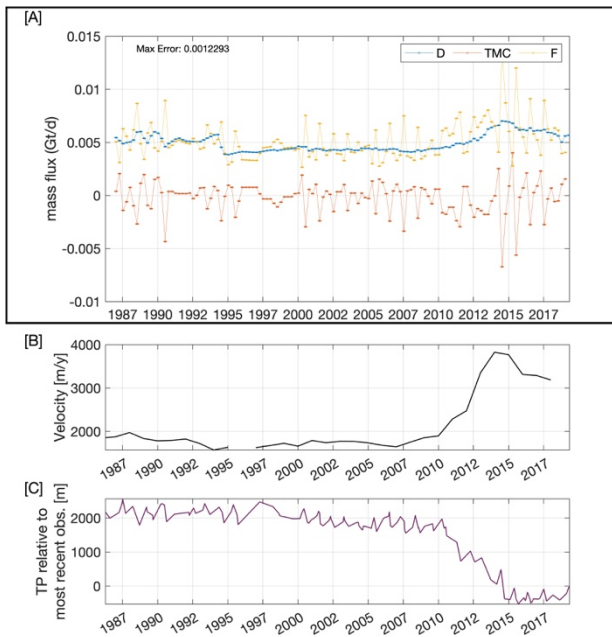
Figure S 9 | Results for Dietrichson Glacier

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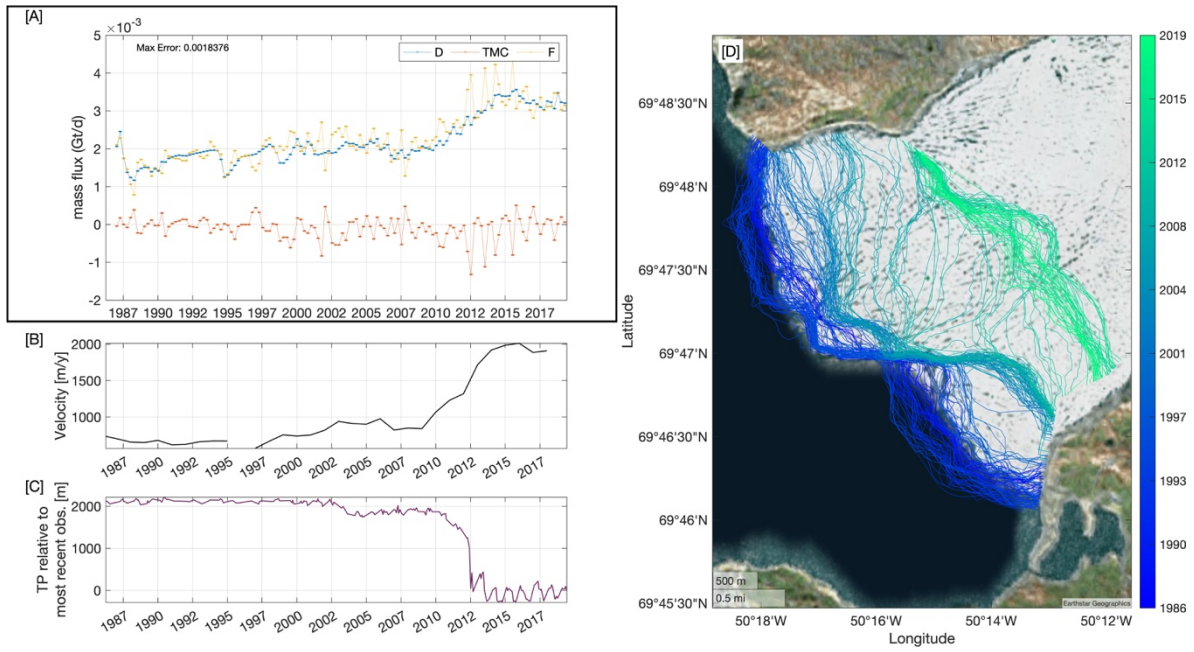
Figure S 11 | Results for Eqip Sermia

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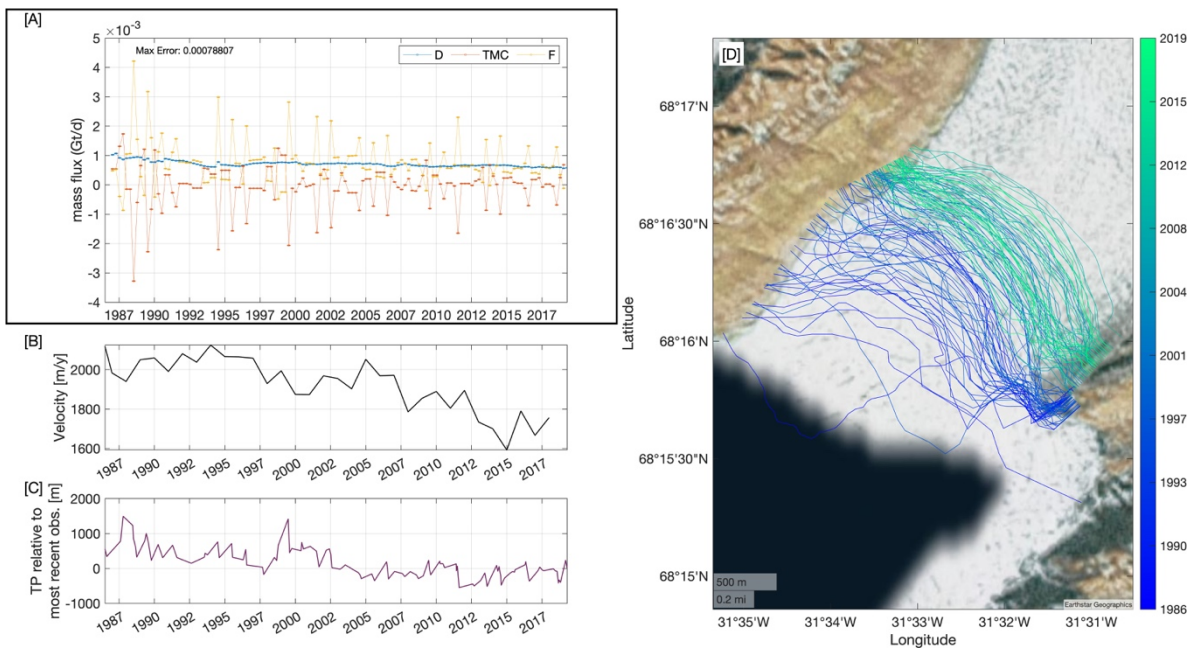
Figure S 10 | Frederiksborg Glacier

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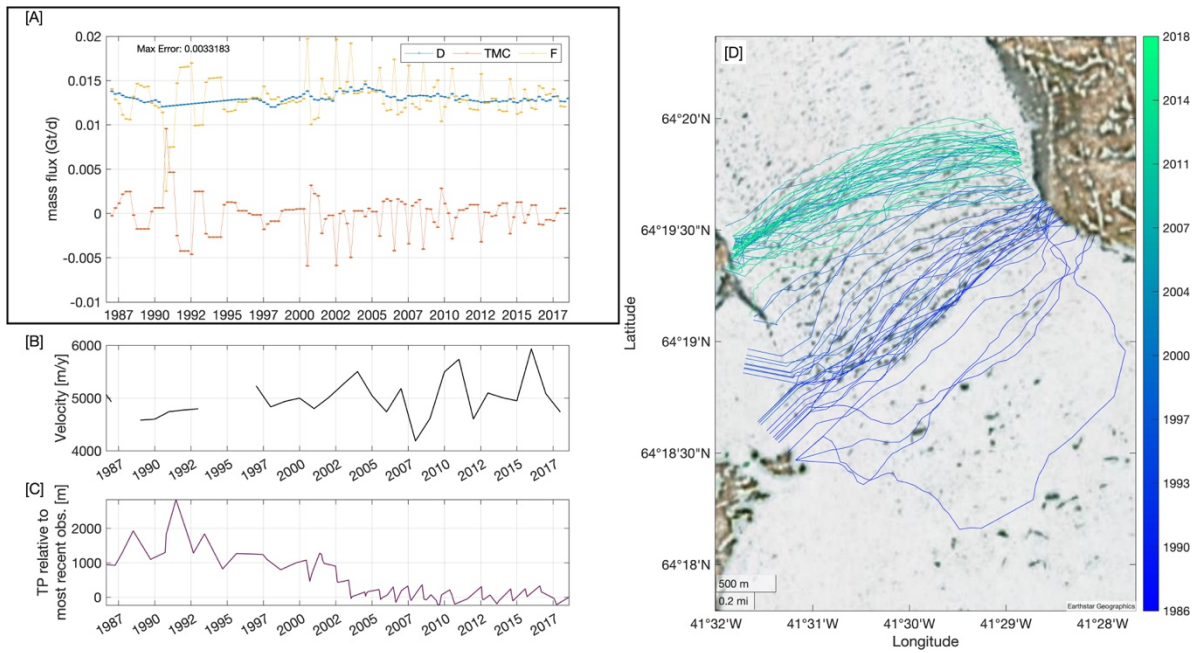
Figure S 12 | Results for Graulv

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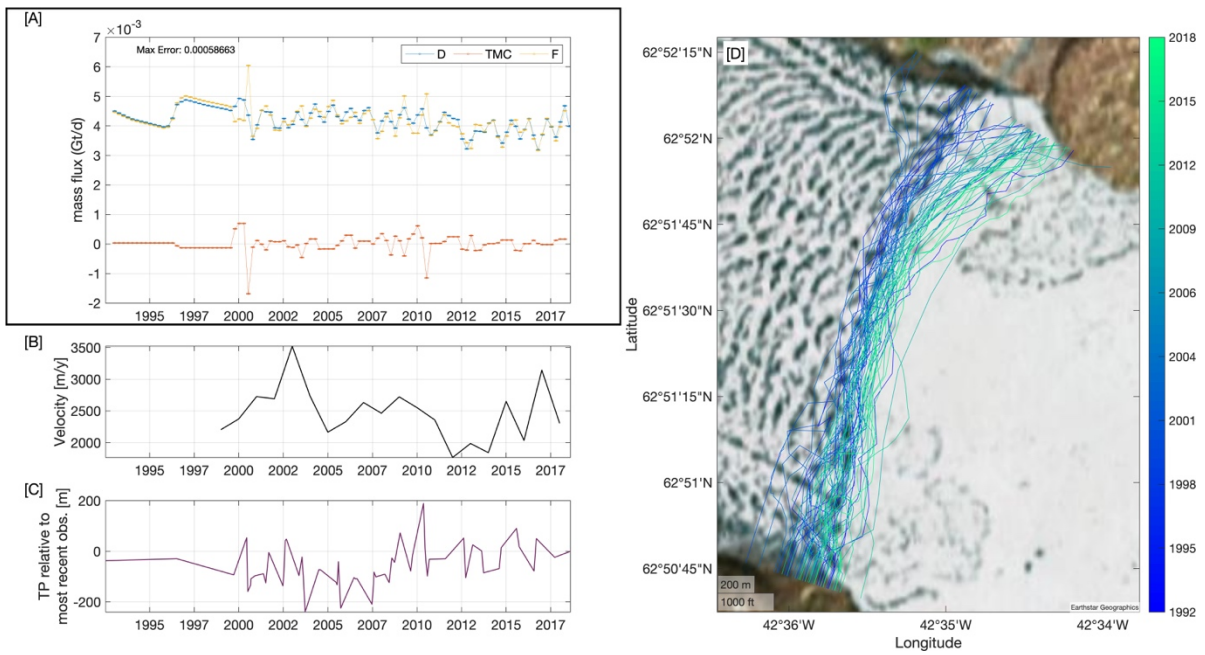
Figure S 13 | Results for Heimdal Glacier

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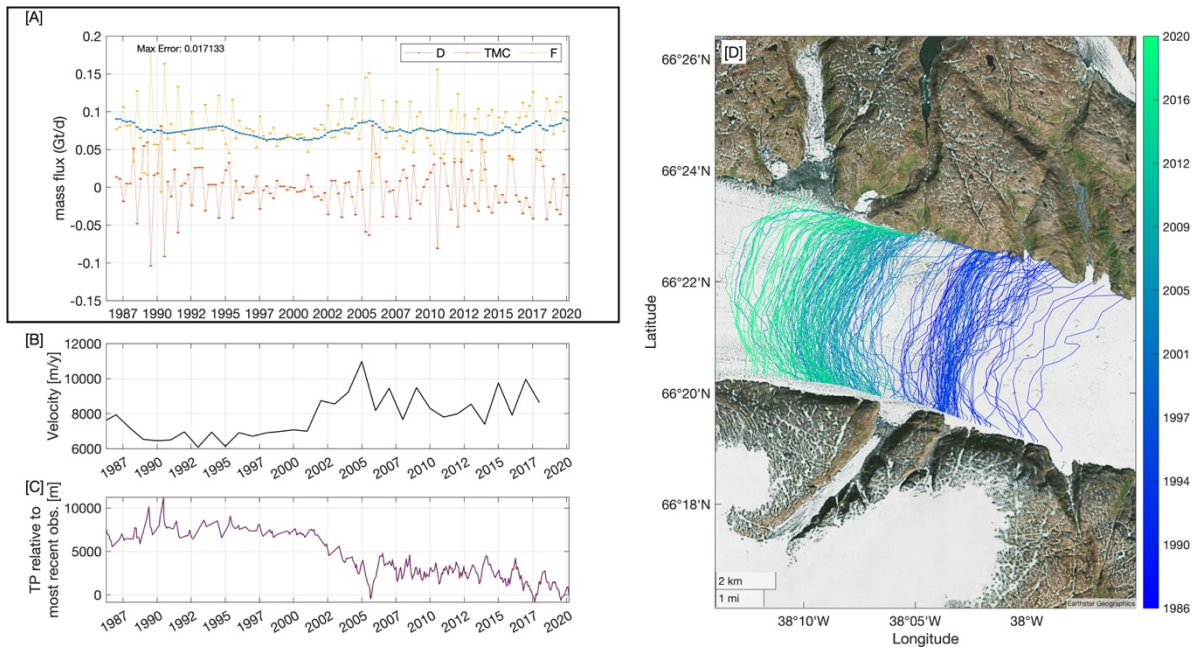
Figure S 14 | Results for Helheim Glacier

