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Ice stream activity scaled to ice sheet volume during deglaciation of the Laurentide Ice Sheet

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Supplementary Table 1: Database of all 117 ice streams from a recent inventory[19] alongside our estimated age brackets (minimum, maximum and best estimate). Ice stream locations are shown in Supplementary Figure 1.

ID No	Ice Stream name	Earliest start	Best estimate start	Latest start	Earliest stop	Best estimates stop	Latest stop	Min duration	Max duration	Best estimate duration
1	Mackenzie Trough	21.8	21.8	21.8	14.7	14.3	13.9	7.1	7.9	7.5
2	Anderson	21.8	16.3	15.6	15.6	15.6	14.3	0.1	7.5	0.7
3	Horton / Paulatuk	13.9	13.7	13.6	13.7	13.6	13.5	0.1	0.4	0.1
4	Haldane	13.7	13.5	13.3	13.3	13.2	13.1	0.1	0.6	0.3
5	Bear Lake	14.5	14.1	14.0	12.9	12.7	12.7	1.1	1.8	1.4
6	Dubawnt Lake	9.4	9.3	9.2	9.2	9.1	8.6	0.1	0.8	0.2
7	Saneraun Hills	13.2	13.1	13.0	13.0	12.7	12.4	0.1	0.8	0.4
8	Collinson Inlet	13.4	13.2	13.2	13.0	12.9	12.8	0.2	0.6	0.3
10	M'Clintock Channel	13.1	13.0	12.9	12.8	12.7	12.6	0.1	0.5	0.3
11	Crooked Lake	14.4	14.1	13.8	13.6	13.5	13.0	0.2	1.4	0.6
12	Transition Bay	10.1	10.0	9.9	9.9	9.7	9.5	0.1	0.6	0.3
13	Peel Sound	10.7	10.4	10.3	10.3	10.1	10.0	0.1	0.7	0.3
14	Central Alberta	21.8	20.5	17.7	16.3	16.3	13.9	1.4	7.9	4.2
15	High Plains	21.8	20.5	17.7	16.3	15.6	14.7	1.4	7.1	4.9
16	Ungava Bay fans 2	10.0	10.0	9.5	9.4	9.4	7.9	0.1	2.1	0.6
17	Ungava Bay fans 1	11.5	11.4	11.4	11.0	11.0	7.9	0.4	3.6	0.4
18	Amundsen Gulf	21.8	21.8	21.8	13.3	11.5	10.8	8.5	11.0	10.3
19	M'Clure Strait	21.8	21.8	21.8	14.8	14.4	14.2	7.0	7.6	7.4
20	Gulf of Boothia	21.8	21.8	21.8	11.0	10.4	10.3	10.8	11.5	11.4

21	Admiralty Inlet	21.8	21.8	21.8	11.5	10.7	10.3	10.3	11.5	11.1
22	Lancaster Sound	21.8	21.8	21.8	12.9	11.5	11.2	8.9	10.6	10.3
23	Cumberland Sound	21.8	21.8	21.8	12.4	12.0	11.5	9.4	10.3	9.8
23	Cumberland Sound deglacial	12.4	12.0	11.5	8.6	8.4	6.9	2.9	5.5	3.6
24	Hudson Strait	21.8	21.8	21.8	16.3	16.3	10.1	5.5	11.7	5.5
25	Laurentian Channel	21.8	21.8	21.8	17.7	17.4	15.6	4.1	6.2	4.4
26	Albany Bay	21.8	17.0	10.8	13.3	10.8	9.4	0.1	12.4	6.2
27	Des Moines Lobe	21.8	18.3	18.3	15.6	14.7	13.9	2.7	7.9	3.6
28	James Lobe	21.8	21.8	18.8	16.3	15.6	15.6	2.5	6.2	6.2
30	Lake Michigan Lobe	21.8	21.8	21.8	17.0	15.6	13.9	4.8	7.9	6.2
31	Superior Lobe	21.8	21.8	21.8	12.9	12.9	11.5	8.9	10.3	8.9
33	James Bay	10.8	9.4	9.3	9.2	9.1	8.9	0.1	1.9	0.3
45	Notre Dame Channel	21.8	21.8	21.8	25.4	19.3	17.0	0.1	4.8	2.5
49	Huron-Erie Lobe	21.8	21.8	21.8	17.7	15.6	14.7	4.1	7.1	6.2
101	N Prince of Wales Island	12.0	11.5	11.0	11.0	11.0	10.8	0.1	1.2	0.5
102	Browne Bay	10.8	10.4	10.1	10.3	10.1	10.0	0.1	0.8	0.3
103	Bernier Bay	10.1	9.5	9.3	9.5	9.3	9.1	0.1	1.1	0.2
104	Eclipse Sound	21.8	21.8	21.8	11.5	11.2	10.8	10.3	11.0	10.6
105	Navy Board Inlet	21.8	21.8	21.8	12.4	11.5	10.1	9.4	11.7	10.3
106	S of Milne Inlet W	9.1	8.1	7.4	7.9	7.7	7.4	0.1	1.7	0.4
107	S of Milne Inlet E	9.1	8.1	7.4	7.9	7.7	7.4	0.1	1.7	0.4
108	Buchan Gulf	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
109	Scott Inlet	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
110	Sam Ford Fiord	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
111	Clyde Trough	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
112	Home Bay	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
113	Okoa Bay	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
114	Kangeeak Pt	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
115	Broughton Trough	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
116	Merchants Bay	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
117	Frobisher Bay	21.8	21.8	21.8	13.3	12.4	11.5	8.5	10.3	9.4
117	Frobisher Bay deglacial	9.5	8.9	8.3	7.9	7.4	6.9	0.4	2.6	1.5
118	Amadjuak Lake	8.3	7.9	7.4	7.4	6.9	6.9	0.1	1.4	1.0
119	Erichsen L - Munk Island	7.4	7.1	6.9	6.6	6.2	6.0	0.3	1.4	0.9
120	Steensby Inlet	6.3	6.2	6.1	5.8	5.5	5.2	0.3	1.1	0.7