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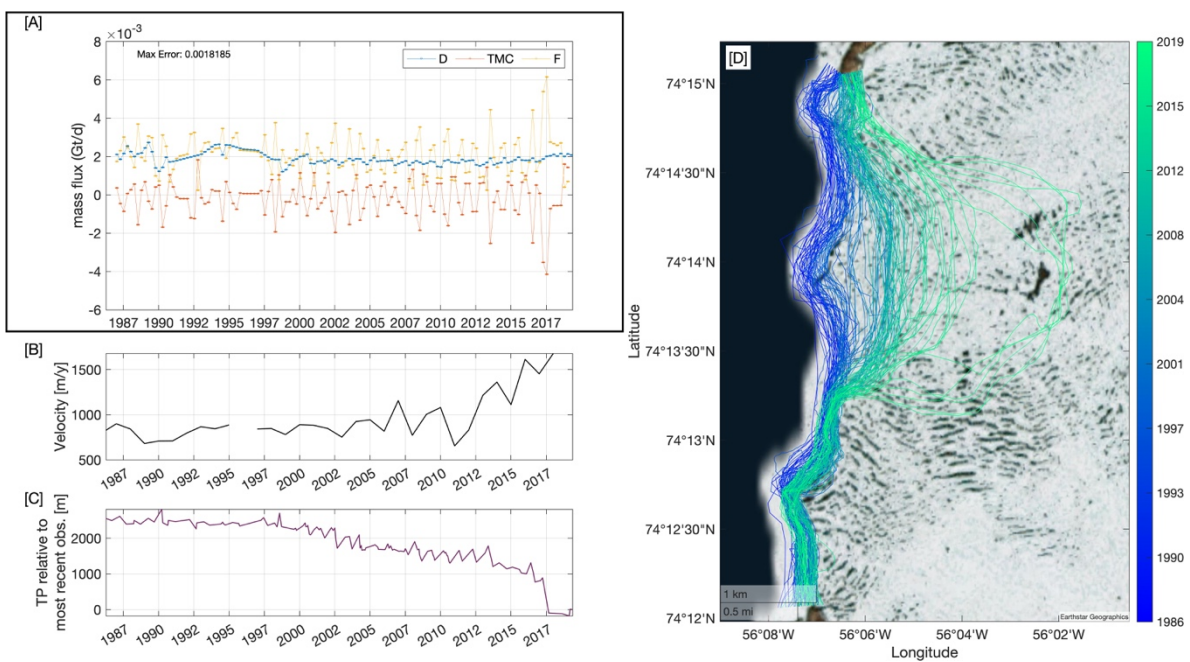
Figure S 15 | Results for Ikissuup Sermersua

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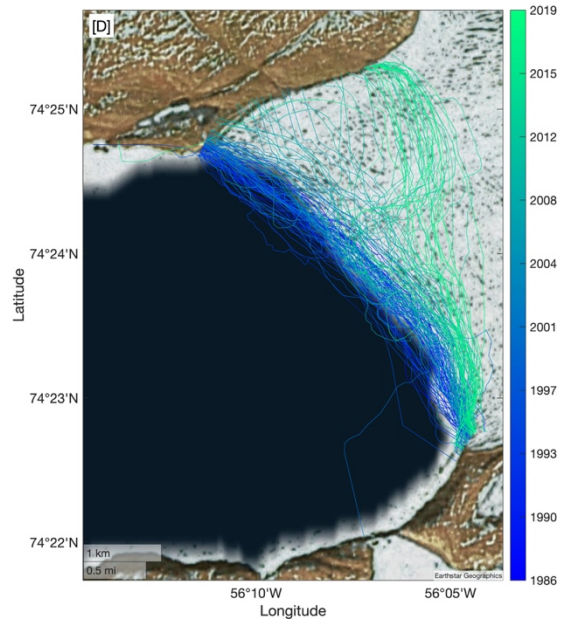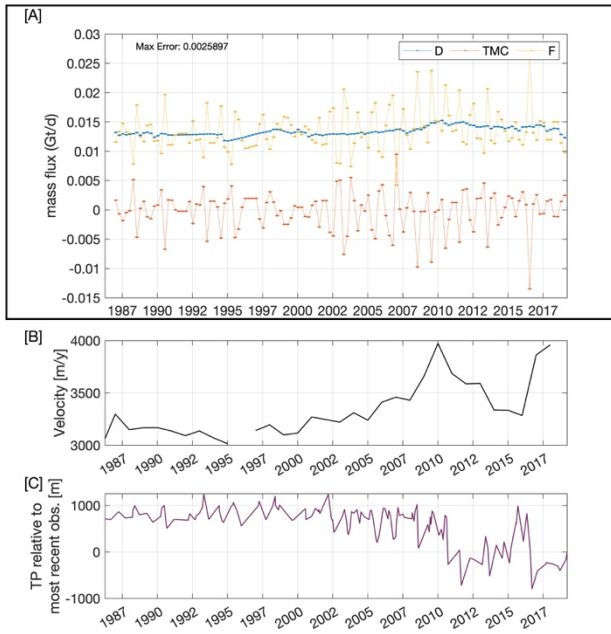
Figure S 16 | Results for Illullip Sermia

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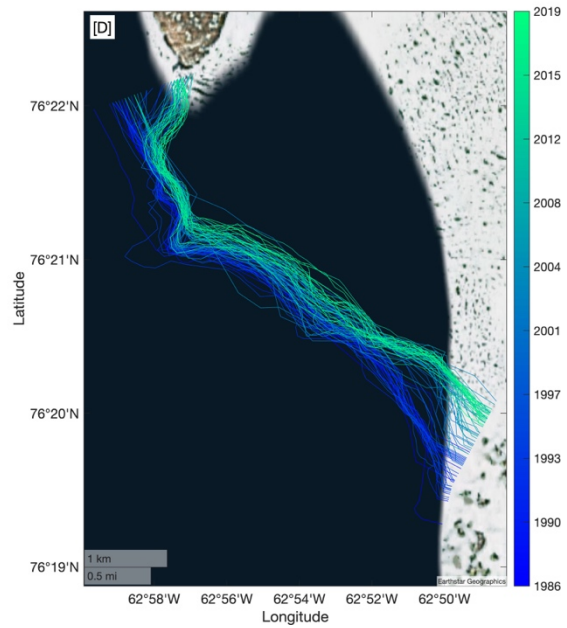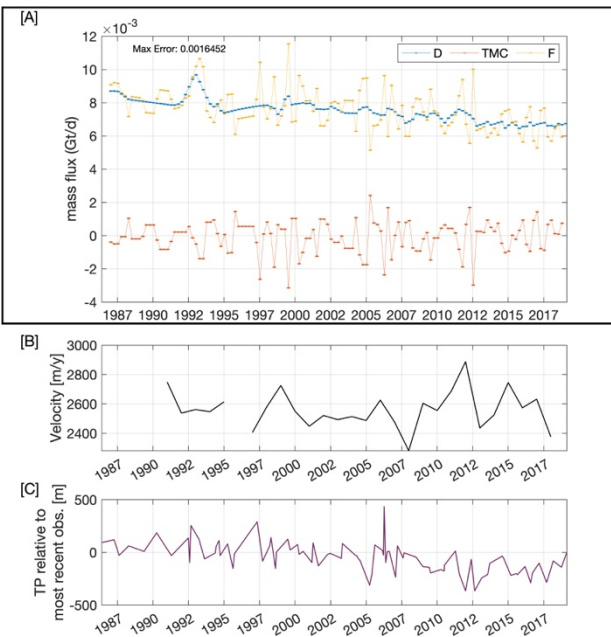
Figure S 17 | Results for Innaqqissorsuup Oqquani Sermeq

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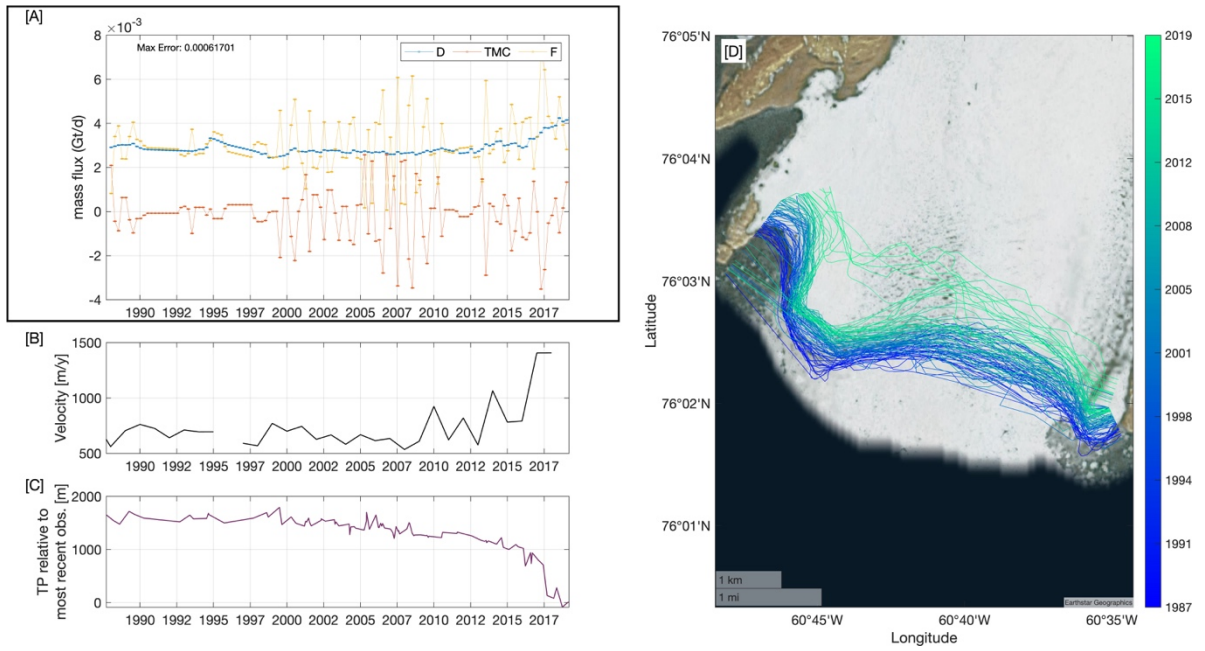
Figure S 18 | Results for Issuusarsuit Sermiat

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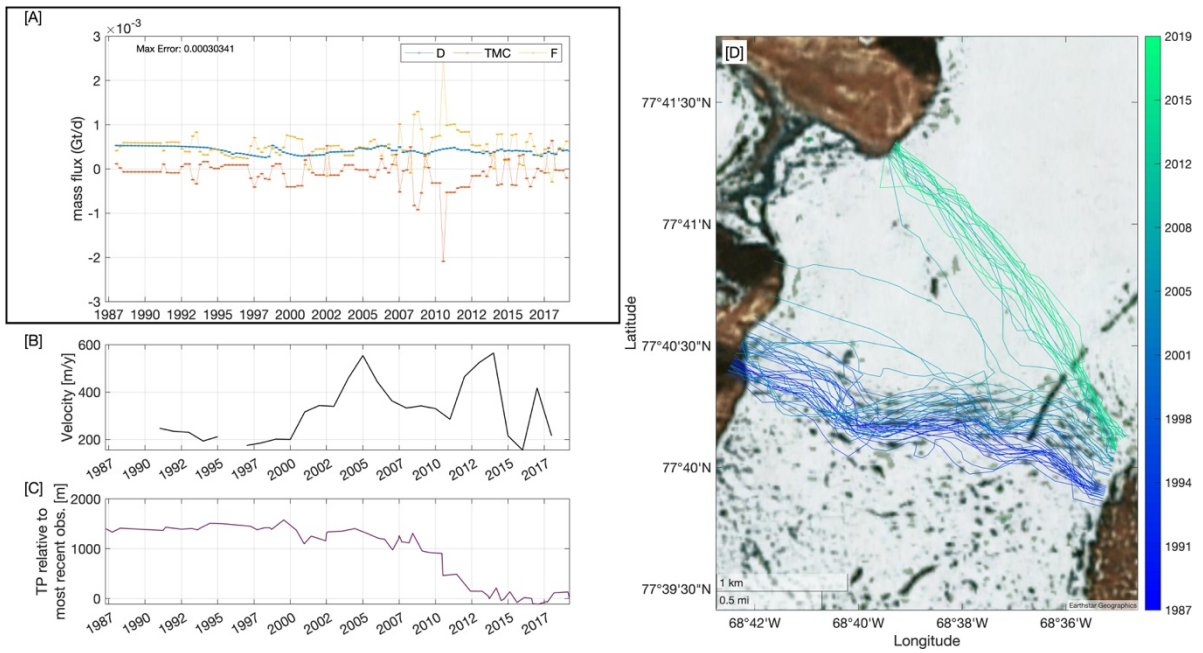
Figure S 19 | Results for Kangerluarsuup Sermia (Bowdoin glacier)

Same as in Figure S 2
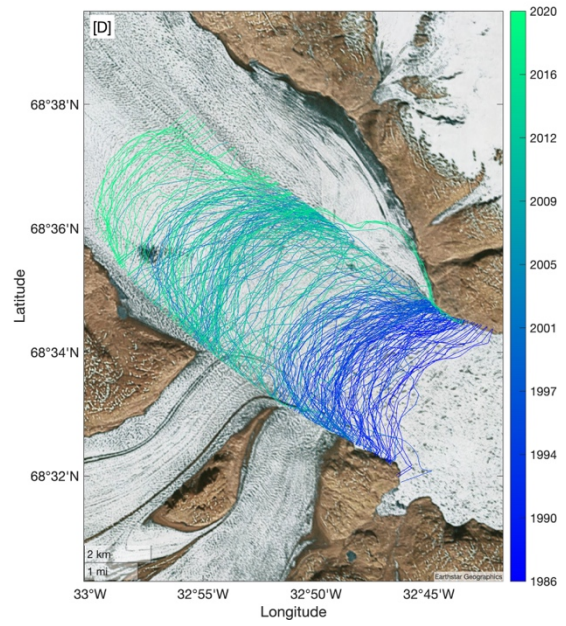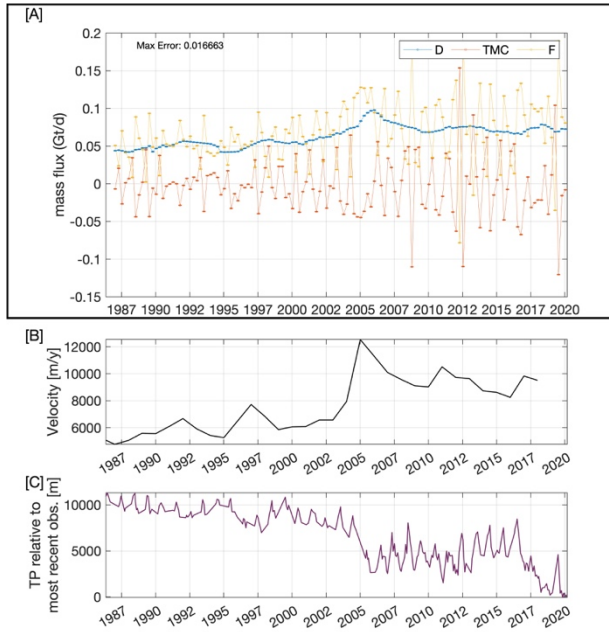
Figure S 20 | Results for Kangerlussuaq Glacier

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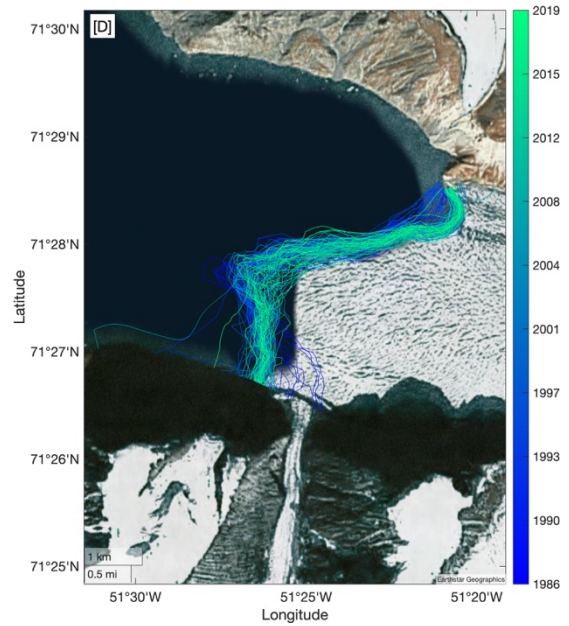
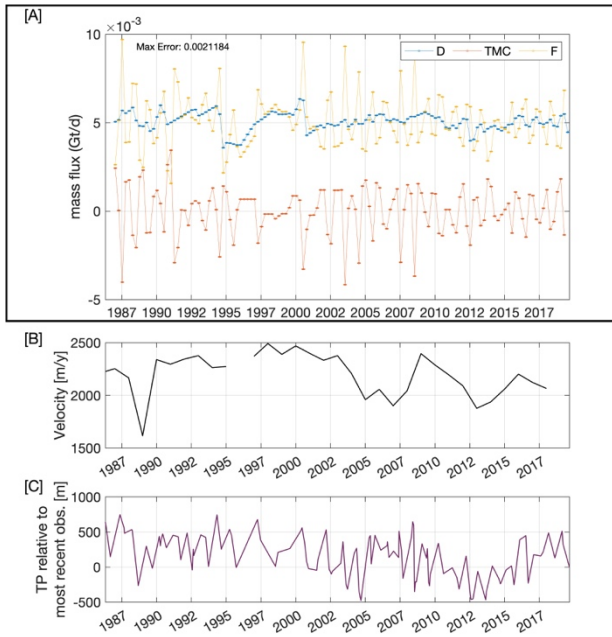


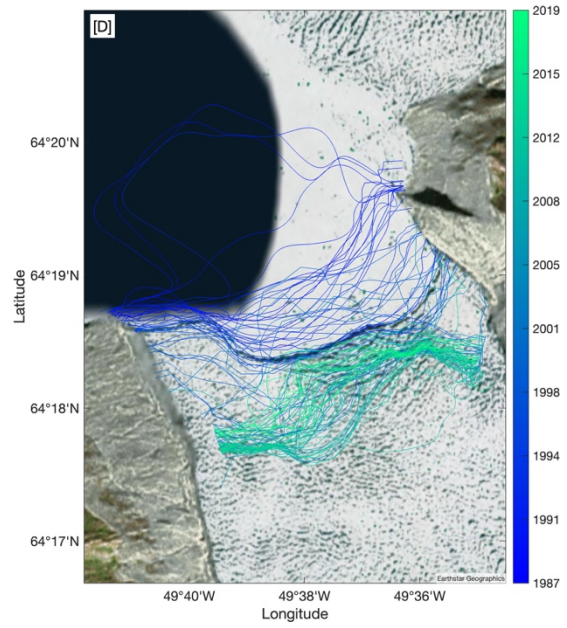
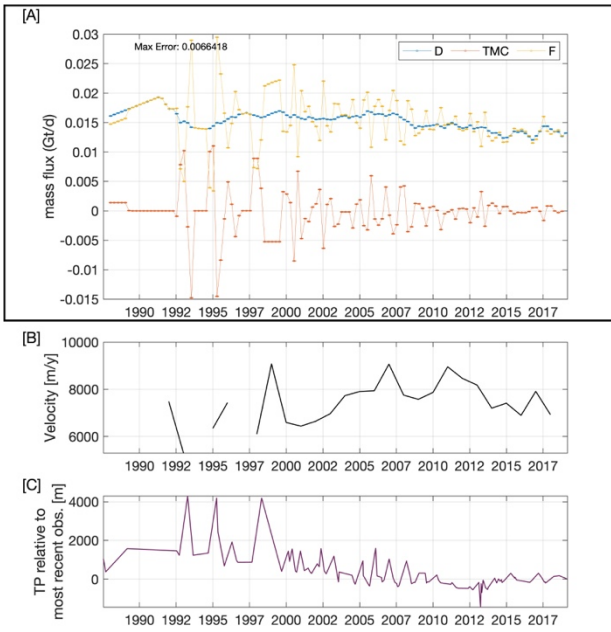
Figure S 21 | Results for Kangerlussuup Sermia

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Figure S 22 | Results for Kangiata Nunaata Sermia

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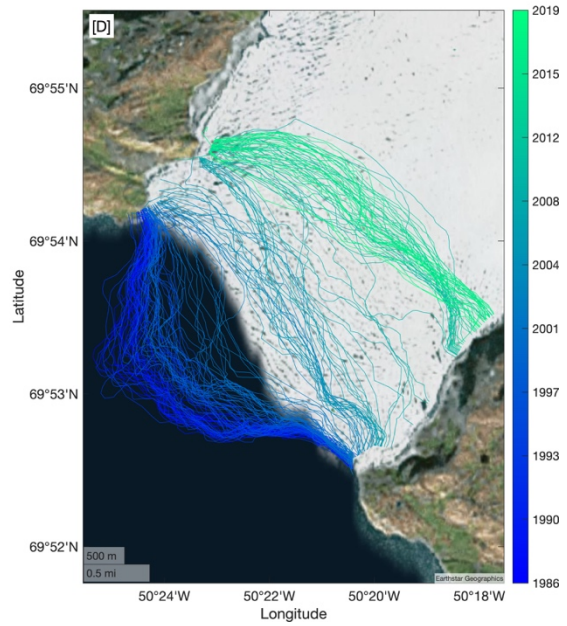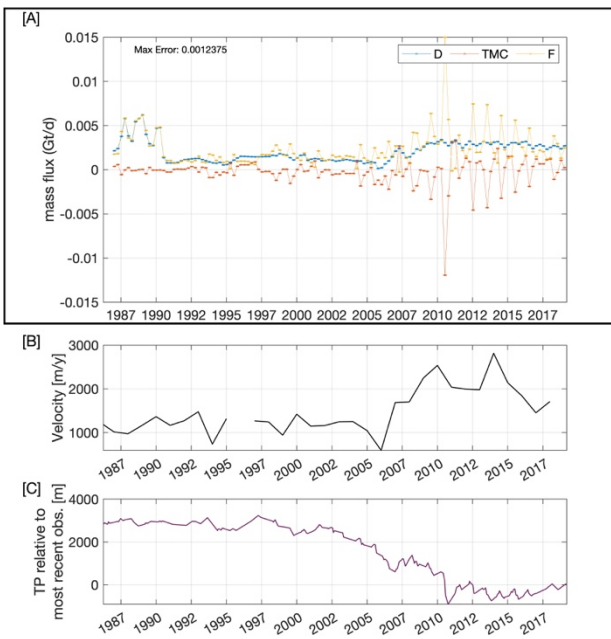
Figure S 23 | Results for Kangilernata Sermia

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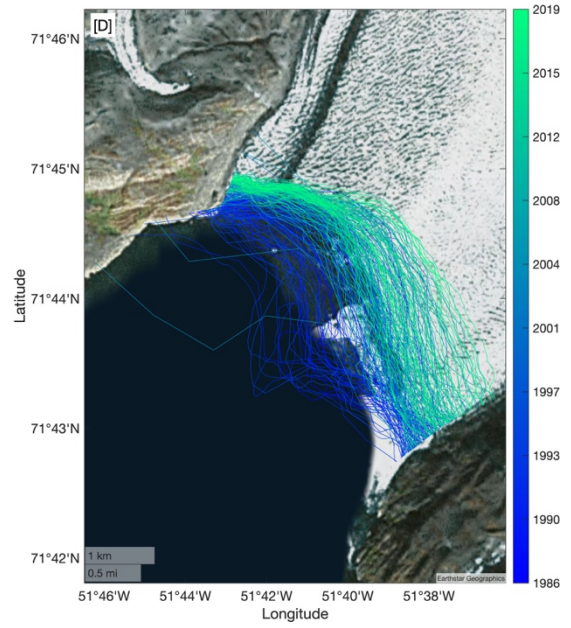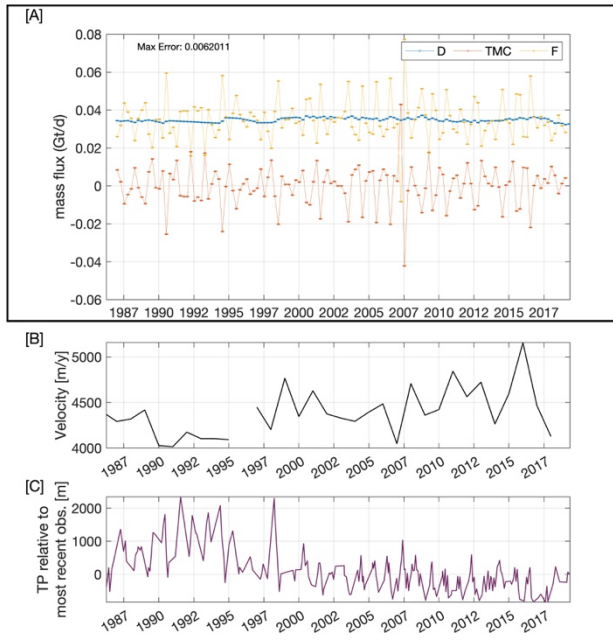
Figure S 24 | Results for Kangilliup Sermia (Rink glacier)

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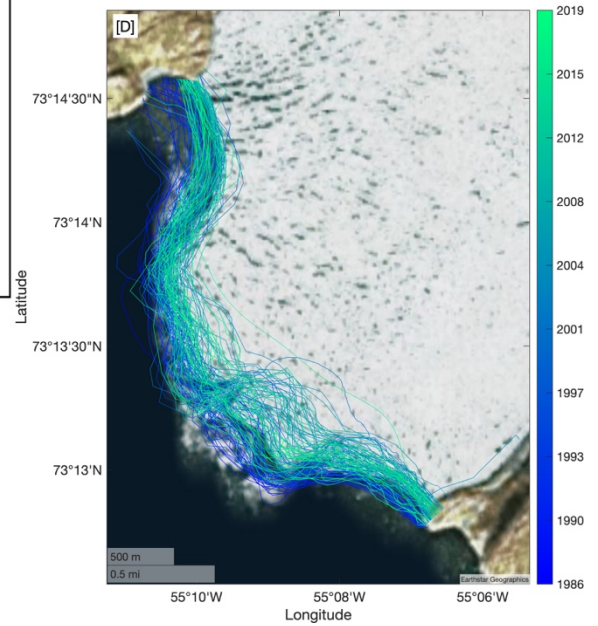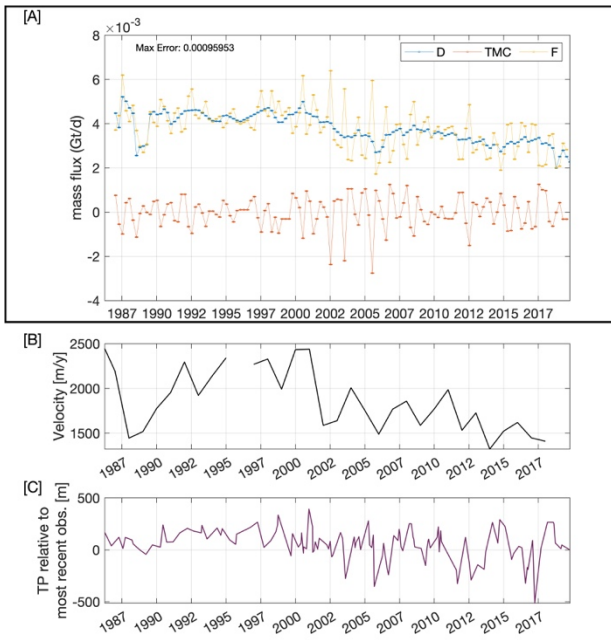
Figure S 25 | Results for Naajarsuit Sermiat