121	S Southampton Island / pIS 5	9.3	8.9	8.6	8.8	8.6	8.5	0.1	0.8	0.3
122	C Southampton Island / pIS 11	9.3	8.9	8.6	8.8	8.6	8.5	0.1	0.8	0.3
123	Massey Sound	21.8	21.8	21.8	13.9	13.3	11.5	7.9	10.3	8.5
124	Nansen Sound	21.8	21.8	21.8	11.5	10.4	9.9	10.3	11.9	11.4
125	Cap Discovery	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
126	Smith Sound / Nares Strait	21.8	21.8	21.8	15.6	12.9	10.1	6.2	11.7	8.9
127	Jones Sound	21.8	21.8	21.8	12.9	12.4	11.5	8.9	10.3	9.4
128	Wellington Channel	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
129	Prince Gustaf Adolf Sea	21.8	21.8	21.8	13.9	12.9	12.9	7.9	8.9	8.9
130	Trinity Trough	21.8	21.8	21.8	19.3	18.3	17.0	2.5	4.8	3.5
131	(IS in) The Gully	21.8	21.8	21.8	21.8	20.5	19.3	0.1	2.5	1.3
133	Placentia Bay - Halibut Channel	21.8	21.8	21.8	19.30	18.3	17.0	2.5	4.8	3.5
134	Northeast Channel IS	21.8	21.8	21.8	24.1	21.8	20.5	0.0	1.3	0.00
135	(IS) offshore Massachusetts	pre-OIS 2	pre-OIS 2	pre-OIS 2	pre-OIS 2	pre-OIS 2	pre-OIS 2	-	-	-
136	Oneida Lobe	17.0	16.3	15.6	16.3	15.6	14.7	0.1	2.3	0.7
137	Tug Hill Plateau	17.0	17.0	16.3	16.3	15.6	15.6	0.1	1.4	1.4
139	Yelverton Bay	21.8	21.8	21.8	12.9	12.9	11.5	8.9	10.3	8.9
140	Phillips Inlet	21.8	21.8	21.8	12.9	12.9	11.5	8.9	10.3	8.9
141	Kennedy - Robeson Channel	21.8	21.8	21.8	17.7	15.6	11.5	4.1	10.3	6.2
142	Kugluktuk	12.9	12.7	12.4	12.7	12.4	11.5	0.1	1.4	0.3
143	Horn	12.7	12.7	12.6	12.7	12.6	12.4	0.1	0.3	0.1
144	Fort Simpson	13.9	13.3	12.9	12.9	12.7	12.6	0.1	1.3	0.6
145	Cameron Hills fragment	15.6	14.7	13.9	14.7	13.9	13.3	0.1	2.2	0.8
146	Buffalo River	12.9	12.4	11.5	12.4	11.9	11.5	0.1	1.4	0.5
147	Caribou Mountains	13.9	13.2	12.9	13.3	12.9	11.9	0.1	2.0	0.3
148	Birch Mountains fragments	17.0	15.6	13.9	14.7	13.9	12.7	0.1	4.3	1.7
150	pre-Maskwa	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	-	-	-
151	Rocky Mountian Foothills	21.8	20.5	21.8	17.7	16.3	15.6	4.1	6.2	4.2
152	IS2	17.0	16.3	15.6	15.6	15.6	14.7	0.1	2.3	0.7
153	Maskwa	21.8	21.8	15.6	18.3	17.7	17.0	0.1	4.8	4.1
154	Smoothstone Lake fragment	17.0	16.3	15.6	15.6	15.6	14.7	0.1	2.3	0.7

155	IS3	17.0	15.6	13.9	14.7	14.7	13.9	0.1	3.1	0.9
156	IS4/5	15.6	13.9	13.3	13.9	12.9	12.7	0.1	2.9	1.0
157	Winefred Lake fragment	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	-	-	-
158	Lac La Ronge	13.9	13.6	13.3	13.6	13.3	12.9	0.1	1.0	0.3
159	Buffalo Ice Stream Corridor	21.8	21.8	18.8	16.3	15.6	13.9	2.5	7.9	6.2
160	Pasquia Hills fragments	17.0	16.3	15.6	15.6	15.6	14.7	0.1	2.3	0.7
161	Suggi Lake	13.3	12.9	12.7	12.9	12.4	12.3	0.1	1.0	0.5
162	Saskatchewan River	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	pre-LGM	-	-	-
163	Red River Lobe	13.6	13.3	13.1	13.1	12.9	12.7	0.1	0.9	0.4
164	Quinn Lake	9.4	9.3	9.1	8.9	8.6	8.5	0.2	0.9	0.7
165	Ekwan River	9.9	9.5	9.4	9.5	9.4	9.3	0.1	0.6	0.1
166	Maguse Lake	8.4	8.2	8.1	8.2	8.1	8.1	0.1	0.3	0.1
167	Okak Bank 1, 2	21.8	21.8	21.8	19.3	13.9	12.9	2.5	8.9	7.9
168	Hopedale Saddle	21.8	21.8	21.8	19.3	13.9	12.9	2.5	8.9	7.9
169	Hawke Saddle	21.8	21.8	21.8	24.1	19.3	17.0	0.00	4.80	2.5
170	Cartwright Saddle	21.8	21.8	21.8	24.1	13.9	12.9	0.00	8.9	7.9
171	Karlsefni Trough	21.8	21.8	21.8	19.30	13.9	12.9	2.5	8.9	7.9
172	McBeth Fiord	21.8	21.8	21.8	12.9	11.5	10.1	8.9	11.7	10.3
174	Remnant Dubawnt ice stream corridor	21.8	10.1	8.6	16.3	8.6	8.4	0.1	13.4	1.5
175	Great Slave Lake	16.3	15.6	13.3	13.3	12.9	12.7	0.1	3.6	2.7
176	Hay River	14.7	13.9	13.3	13.3	12.9	11.5	0.1	3.2	1.0
177	Peace River IS	14.7	13.9	13.3	13.3	12.9	11.5	0.1	3.2	1.0
178	Athabasca River IS	16.3	13.9	13.3	13.3	12.4	12.0	0.1	4.3	1.5
179	Hayes Lobe	12.4	11.7	10.8	10.8	10.1	9.5	0.1	2.9	1.6
180	Rainy Lobe	12.7	12.4	12.3	11.5	11.0	10.8	0.8	1.0	1.4
181	Bathurst IS	15.6	15.3	14.9	14.7	14.5	13.9	0.2	1.7	0.8
182	Conception Bay IS	21.8	19.3	13.9	18.3	17.0	12.9	0.1	8.9	2.3
183	Green Bay Lobe	21.8	21.8	21.8	19.3	15.6	14.7	2.5	7.1	6.2
184	Saginaw Lobe	21.8	21.8	17.7	21.2	20.5	15.6	0.1	6.2	1.3
185	Bay of Fundy	21.8	20.5	19.3	18.3	17.7	17.0	1.0	4.8	2.8
186	Happy Valley-Goose Bay IS	8.9	8.8	8.8	8.8	8.6	8.5	0.1	0.3	0.2
187	Kogaluk River	9.5	9.2	8.9	8.9	8.6	8.5	0.1	1.0	0.6
188	Payne Bay	9.5	8.9	8.3	8.9	8.4	8.1	0.1	1.4	0.5

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Supplementary Table 2: Calculations of the total ice stream discharge from the LIS at 32 time-steps from 21.8 to 5.75 kyr (shown in Fig. 3). The table shows the number of ice streams operating at each time-step and their cumulative width at the ice sheet margin. The width of each ice stream was used to estimate its discharge based on modern ice stream data (see Supplementary Tables 3 and 4, and Figure 9). The final two columns show the discharge obtained if we use the minimum possible duration of each ice stream and the maximum possible duration of each ice stream (see Supplementary Table 1).

Time cal ka	Time C-14	No. of ice streams	Total width (km)	Best Estimate Discharge (km^3a^{-1})	Min. discharge (km^3a^{-1})	Max. discharge (km^3a^{-1})
21.8	18	51	3347	1522	951	2094
21.15	17.5	50	3347	1522	951	2094
20.5	17	54	3537	1611	1004	2218
19.9	16.5	52	3427	1559	974	2144
19.3	16	53	3443	1569	977	2160
18.75	15.5	51	3323	1512	944	2081
18.25	15	49	3303	1504	938	2071
17.65	14.5	49	3118	1421	885	1957
17	14	48	3073	1399	873	1926
16.25	13.5	47	3047	1396	863	1928
15.55	13	49	3052	1401	864	1939
14.7	12.5	43	2499	1149	706	1592
13.85	12	40	2672	1224	757	1691
13.35	11.5	40	2504	1151	708	1595
12.9	11	44	2582	1201	726	1676
12.4	10.5	33	1510	725	418	1032
12	10.25	30	1337	644	370	918
11.5	10	30	1438	689	399	979
10.95	9.6	7	951	429	271	588
10.8	9.5	7	670	303	191	416
10.1	9	7	620	283	176	390
9.5	8.5	5	455	208	129	287
8.85	8	6	690	319	195	442
8.6	7.8	11	713	331	201	462
8.5	7.7	3	110	56	30	82
8.4	7.6	3	110	56	30	82
8.05	7.2	3	48	30	11	49
7.85	7	4	93	52	24	81
7.4	6.5	2	75	38	20	55
6.85	6	2	105	50	29	71
6.3	5.5	1	40	20	11	29
5.75	5	1	35	18	9	26

Supplementary Table 3: Width, velocity, cross-sectional area and flux of 50 ice streams from Antarctica (location shown on Supplementary Figure 7) that were used to predict discharge from palaeo-ice streams (see Supplementary Figure 9)

Name	Width (km)[a]	Average velocity (m a^{-1})[b]	Cross-sectional area (km^2)[c]	Discharge (km^3 a^{-1})[d]
Pine Island Glacier	42.3	1575.9	60.5	105.0
Thwaites Glacier	161.3	861.9	151.4	133.6
Evans Ice Stream	48.6	523.5	60.6	33.4
Byrd Glacier	21.3	670.1	27.9	21.8
MacAyeal Ice Stream	73.1	355.5	70.3	25.3
Denman Glacier	14.1	777.3	26.2	22.0
Foundation Ice Stream	36.6	484.8	59.6	30.8
Recovery Glacier	53.9	225.4	137.0	32.3
Sör Rondane	105.5	108.7	106.4	12.4
Stancomb-Wills Ice Stream	75.5	191.7	82.3	15.3
Priestley Glacier	6.2	125.4	4.2	0.6
Lillie Glacier	14.2	126.4	14.5	1.9
Rennick Glacier	24.3	78.5	15.9	1.3
Matusevich Glacier	7.9	403.8	5.9	2.6
unnamed EA1	121.9	228.5	177.2	40.1
Ninnis Glacier	82.2	255.3	75.5	20.2
Merz Glacier	13.7	609.4	15.2	10.3
Scott Glacier	17.3	353.7	14.8	5.7
Kronstadskij Glacier	15.4	384.9	12.0	5.0
Shirase Glacier	17.8	1221.4	12.9	16.1
Rayner Glacier	15.3	690.9	12.8	9.3
Jutulstraumen	18.8	679.7	12.0	8.6
Belgica Trough Ice stream	63.6	85.0	63.2	5.5
unnamed EA2	30.0	77.2	37.9	3.1
Slessor Ice Stream	71.5	227.7	117.1	27.1
Bailey Ice Stream	30.3	149.4	46.4	7.0
Institute Ice Stream	58.5	335.1	70.5	24.1
Rutford Ice Stream	25.7	334.5	51.4	18.6
De Vicq Glacier	19.2	568.8	14.1	8.5
Mulock Glacier	12.2	339.7	6.4	2.6
Ferrigno Ice Stream	19.0	730.0	15.8	12.1
Fleming Glacier	11.1	1465.0	5.5	8.6
Nimrod Glacier	14.7	461.8	9.0	4.9
Beardmore Glacier	17.1	204.5	14.8	3.5
Binschadler Ice Stream	27.1	595.7	23.0	14.0

Support Force Glacier	28.5	250.2	42.7	11.4
Mercer and Whillans ISs	107.2	330.0	88.0	29.0
unnamed WA1	41.6	203.7	41.4	8.7
Berry Glacier	6.7	612.2	5.8	3.8
Vanderford Glacier	9.4	440.7	13.1	6.3
Frost Glacier	24.5	711.6	27.3	21.3
Underwood Glacier	8.1	760.9	8.2	6.8
Philippi Glacier	20.4	364.9	19.0	7.4
David Glacier	31.6	179.5	39.6	7.6
Mellor Glacier	14.7	437.7	23.0	10.6
Lambert Glacier	25.3	574.9	32.5	19.5
Fisher Glacier	28.3	186.6	35.1	7.0
Robert Glacier	6.7	674.2	4.2	3.1
Blackwall Ice Stream	23.9	140.3	31.3	4.5
Smith Glacier	27.7	820.7	30.9	27.2
Kohler Glacier	7.7	655.2	8.4	6.4

[a] Velocity data[44] were used to measure the width of each ice stream to the lateral shear margins or exposed rock walls at the grounding line.

[b] Average velocity was extracted as a width-averaged value from velocity data (2007-2009)[44]

[c] Cross-sectional area was calculated at the grounding line from the highest resolution bed-data that was available for Antarctica[30]

[d] Discharge was calculated by multiplying the velocity data by the ice thickness data and integrating the output along the ice stream's width at the grounding line

Supplementary Table 4: Width, velocity, cross-sectional area and flux of 31 ice streams from Greenland (location shown on Supplementary Figure 8) that were used to predict fluxes from palaeo-ice streams (see Supplementary Figure 9).

Name	Width (km)[a]	Average velocity (ma^{-1})[b]	Cross-sectional area (km^2)[c]	Discharge (km^{3}a^{-1})[d]
Jakobshavn	5.7	4660.0	4.6	32.4
Petermann	22.7	779.6	13.2	11.5
Kangerdlugssuaq	4.6	6224.1	2.7	24.5
Daugaard-Jensen	5.1	1755.0	2.5	8.1
Nioghalvfjerdsbrae	18.3	1054.5	8.4	9.6
Zachariae I.	16.9	1197.1	8.5	11.5
Store Gletscher	6.7	1294.5	5.8	9.0
Rink Isbrae	5.2	1349.8	4.8	8.0
Umiamako Isbrae	3.4	1159.4	2.0	5.0
Upernavik Gl. 1	3.0	3508.1	2.4	8.5
Upernavik Gl. 2	3.6	1675.2	1.6	3.6
Upernavik Gl. 2	3.0	1746.5	1.2	3.3
Kakivfait sermiat	5.2	913.1	3.8	4.2
Igdlugdlip sermia	5.2	1517.1	3.2	6.1
Kong Oscar	4.6	2148.0	3.8	10.5
Ryder Gl.	8.9	446.9	5.1	2.7
Academy/Hagen	10.1	157.8	10.5	1.9
Storstrømmen	24.5	228.2	17.1	4.3
Helheim	4.7	6402.7	3.2	27.2
Køge Bugt	7.5	4647.9	2.6	19.8
Gyldenløve	2.4	2491.9	1.3	5.2
Kangiata Nunaata Sermia	6.5	851.6	3.2	2.9
Ukaasorsuaq	7.3	721.9	3.4	2.8
Kong Christian IV	6.8	1385.2	3.0	4.5
Humboldt	35.0	347.6	10.3	3.6
C.H. Ostenfeld Gl.	6.7	338.0	3.5	1.4
Hayes Gl.	10.1	699.7	9.1	7.1
Sverdrup Gl.	5.6	1569.1	2.7	6.8
K.I.V. Steenstrup N	3.0	1221.5	2.1	3.0
Uunartit Is.	4.0	879.3	4.2	4.7