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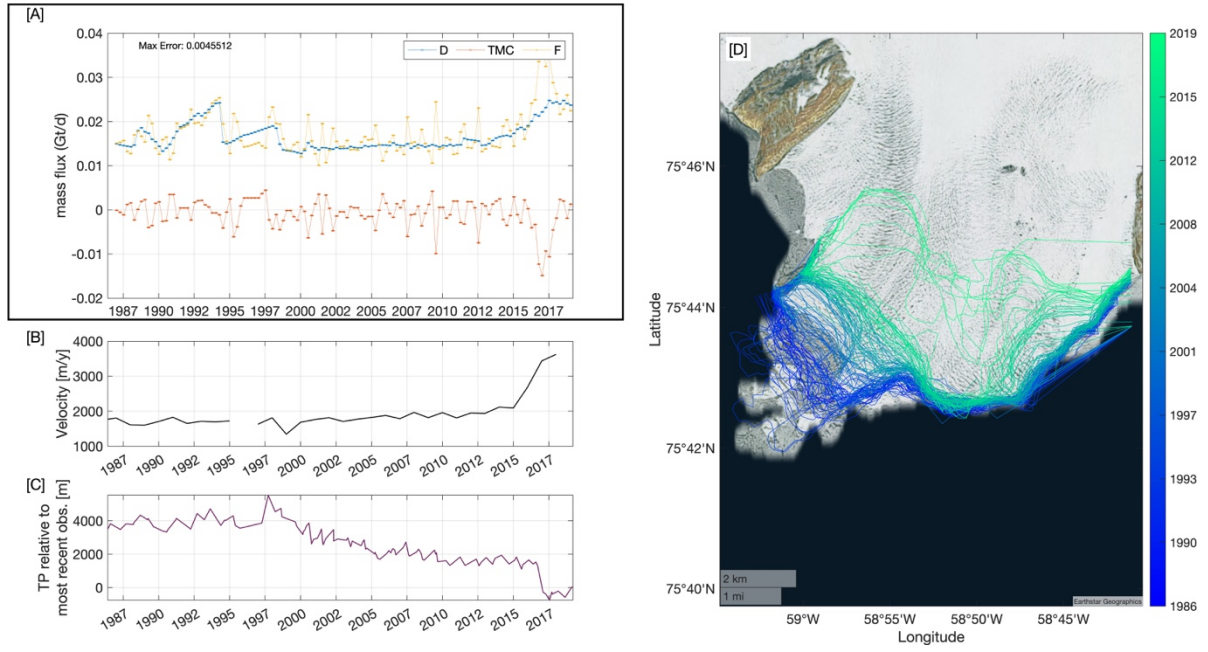
Figure S 26 Results for Nansen Glacier

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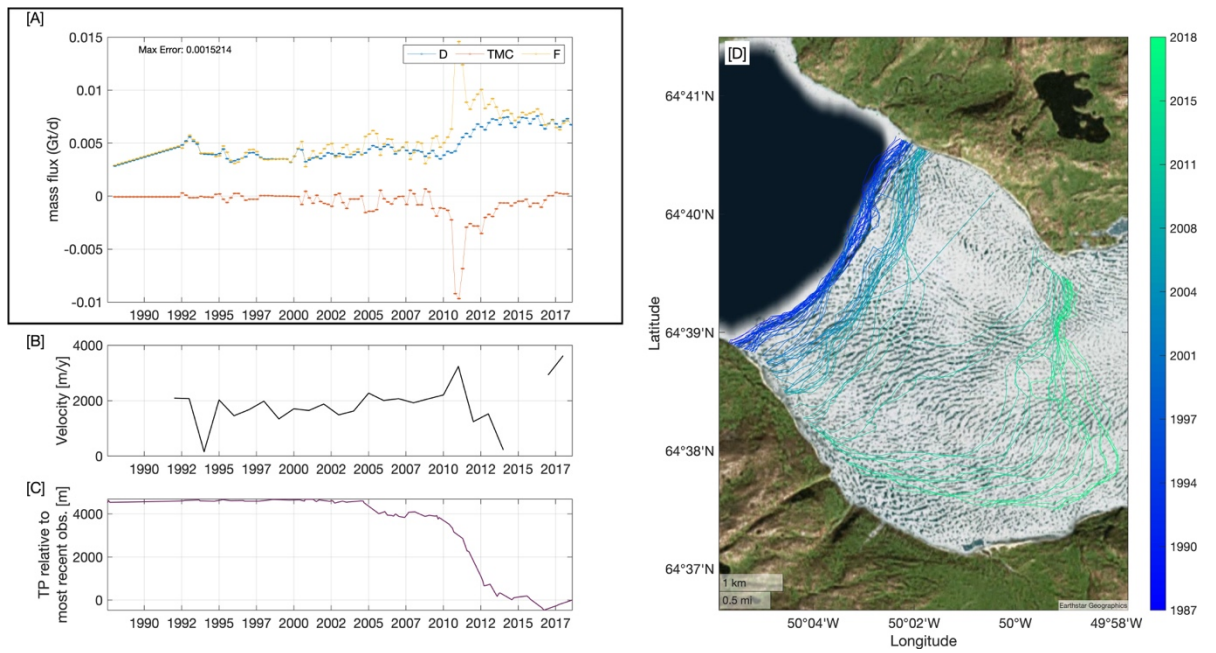
Figure S 27 | Results for Narsap Sermia

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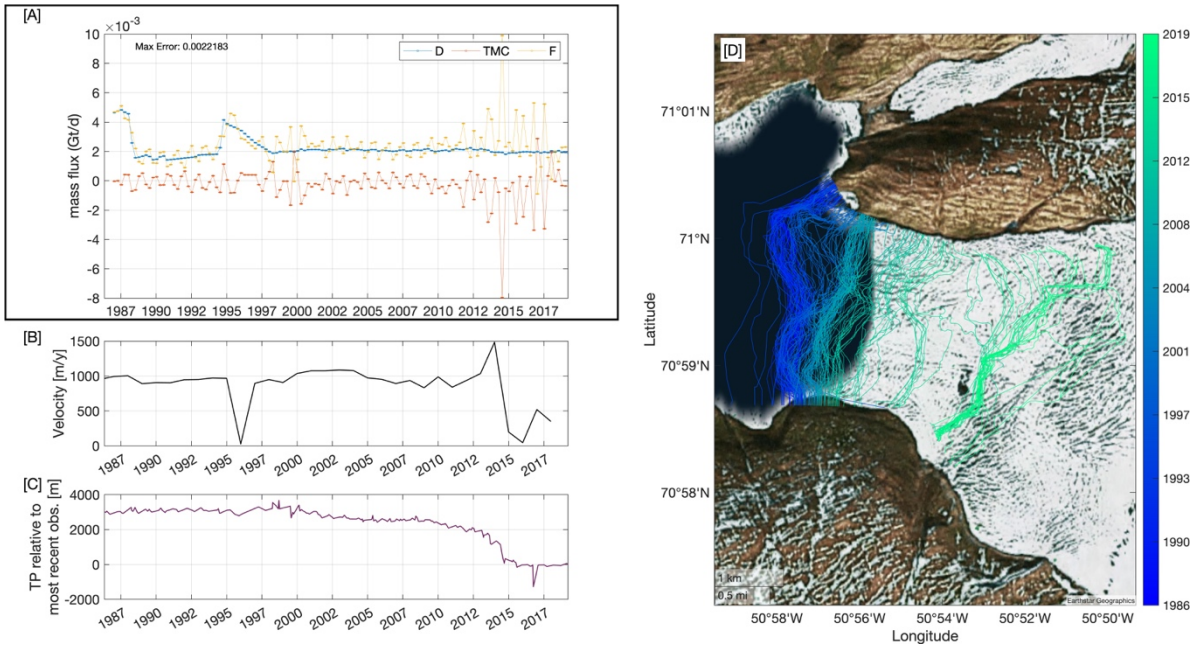
Figure S 28 | Results for Perlerfiup Sermia

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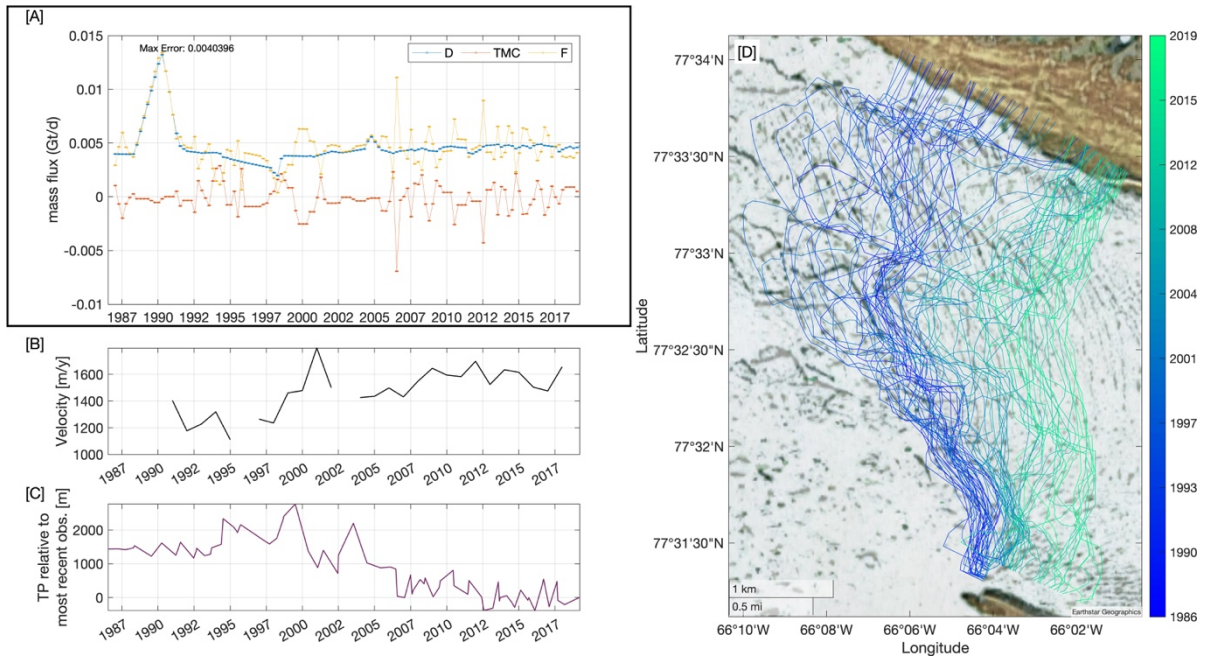
Figure S 29 | Results for Qaqujaarsuup Sermia

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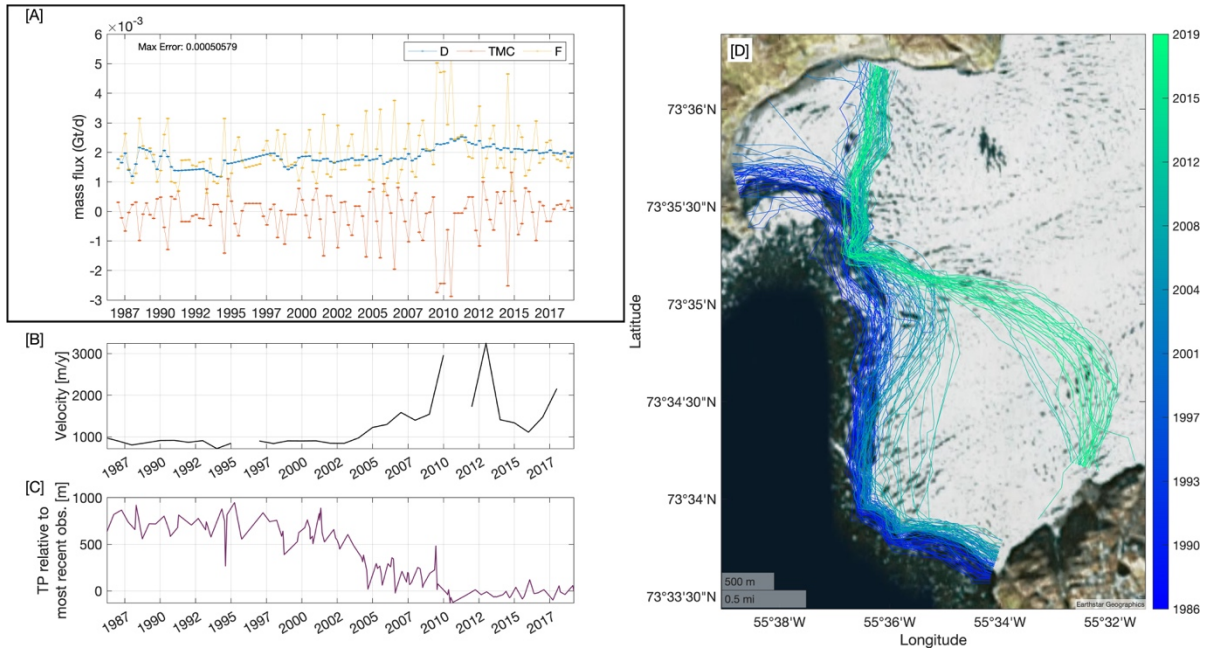
Figure S 30 | Results for Qeqertarsuup Sermia

Same as in Figure S 2
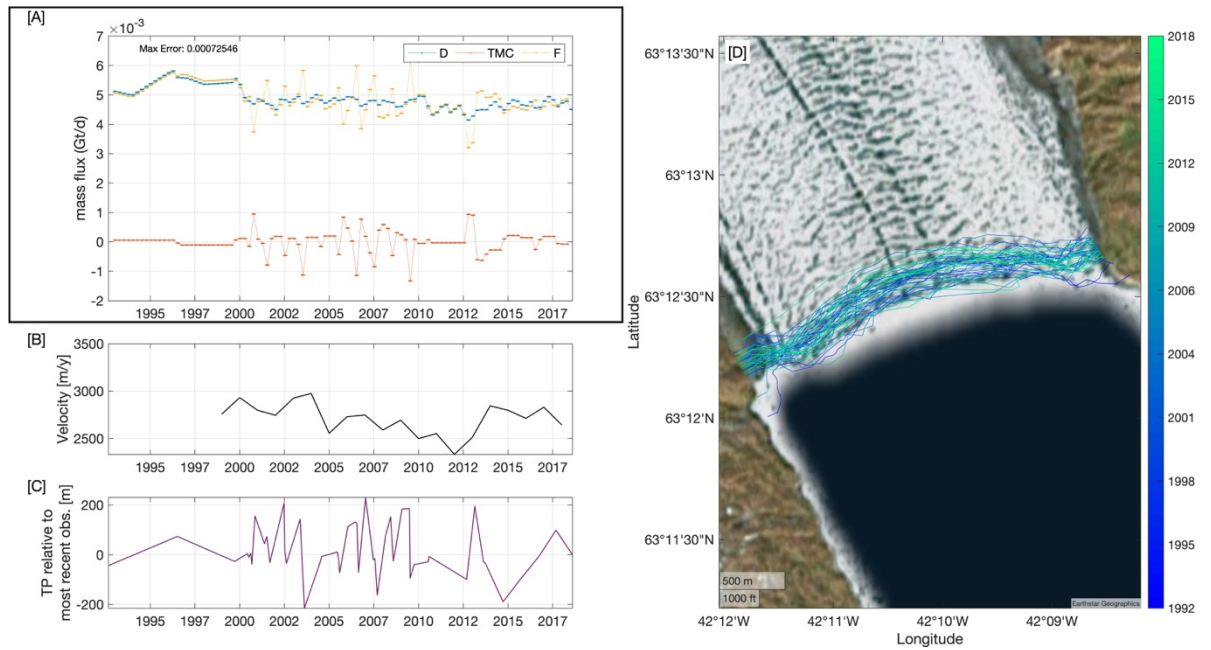
Figure S 31 | Results for Rimaxe/Guldfaxe