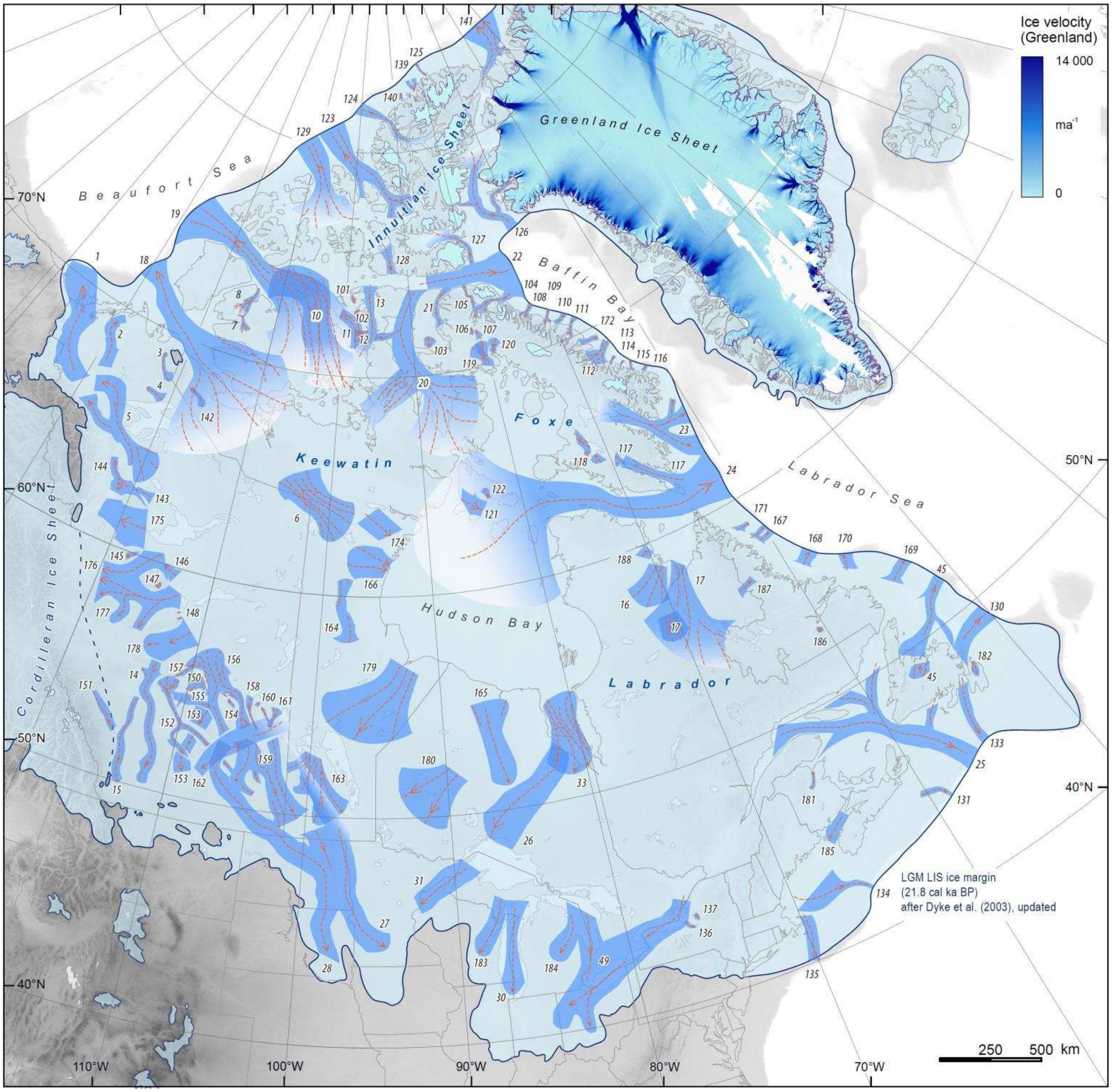
[a] Velocity data[43] were used to measure the width of each ice stream to the lateral shear margins or exposed rock walls at the grounding line.

[b] Average velocity was extracted as a width-averaged value from velocity data (2008-2009)[43]

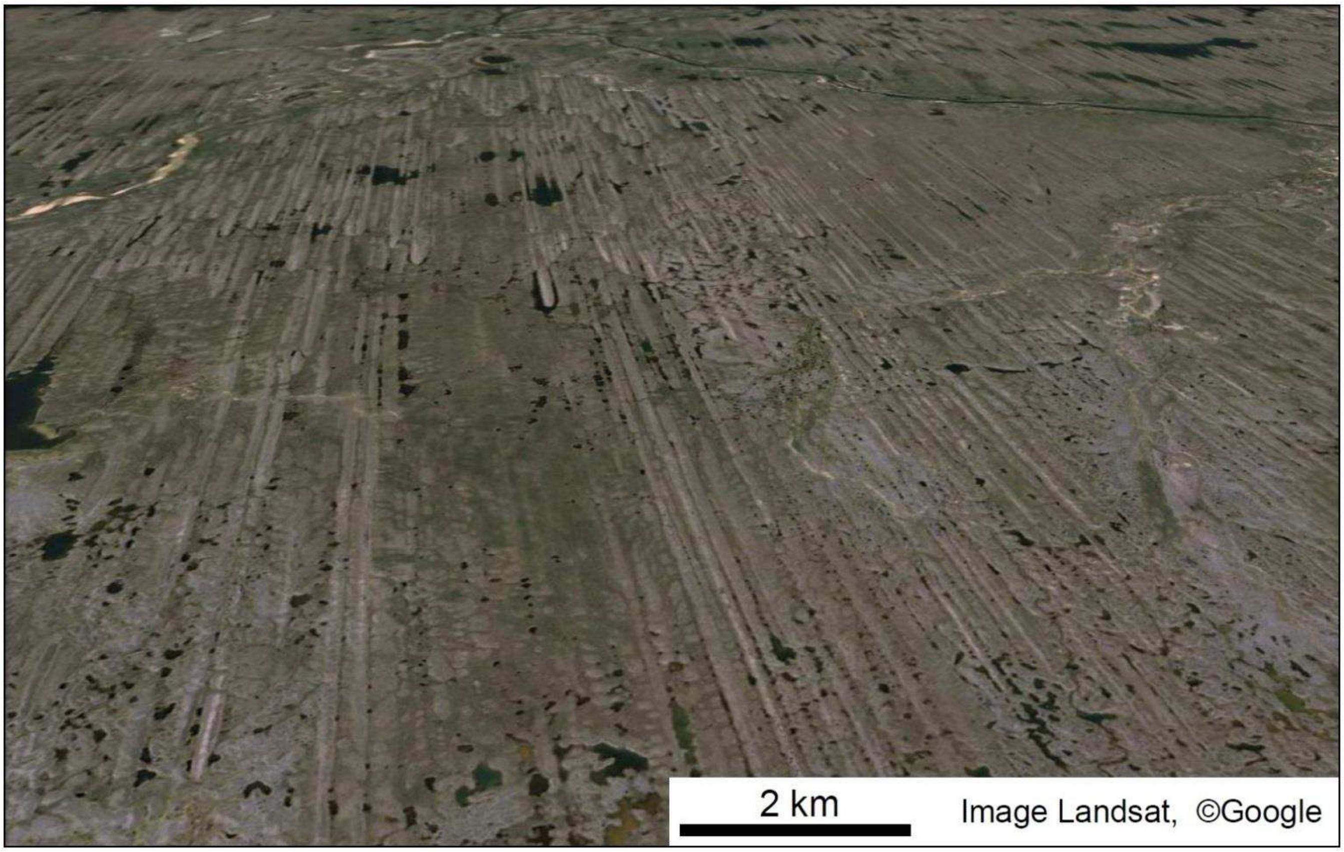
[c] Cross-sectional area was calculated at the grounding line from the highest resolution bed-data that was available for Greenland[29]

[d] Discharge was calculated by multiplying the velocity data by the ice thickness data and integrating the output along the ice stream's width at the grounding line

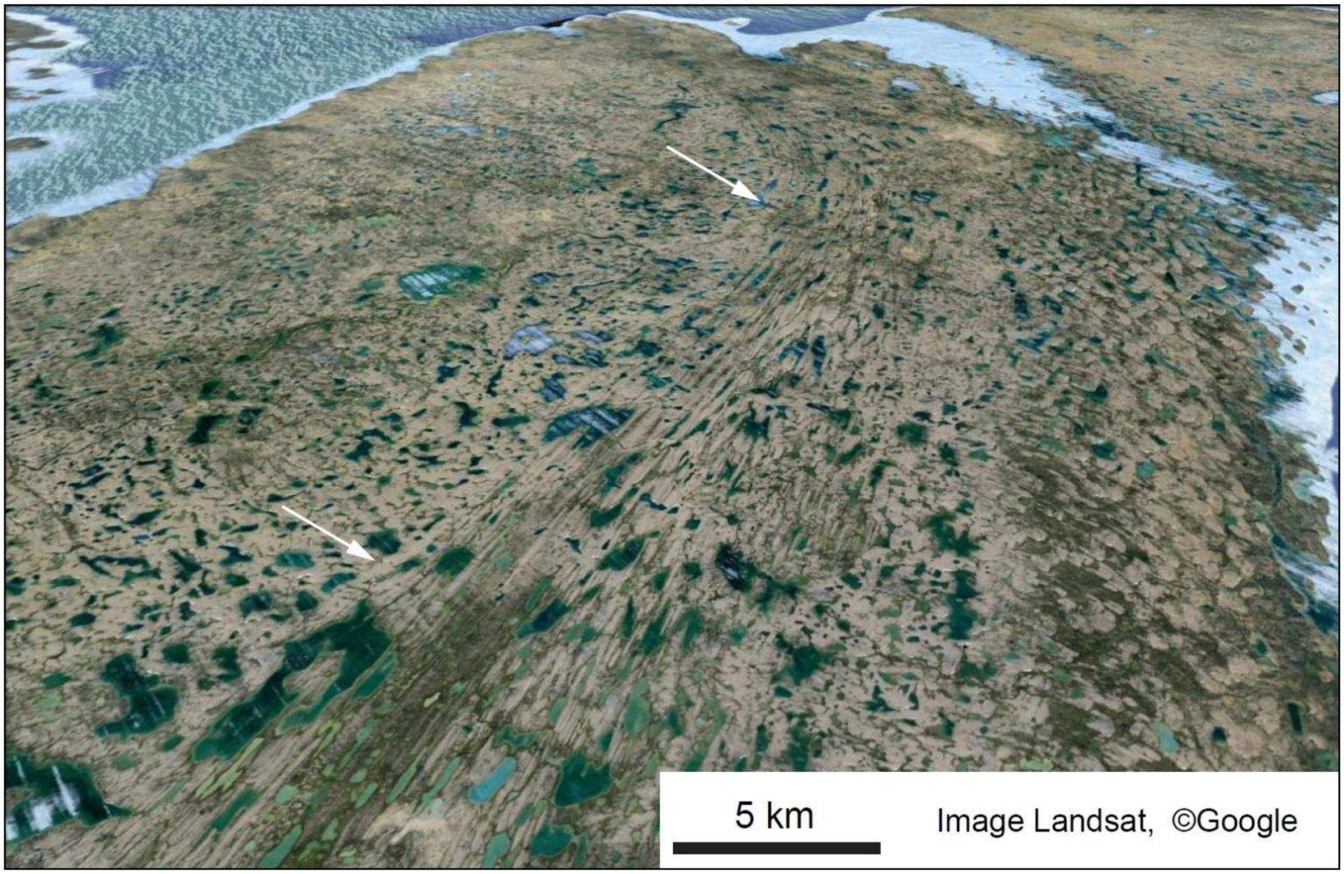
Supplementary Information Figures:



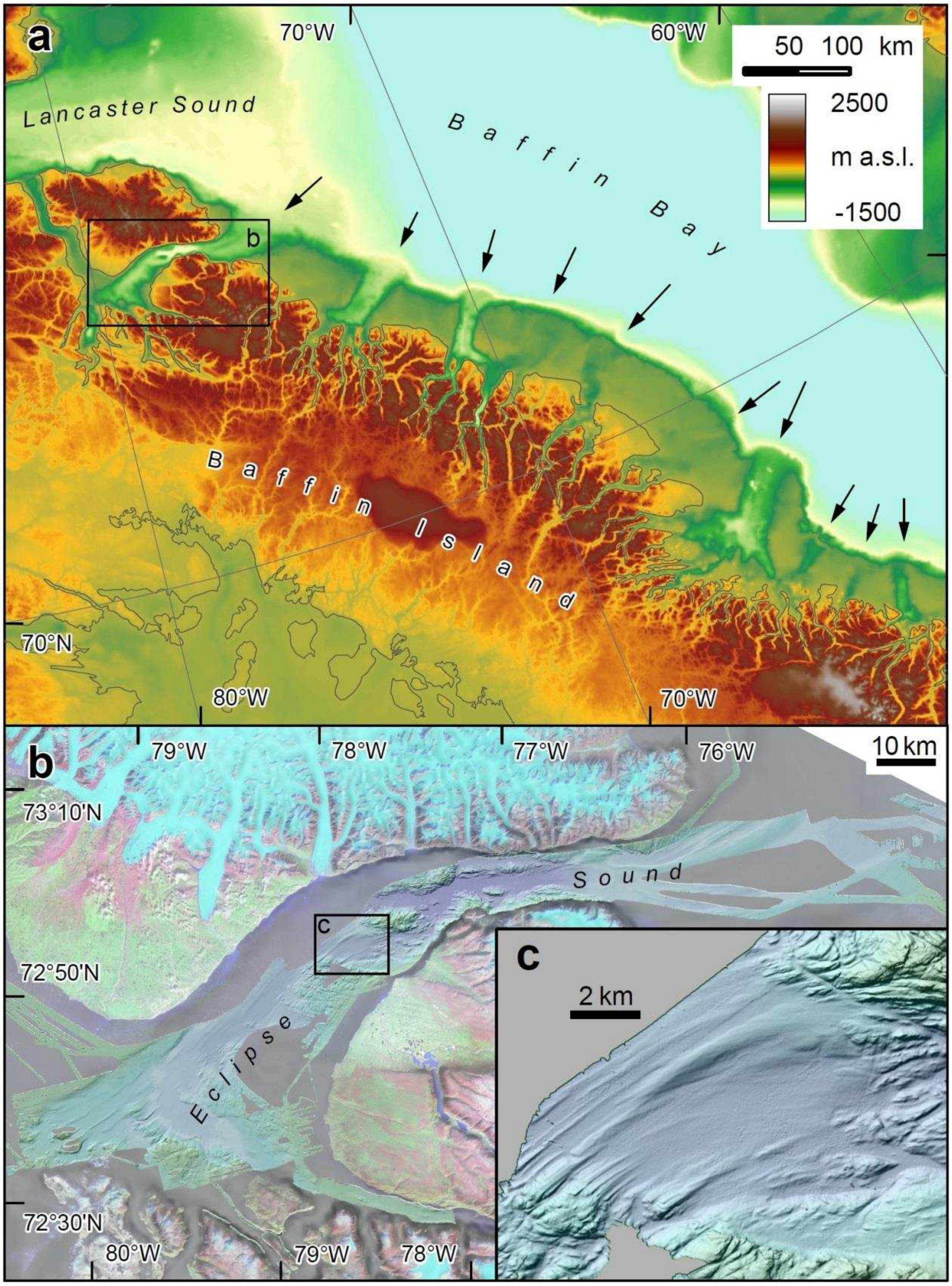
Supplementary Figure 1: Location of 117 ice streams (numbered) from a recently-compiled inventory[19] based on previous work and systematic mapping across the ice sheet bed. Numbers are arbitrary, but can be cross-referenced to Supplementary Table 1. Modern-day ice velocity is shown for Greenland[43].