Same as in Figure S 2
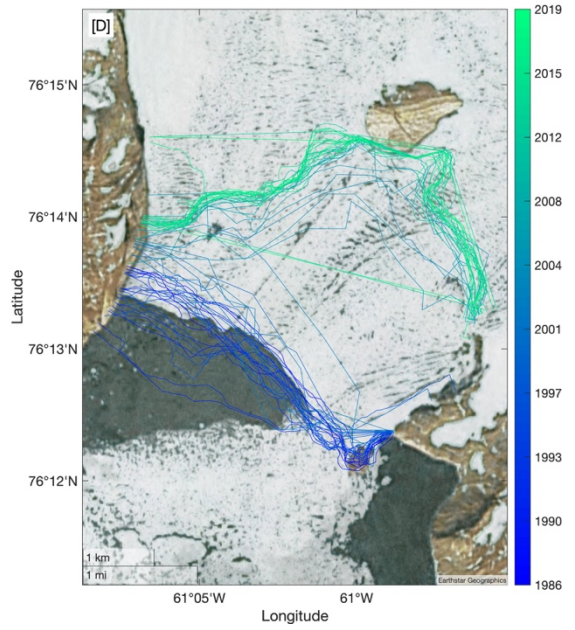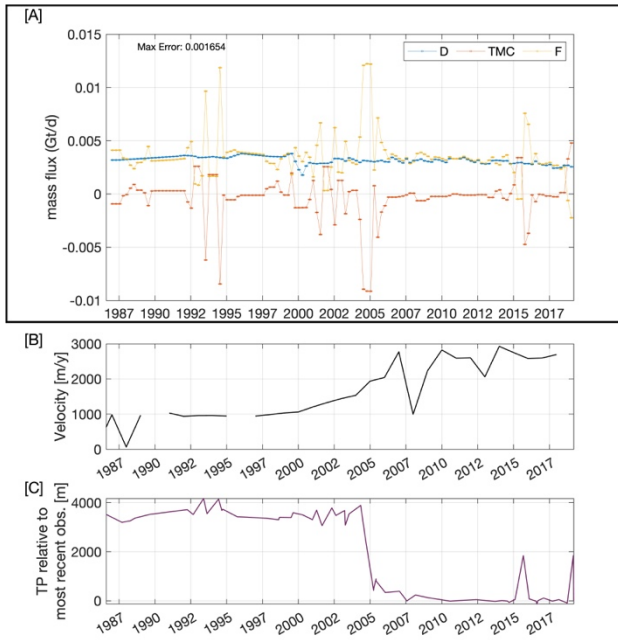
Figure S 32 | Results for Rink Glacier

Same as in Figure S 2
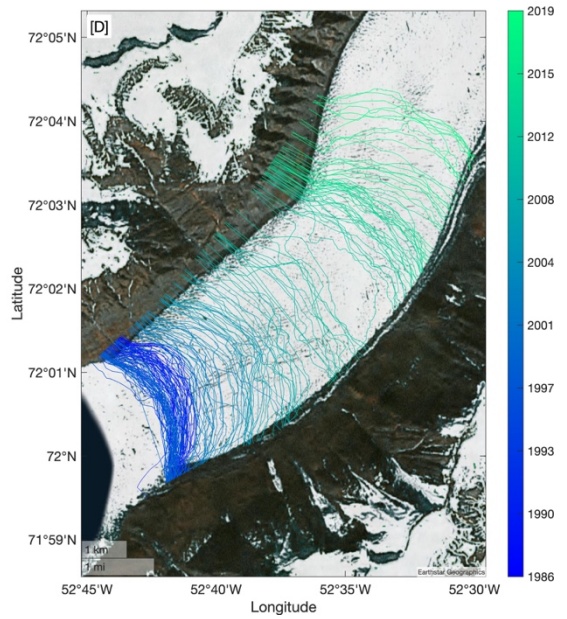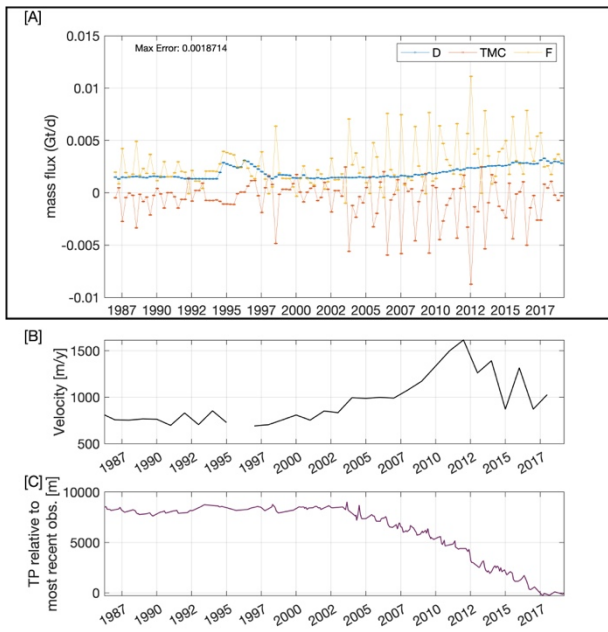
Figure S 33 | Results for Salliarutsip Sermia

Same as in Figure S 2
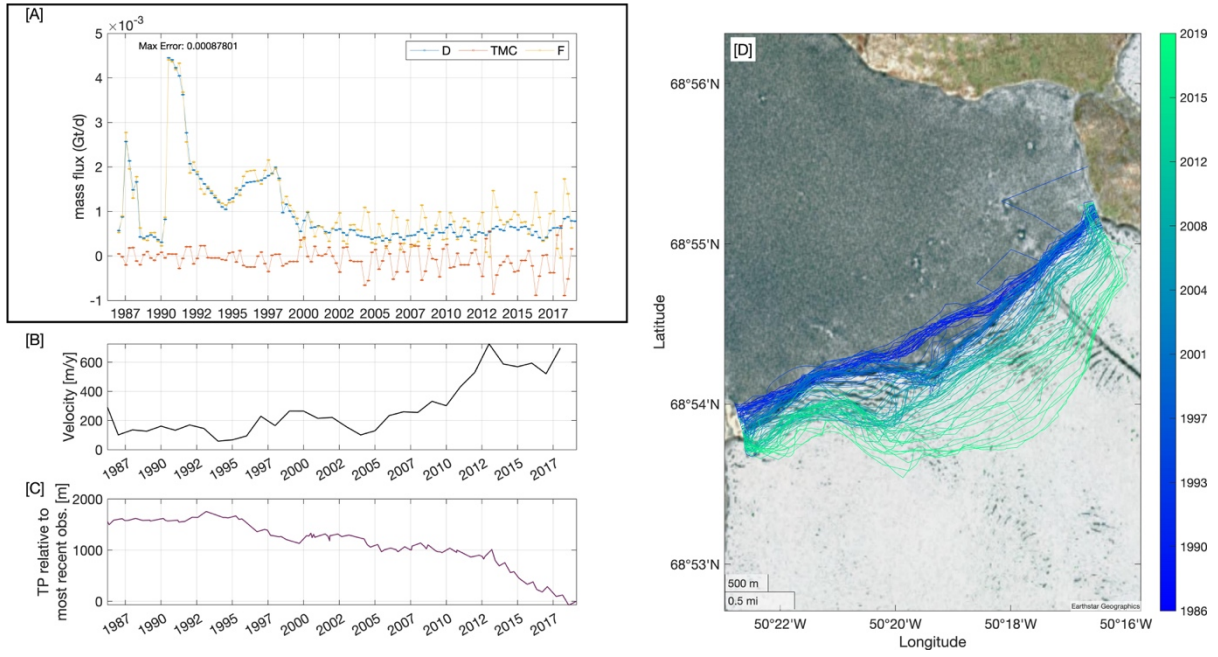
Figure S 34 | Results for Saqqarliup Sermia

Same as in Figure S 2
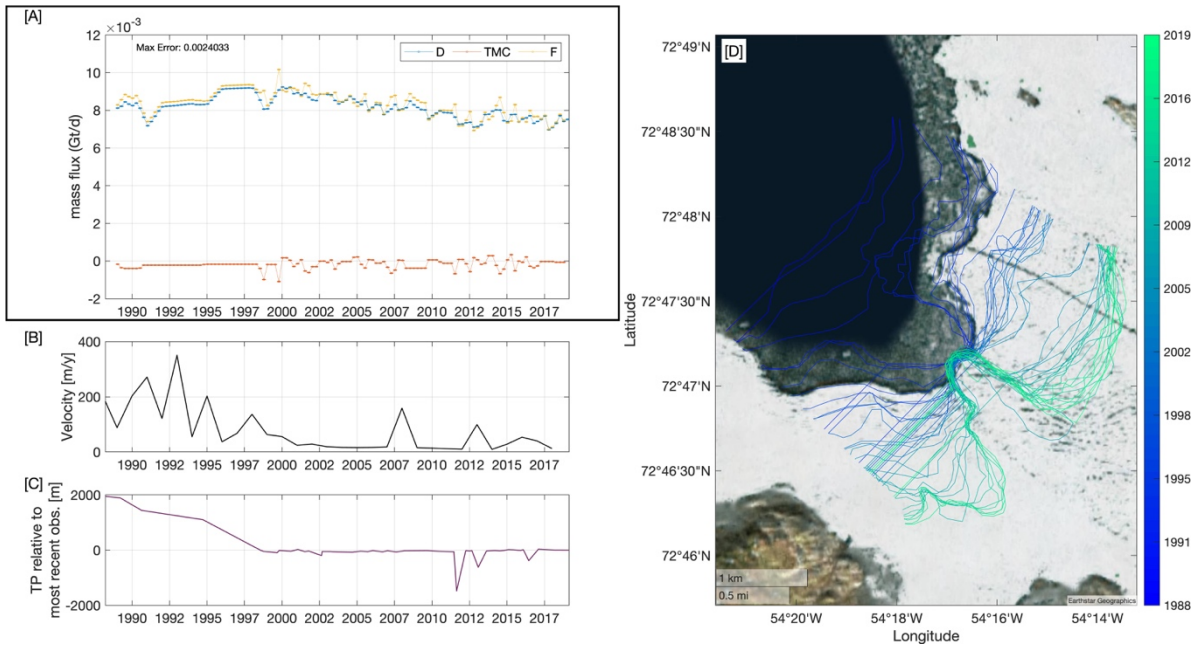
Figure S 35 | Results for Sermeq (Upernavik Isstrøm) 1

Same as in Figure S 2
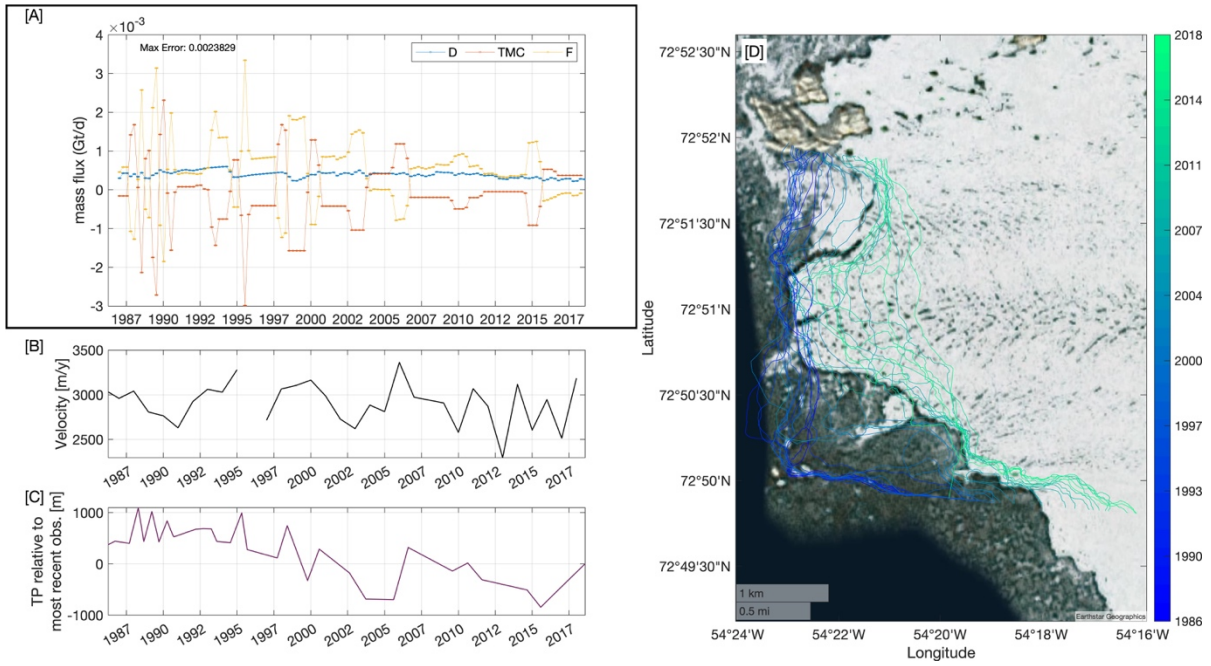
Figure S 36 | Results for Sermeq (Upernavik Isstrøm) 2