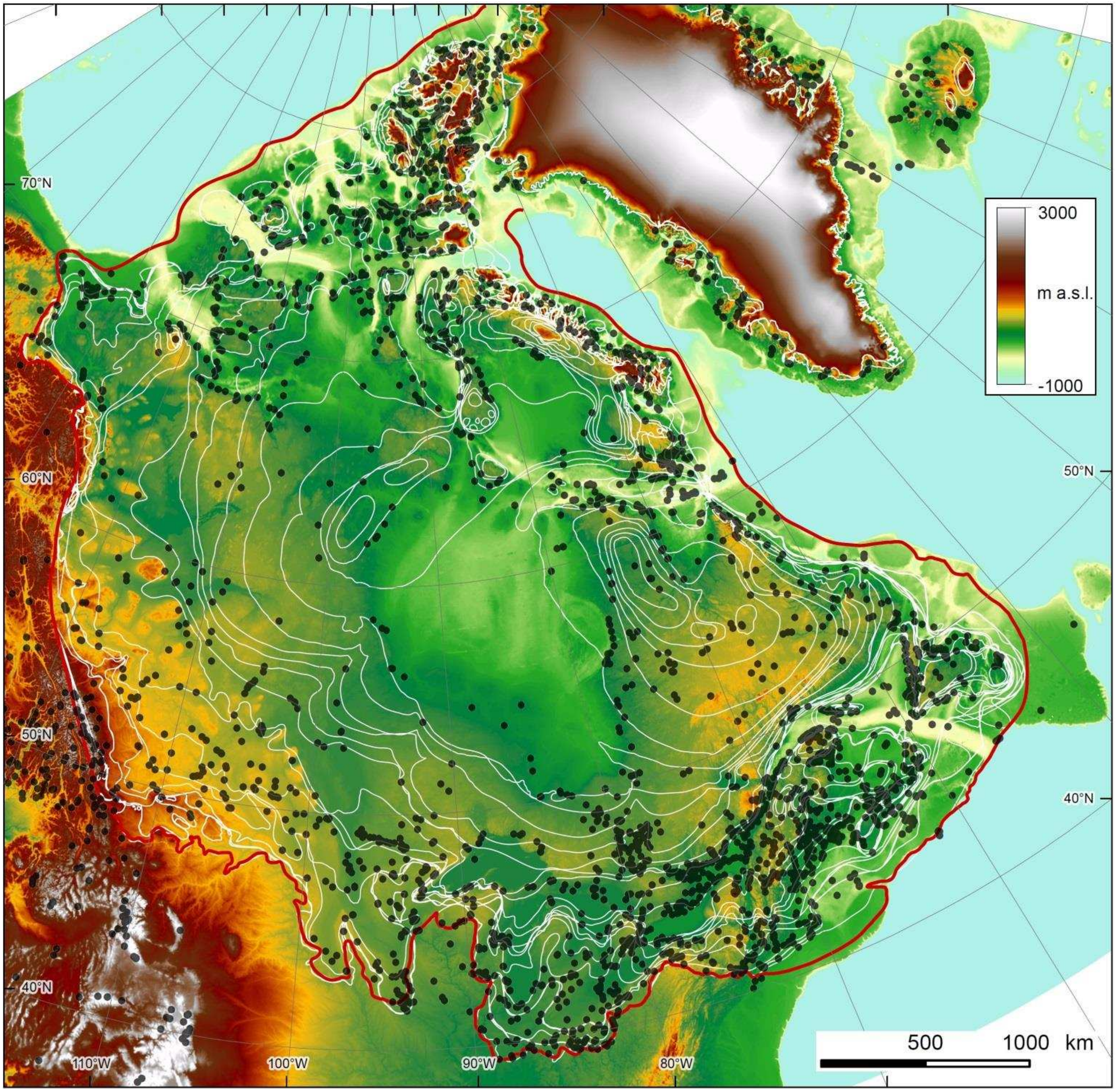
Supplementary Figure 2: Landsat satellite image of mega-scale glacial lineations[33] on the Dubawnt Lake Ice Stream bed[23] **(no. 6), central Canada.** These features are a characteristics geomorphological signature of ice streaming and identical features have been detected beneath Rutford Ice Stream in West Antarctica[34].