Same as in Figure S 2
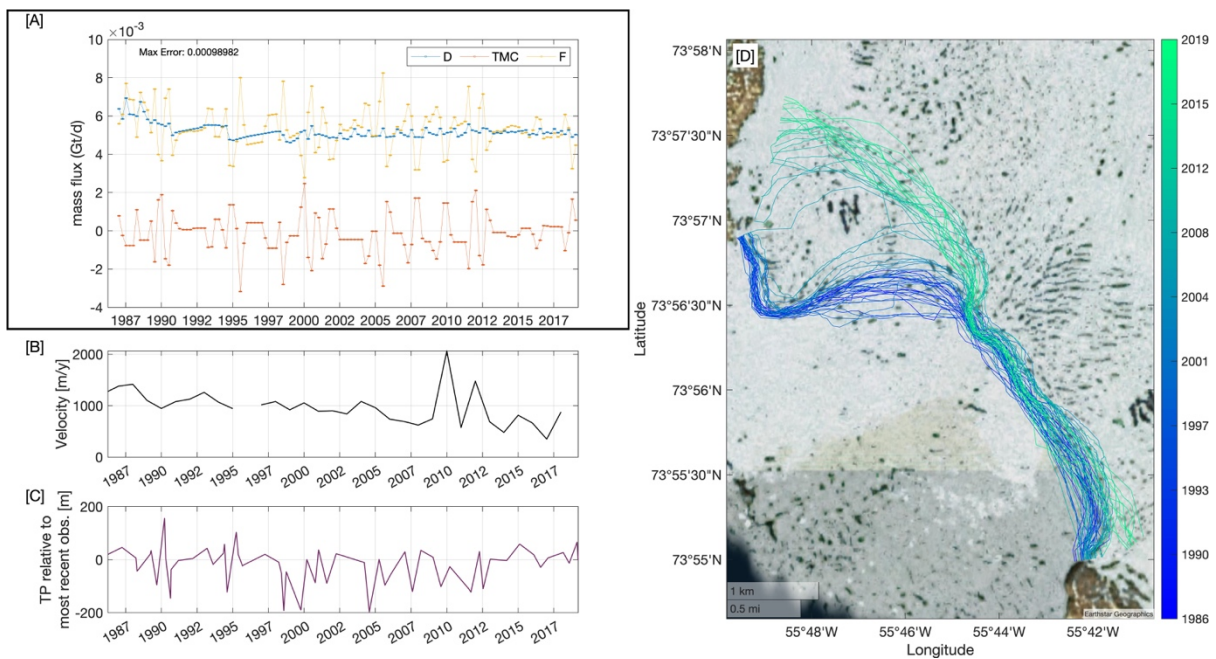
Figure S 37 | Results for Sermeq Avanarleq

Same as in Figure S 2
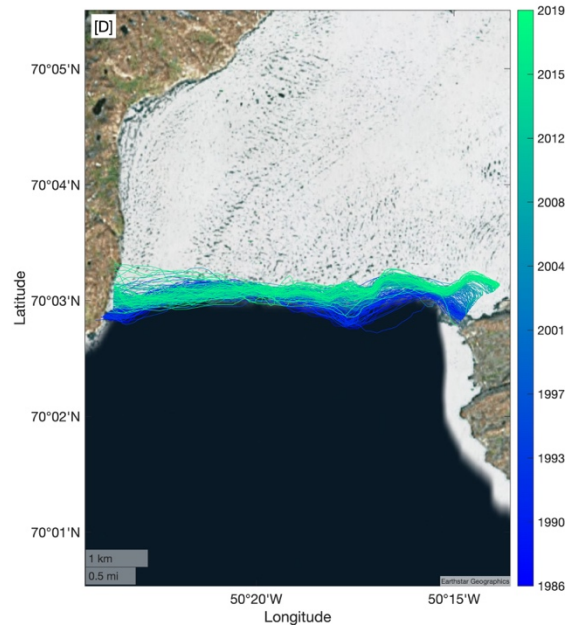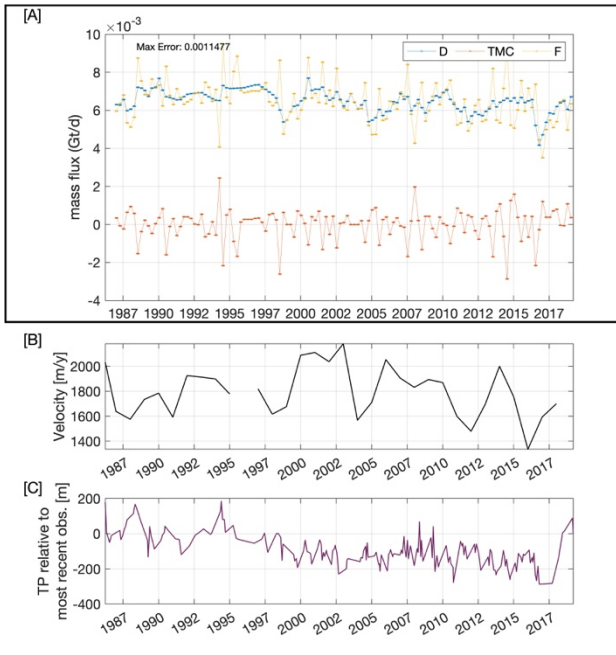
Figure S 38 | Results for Sermeq Avannarleq

Same as in Figure S 2
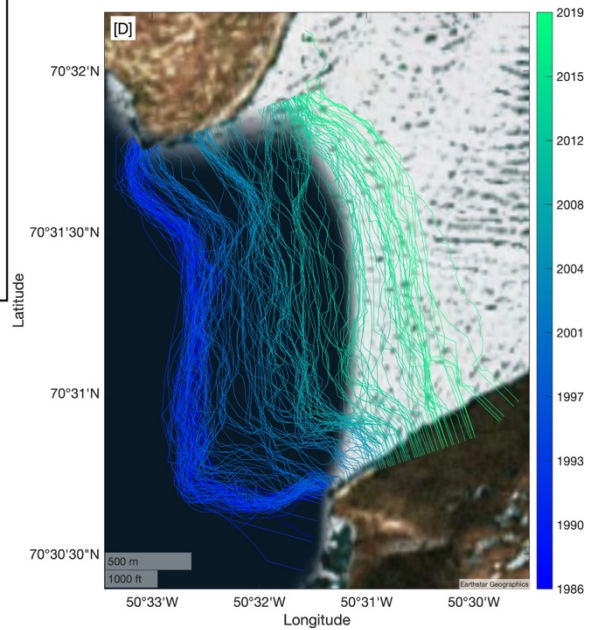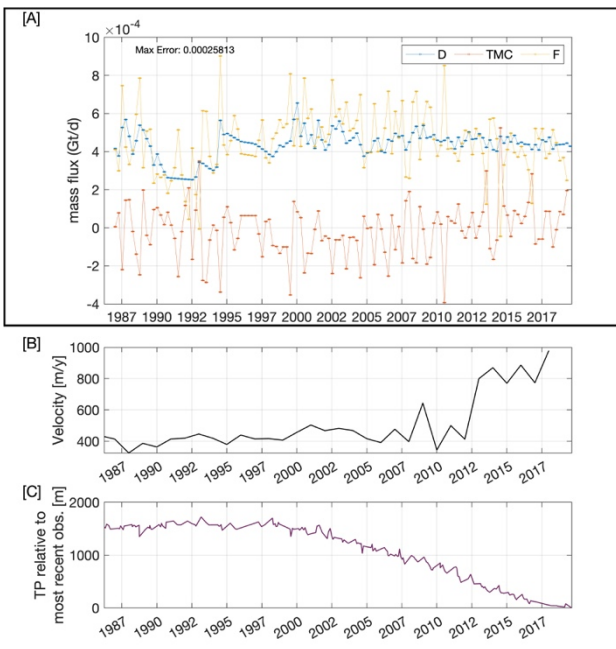
Figure S 39 | Results for Sermeq Avannarleq (Lille Glacier)

Same as Figure S 2
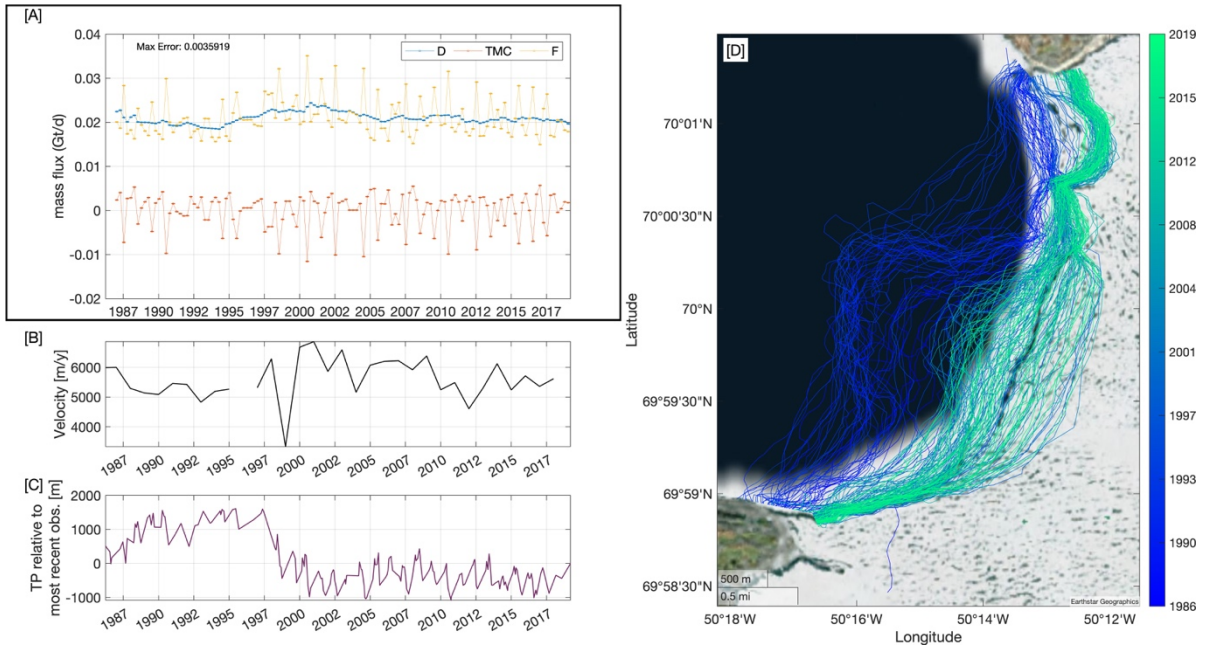
Figure S 41 | Results for Sermeq Kujalleq (CW)

Same as in Figure S 2
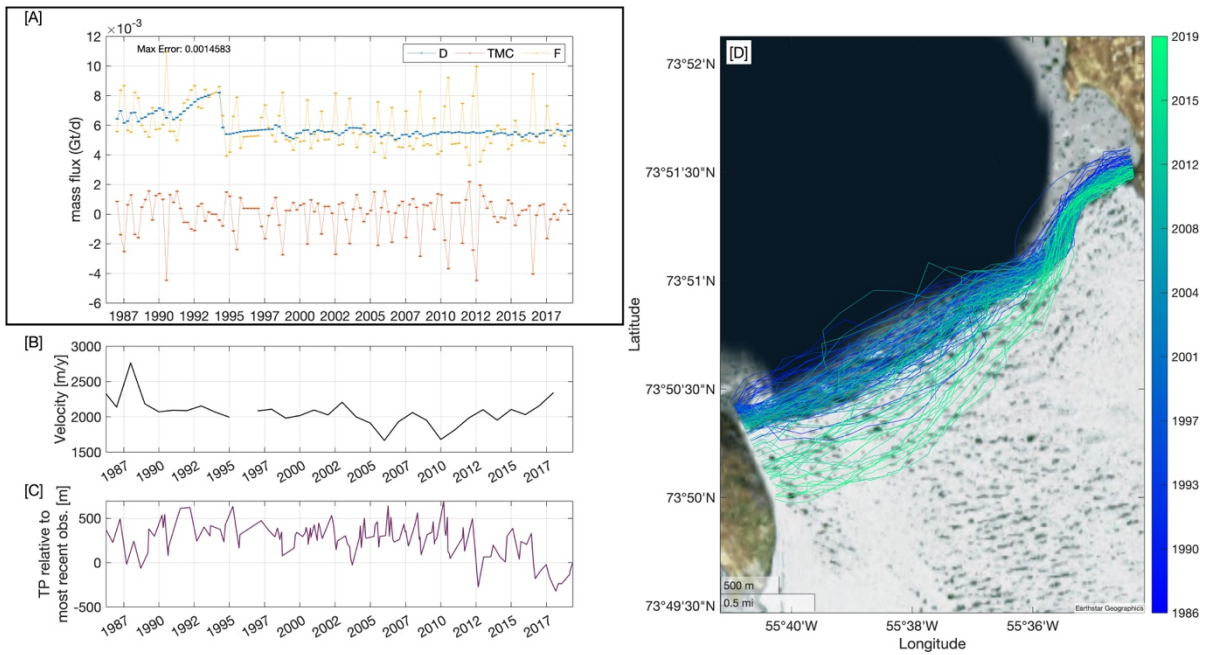
Figure S 40 | Results for Sermeq Kujalleq (NW)

Same as in Figure S 2
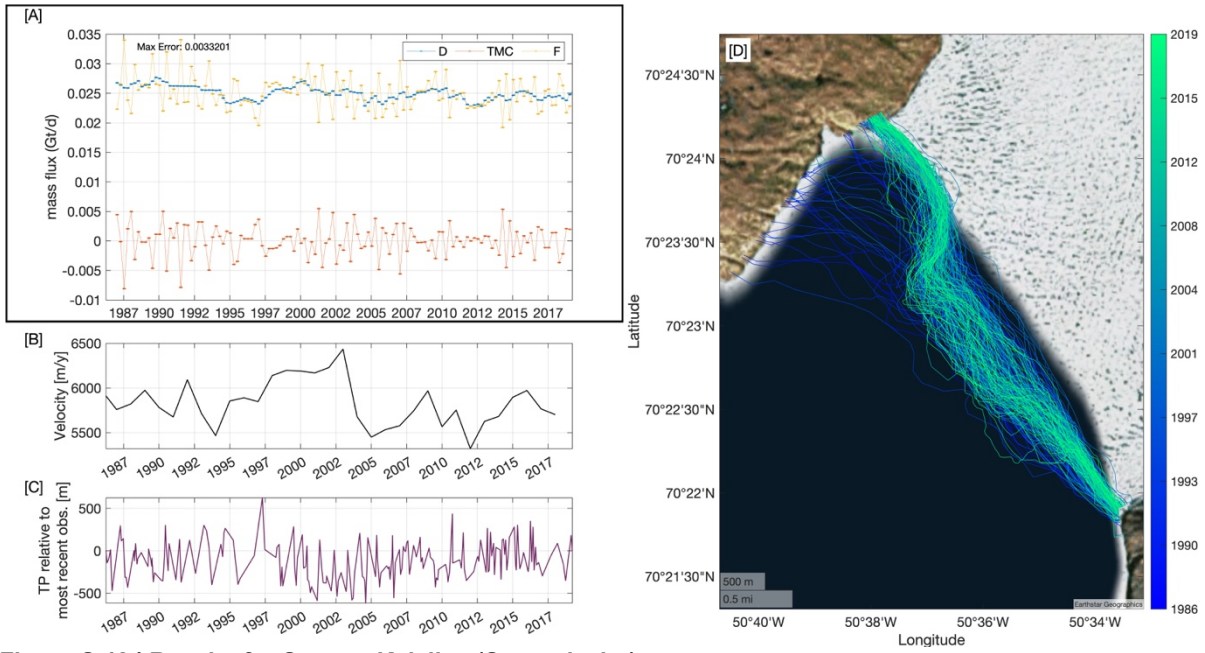
Figure S 42 | Results for Sermeq Kujalleq (Store glacier)

Same as in Figure S 2
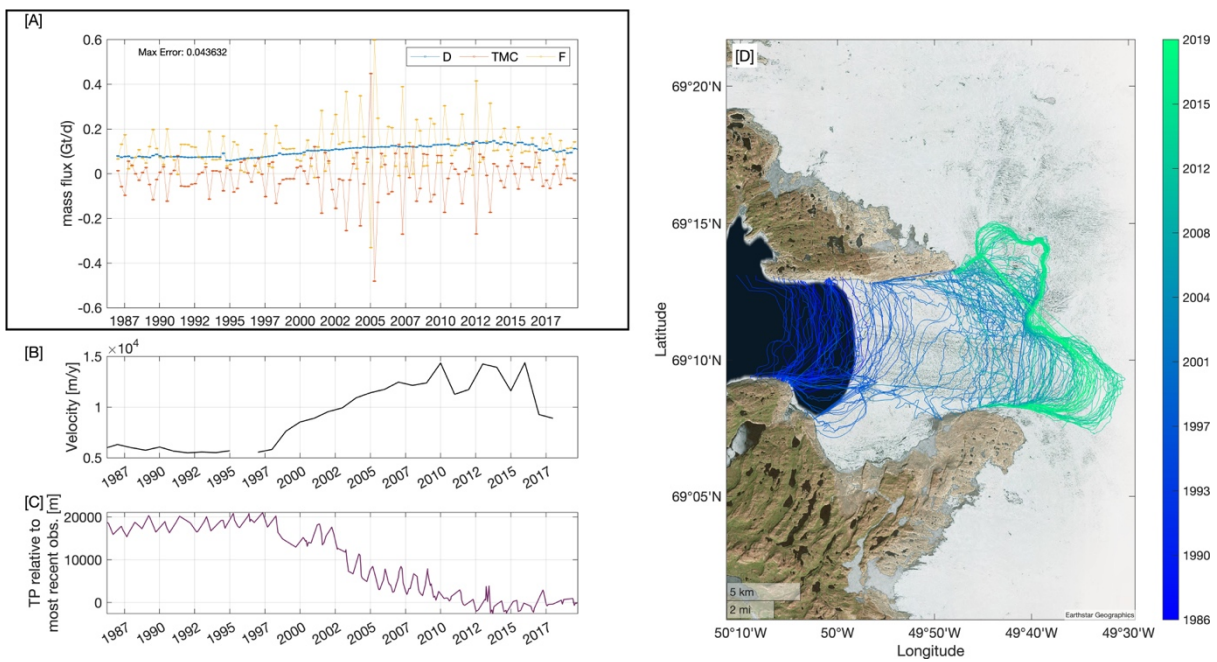
Figure S 43 | Results for Sermeq Kujalleq (Jakobshavn Isbræ)

Same as in Figure S 2
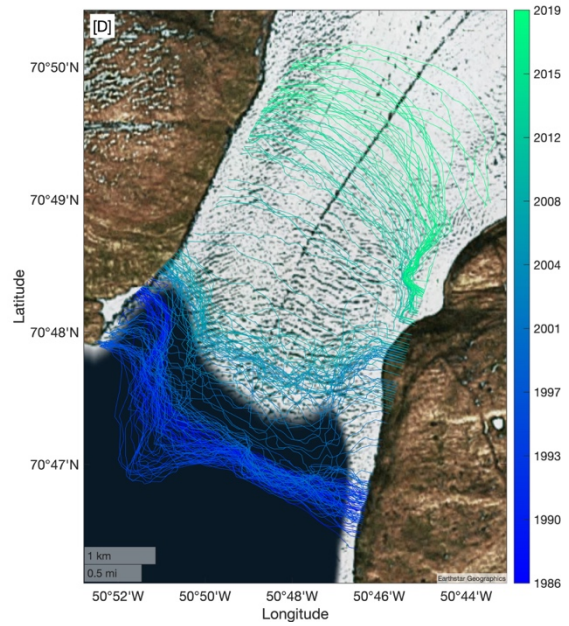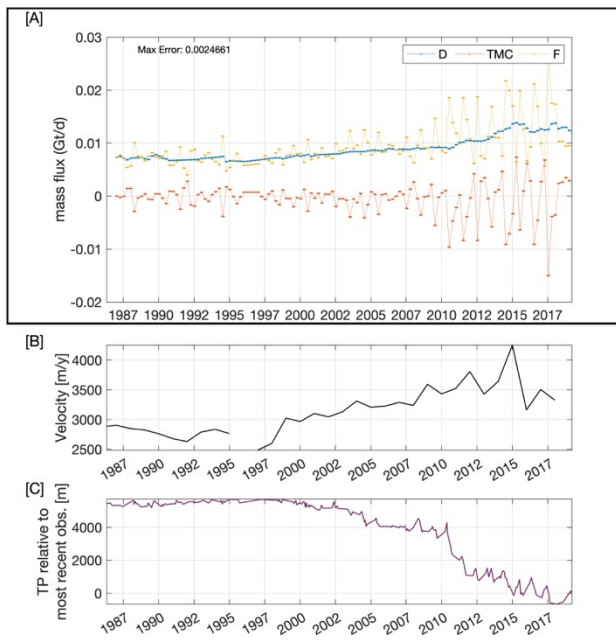
Figure S 44 | Results for Sermeq Silarleq

Same as in Figure S 2
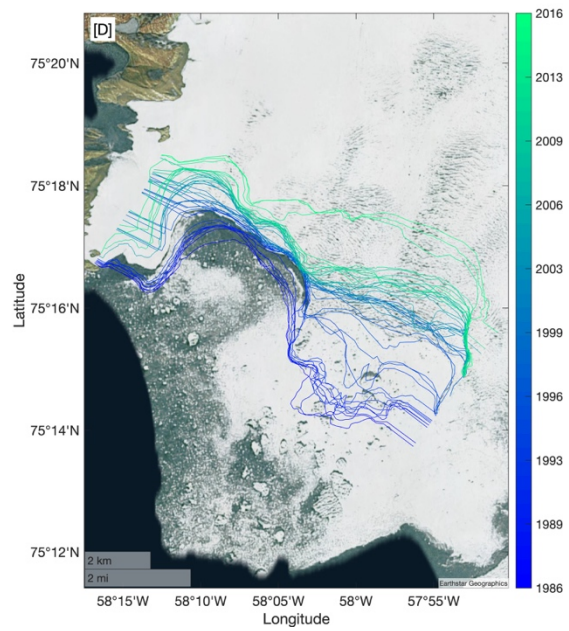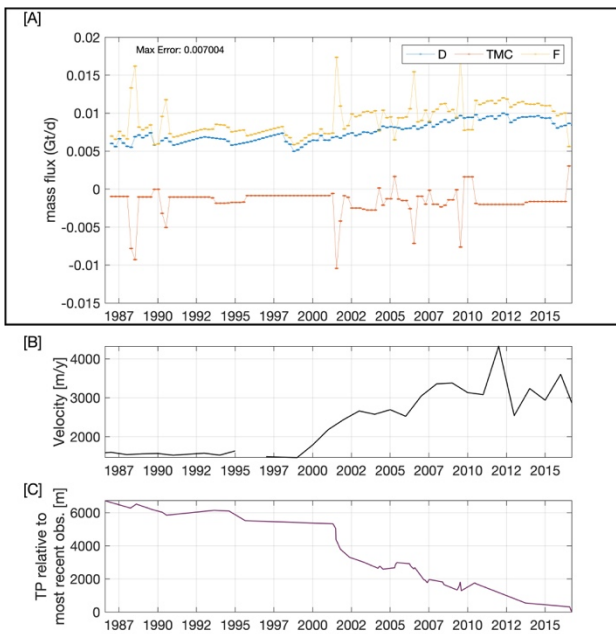
Figure S 45 | Results for Sermersuaq

Same as in Figure S 2
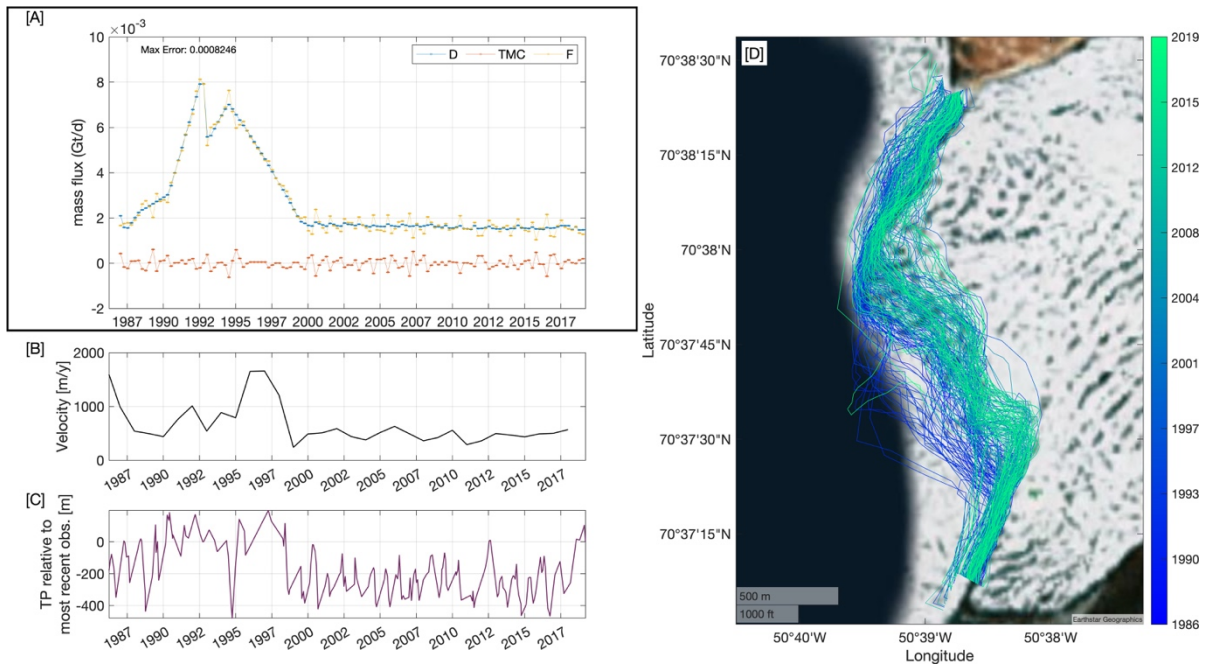
Figure S 46 | Results for Sermilik

Same as in Figure S 2
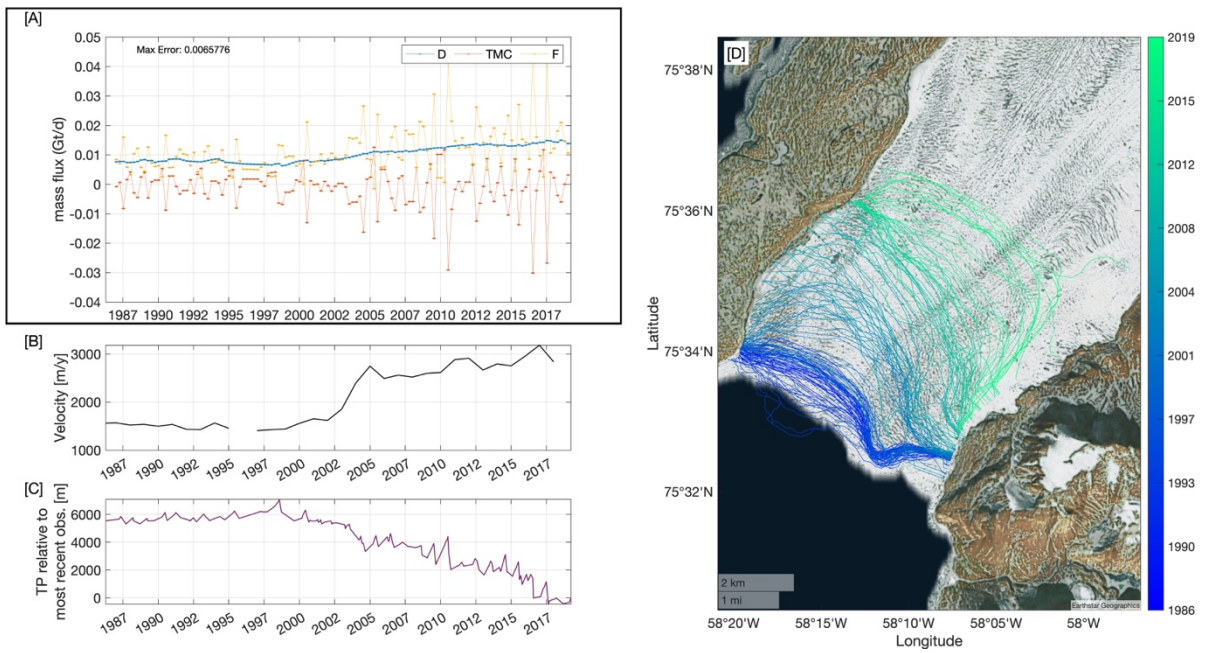
Figure S 47 | Results for Sverdrup glacier