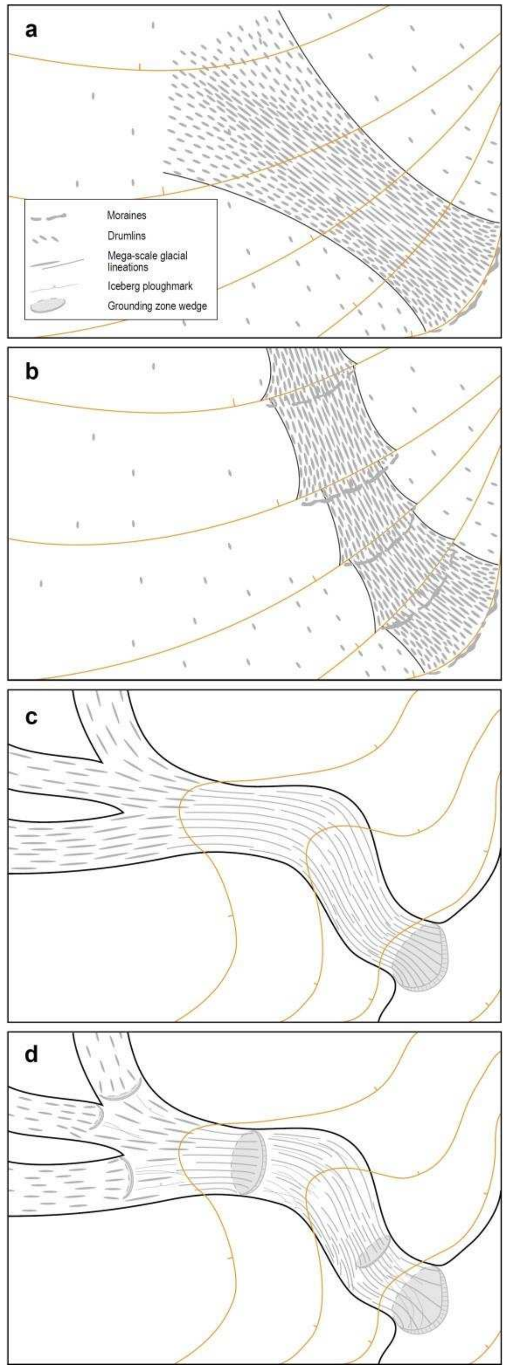
Supplementary Figure 3: Oblique Google Earth Landsat image of the lateral margin of the M'Clintock Channel Ice Stream[35,36] on Victoria Island, Canadian Arctic Archipelago. Note the abrupt lateral margin (marked by white arrows) of the assemblage of mega-scale glacial lineations, marked by lateral shear margin moraines[37]. Ice flow direction is from bottom (south) to top (north).



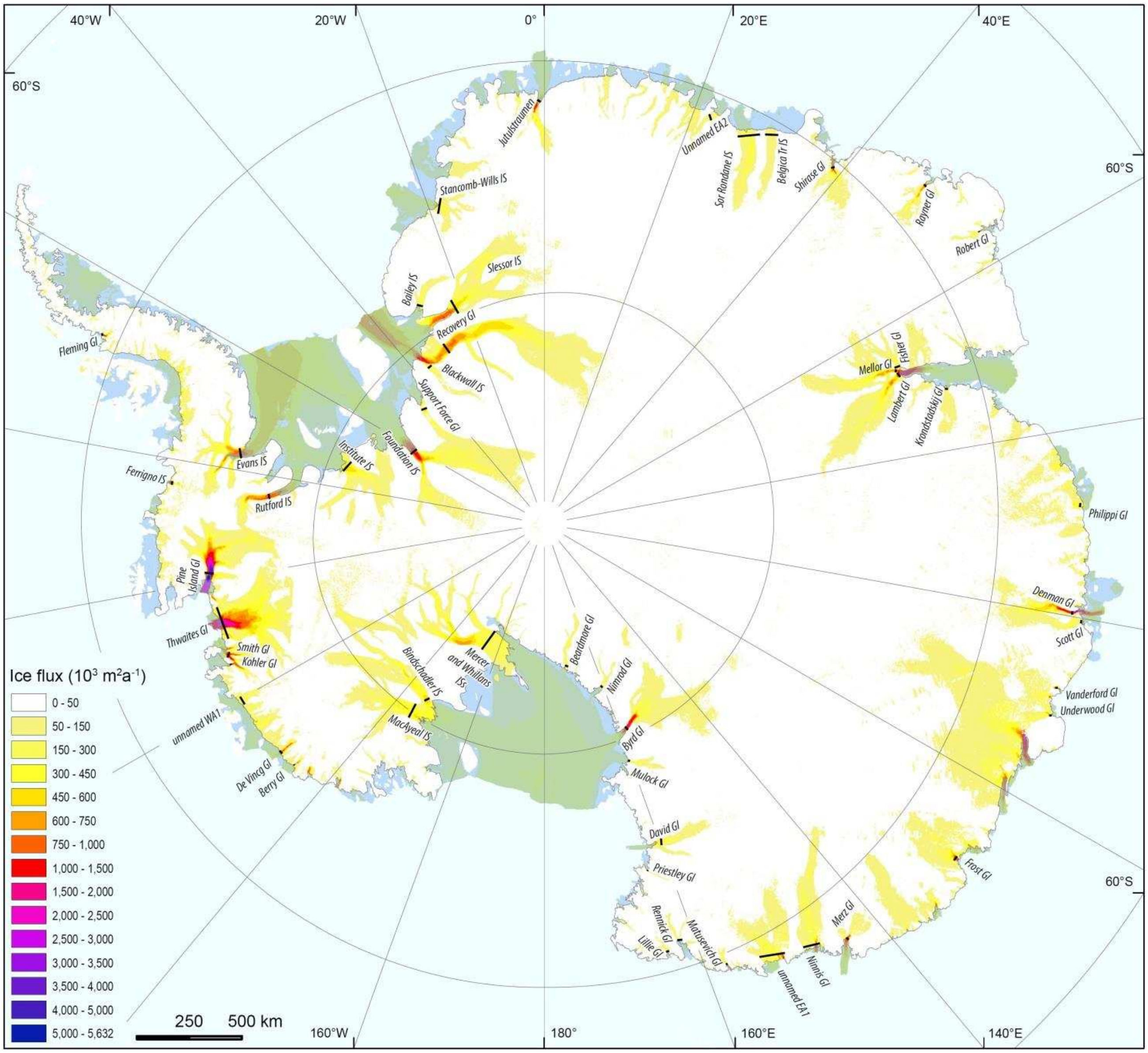
Supplementary Figure 4: Bathymetric data showing cross-shelf troughs (arrows) formed by ice streams fed by convergence of ice flow from several fjords along the east coast of Baffin Island. High resolution swath bathymetry data from Eclipse Sound/Pond Inlet (a and b) indicates a well-preserved bedform imprint on the floor of Eclipse Sound (redrawn from Margold et al., 2015)[46].