Same as in Figure S 2
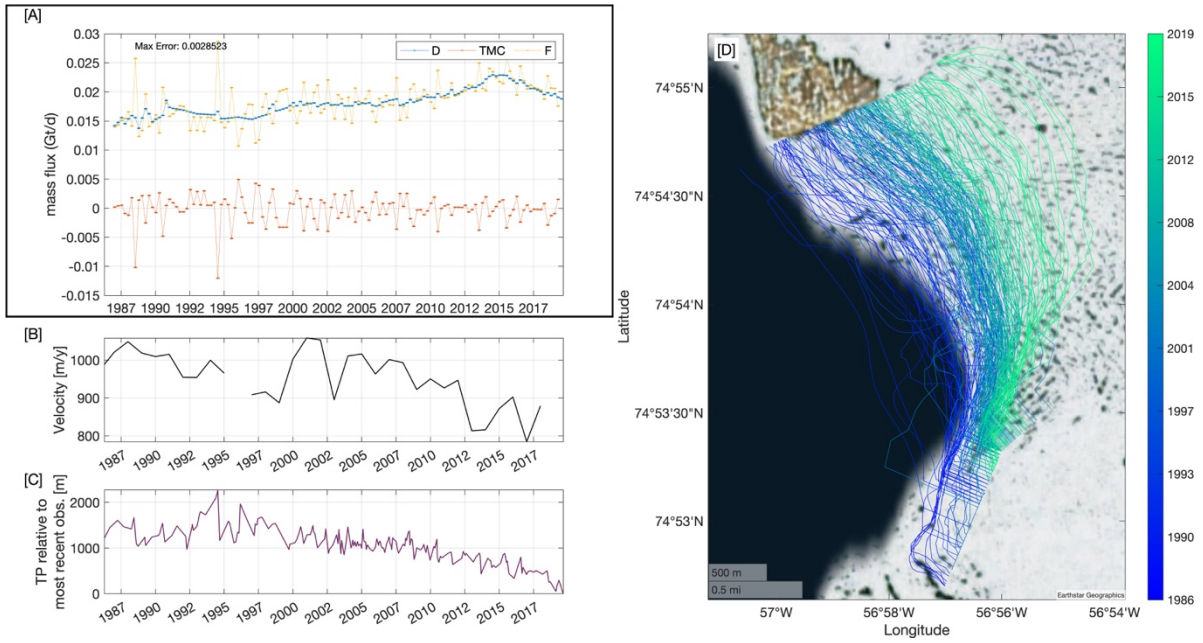
Figure S 49 | Results for Tuttulikassaap Sermia 1

Same as in Figure S 2
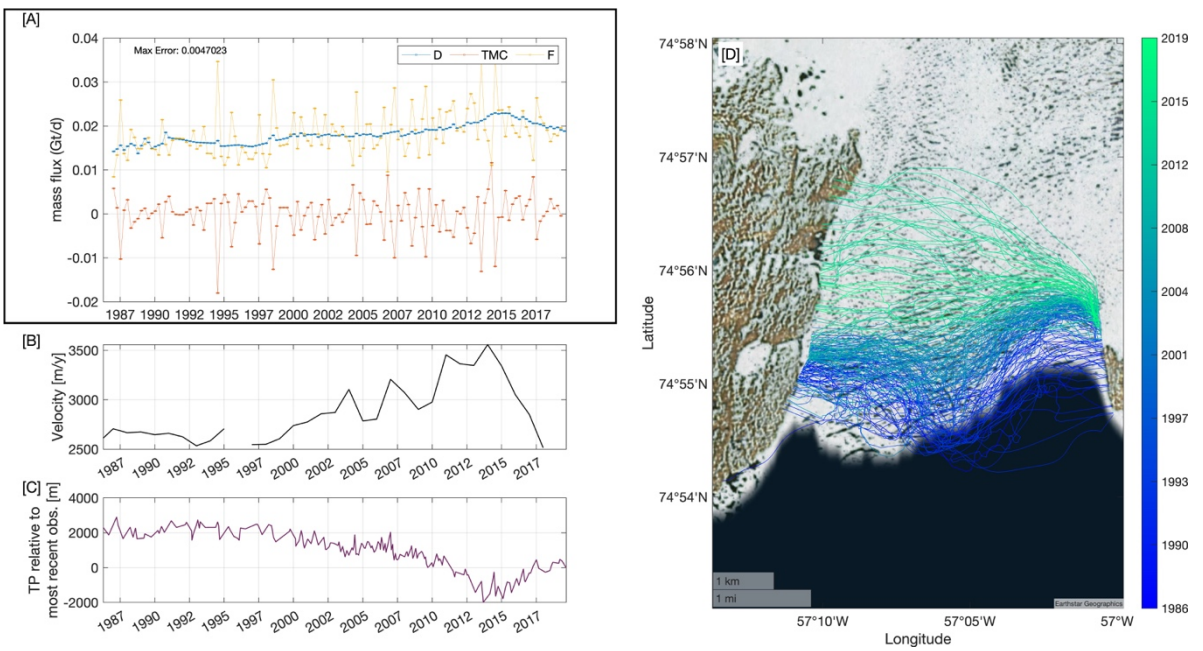
Figure S 48 | Results for Tuttulikassaap Sermia 2

Same as in Figure S 2
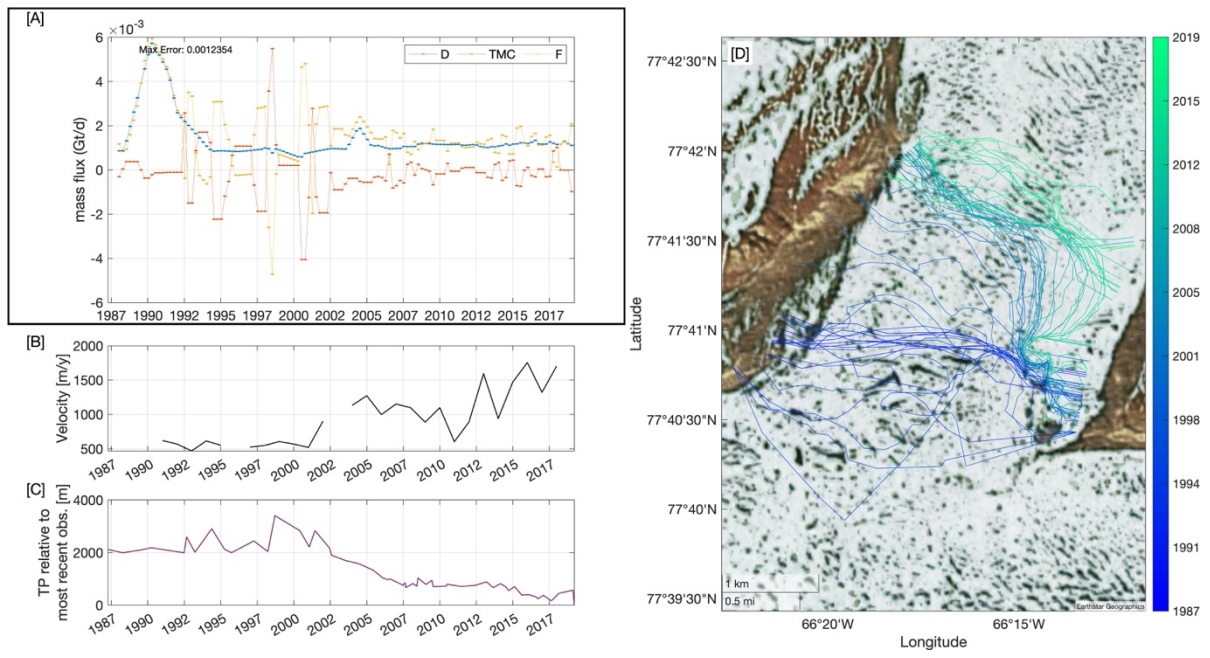
Figure S 50 | Results for Tuttulipaluup Sermia

Same as in Figure S 2
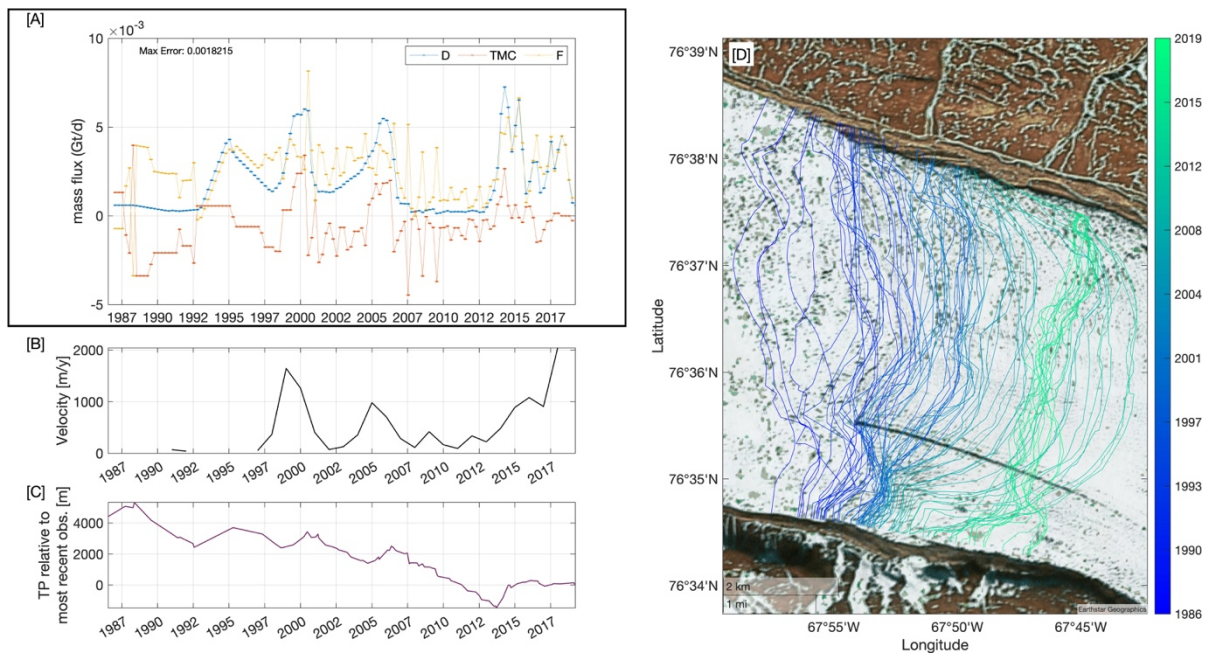
Figure S 51 | Results for Ullip Sermia

Same as in Figure S 2
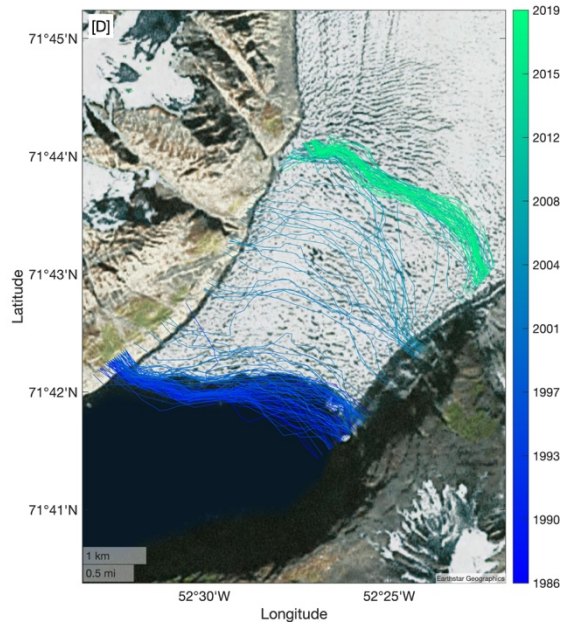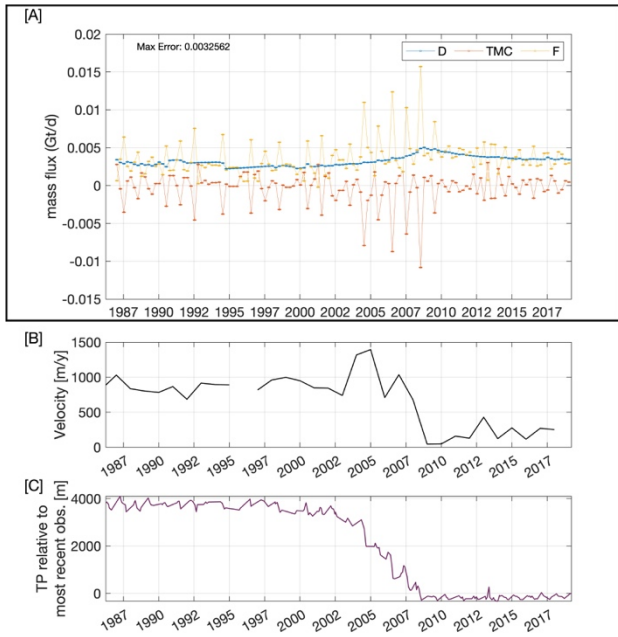
Figure S 52 | Results for Umiammakku Sermiat

Same as in Figure S 2
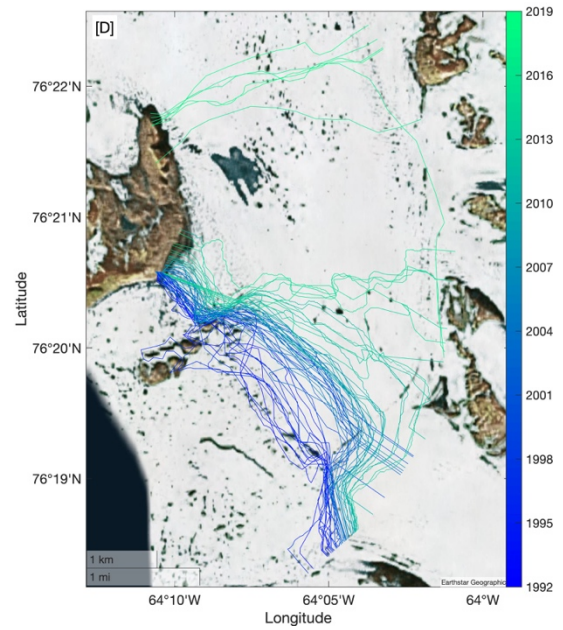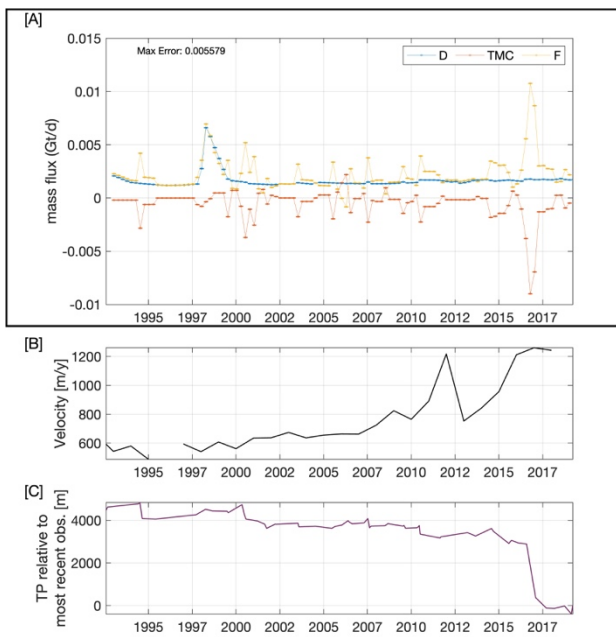
Figure S 53 | Results for Yngvar Nielsen glacier

Same as in Figure S 2

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