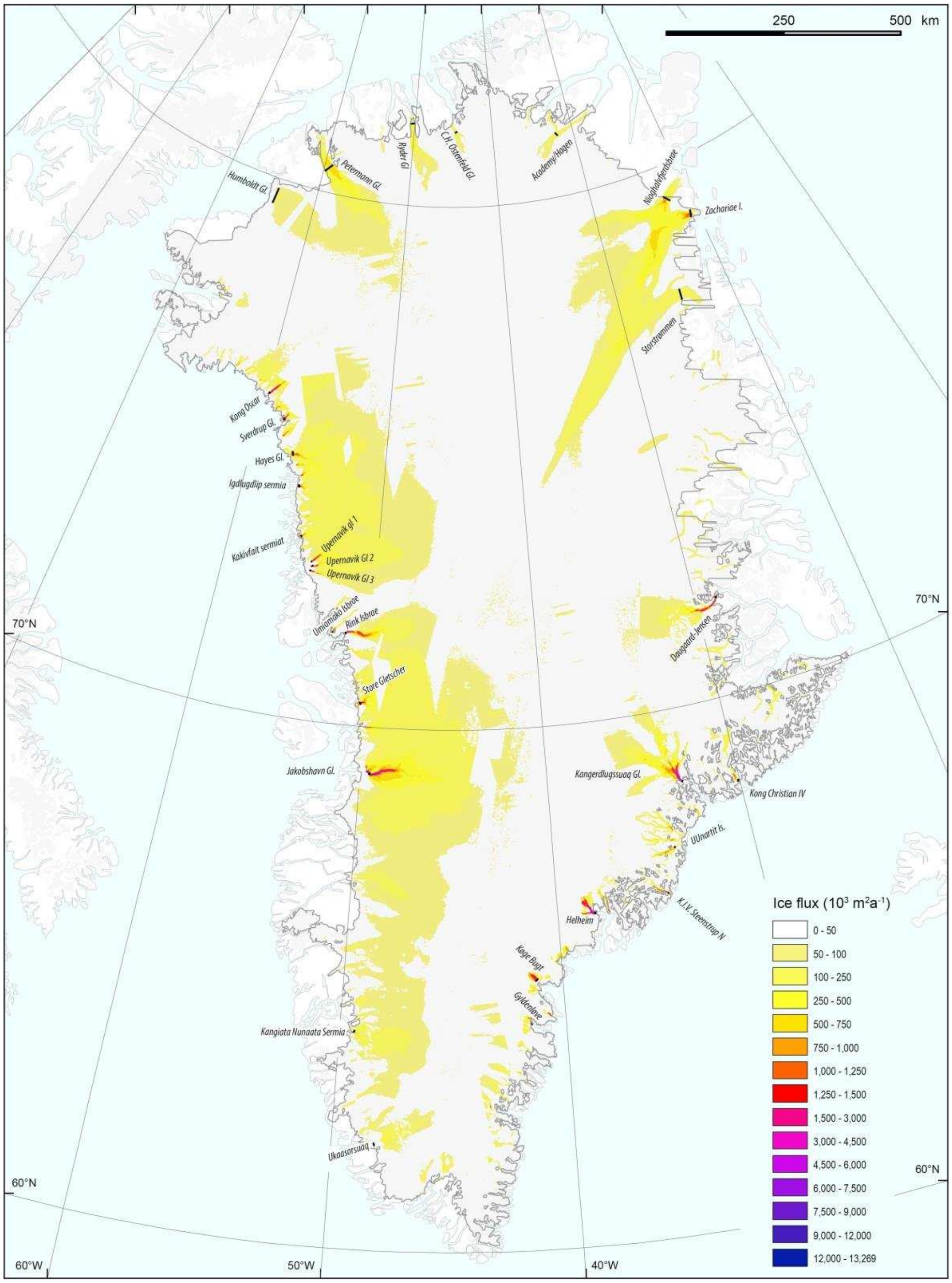
Supplementary Figure 5: Distribution of dates (black dots) and interpolated ice margin positions (white lines) from Dyke et al. (2003)[19]. These ice margin positions were used to bracket the age of the spatial footprint of each ice stream (Supplementary Figure 1). The red line shows the updated LGM ice margin (following recent work[46-52]).



Supplementary Figure 6: Schematic demonstrating the method used to bracket the age of the spatial footprint of palaeo-ice streams in both terrestrial and marine settings, as used in previous work (e.g. [22,23, 35, 36, 41,42]). In some cases, terrestrial ice streams are active, but then deactivate (shutdown) as the ice margin retreats (**a**). In other cases, ice streams remain active during deglaciation and continually remould their landform assemblage, leaving a more complicated time-integrated landform record, often with a series of overprinted landforms (**b**). The same scenarios are shown for a topographically-controlled marine-terminating ice stream in (**c**) and (**d**). The glacial geomorphology of these different ice stream behaviours is well-established in the literature[22,23, 35, 36, 41,42].

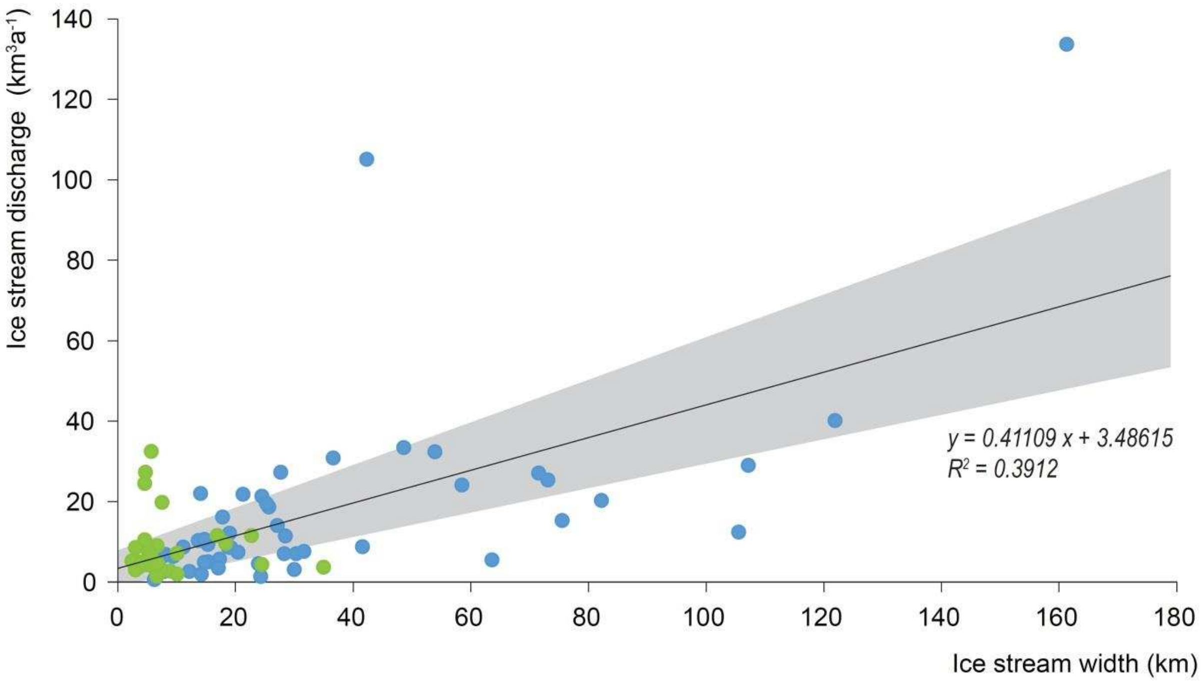


Supplementary Figure 7: Location of ice streams in Antarctica where their width, depth and velocity were extracted in order to calculate their discharge (see Supplementary Table 3). Regression analysis reveals that their discharge is most strongly related to their width (Supplementary Figure 9) and we used this relationship to estimate the discharge of palaeo-ice streams (Supplementary Table 1) where we only know their width.



Supplementary Figure 8: Location of ice streams in Greenland where their width, depth and velocity were extracted in order to calculate their discharge (see Supplementary Table 4). Statistical analysis reveals that their discharge is most strongly related to their width (Supplementary

Figure 9) and we used this relationship to estimate the discharge of palaeo-ice streams (Supplementary Table 1) where we only know their width.



Supplementary Figure 9: Relationship between ice stream discharge and width for 81 active ice streams in Antarctica (blue data-points: Supplementary Table 3) and Greenland (green data-points: Supplementary Table 4). Discharge calculations derived from velocity data in 2008-2009 (Greenland)[44] and 2007-2009 (Antarctica)[45]. Measured ice stream locations are shown in Supplementary Figure 7 and 8.

Supplementary Figure References

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