Updating glacier inventories on the periphery of Antarctica and Greenland using multi-source data

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SUPPLEMENTARY MATERIAL

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Table S1. List of Landsat images with the spatial resolution of 30 m (multispectral) or 15 m (panchromatic) used in Section 4 and 5

Code	Date	Path-Row	Sensor	Sun azimuth	Sun elevation	Image ID	Section
L1	2021/12/23	216-105	OLI	56.4	40.2	LC82161052021357LGN00	4.1
L2	2018/12/02	221-129	OLI	166.6	9.4	LC82211292018336LGN00	4.2
L3	2018/12/02	052-116	OLI	72.3	26.1	LC80521162018336LGN00	4.2
L4	2018/11/28	056-115	OLI	67.8	26.9	LC80561152018332LGN00	4.2
L5	2014/08/16	230-012	OLI	171.9	35.2	LC82300122014228LGN01	4.3
L6	2014/08/09	229-012	OLI	171.4	37.3	LC82290122014221LGN01	4.3
L7	2019/02/26	062-112	OLI	62.3	16.7	LC80621122019057LGN00	5.1
L8	2013/12/25	192-129	OLI	168.9	10.7	LC81921292013359LGN01	5.1
L9	2013/11/08	215-109	OLI	51.8	30.3	LC82151092013312LGN01	5.1
L10	2019/01/11	117-106	OLI	58.4	36.8	LC81171062019011LGN00	5.1
L11	2002/12/15	027-115	ETM+	73.3	27.7	LE70271152002349EDC00	5.1
L12	2019/03/06	175-110	OLI	57.4	16.5	LC81751102019065LGN00	5.1
L13	2016/01/11	221-111	OLI	63.0	31.0	LC82211112016011LGN03	5.1
L14	2016/01/13	219-112	OLI	64.8	29.5	LC82191122016013LGN02	5.1
L15	2013/08/26	233-016	ETM+	165.0	36.7	LE72330162013238EDC00	5.2
L16	2013/08/25	001-016	OLI	166.8	37.2	LC80010162013237LGN01	5.2
L17	1996/11/10	005-111	TM	65.8	25.6	LT50051111996315XXX02	5.3
L18	1996/11/14	001-111	TM	66.3	26.6	LT50011111996319AAA06	5.3
L19	2019/11/14	001-111	OLI	55.7	29.1	LC80011112019318LGN00	5.3
L20	2019/11/19	004-111	OLI	56.3	30.3	LC80041112019323LGN00	5.3
L21	2002/08/12	233-017	ETM+	159.0	42.0	LE72330172002224EDC00	5.3
L22	2018/09/01	233-017	OLI	165.7	36.0	LC82330172018244LGN00	5.3

Table S2. List of SLC pairs for generation of coherence map with the spatial resolution of 40 m in study cases

Path-Frame	Flight direction	Polarization	Code	Start date	End date	Days between images	Section
038-808	Descending	HH	C1	2021/12/12	2022/02/04	54	4.1
			C2	2021/12/12	2021/12/30	18	4.1
			C3	2021/12/12	2022/01/11	30	4.1
			C4	2021/12/12	2022/02/28	78	4.1
			C5	2021/12/18	2021/12/30	12	4.1
			C6	2022/01/23	2022/02/16	24	4.1
070-885	Ascending	HH	C7	2018/11/18	2019/01/05	48	4.2
			C8	2018/11/30	2019/01/05	36	4.2
			C9	2018/11/30	2019/01/17	48	4.2
			C10	2018/11/30	2019/01/29	60	4.2
			C11	2018/12/12	2019/02/10	60	4.2
			C12	2018/12/12	2019/02/22	72	4.2
170-366	Descending	HH	C13	2015/08/13	2015/08/25	12	4.3
			C14	2015/08/13	2015/09/06	24	4.3
			C15	2015/07/20	2015/08/25	36	4.3
			C16	2015/08/01	2015/08/13	12	4.3
			C17	2015/08/01	2015/08/25	24	4.3
			C18	2015/08/01	2015/09/06	36	4.3

Table S3. List of DEMs and ice velocity information used for the peripheral glaciers in Antarctica/Greenland in Section 4 and 5

Source data	Period	Resolution (m)	Section
DEMs			
REMA	2009-21	32	4.1 & 4.2 & 5.1
		200	5.3
ArcticDEM	2015-18	32	4.3 & 5.3
RAMP DEM	1940-99	200	5.3
GIMP DEM	2003-09	30	5.3
Ice velocity maps			
Antarctica ice velocity	1996-2016	450	4.2
Greenland ice velocity	2017-18	200	4.3

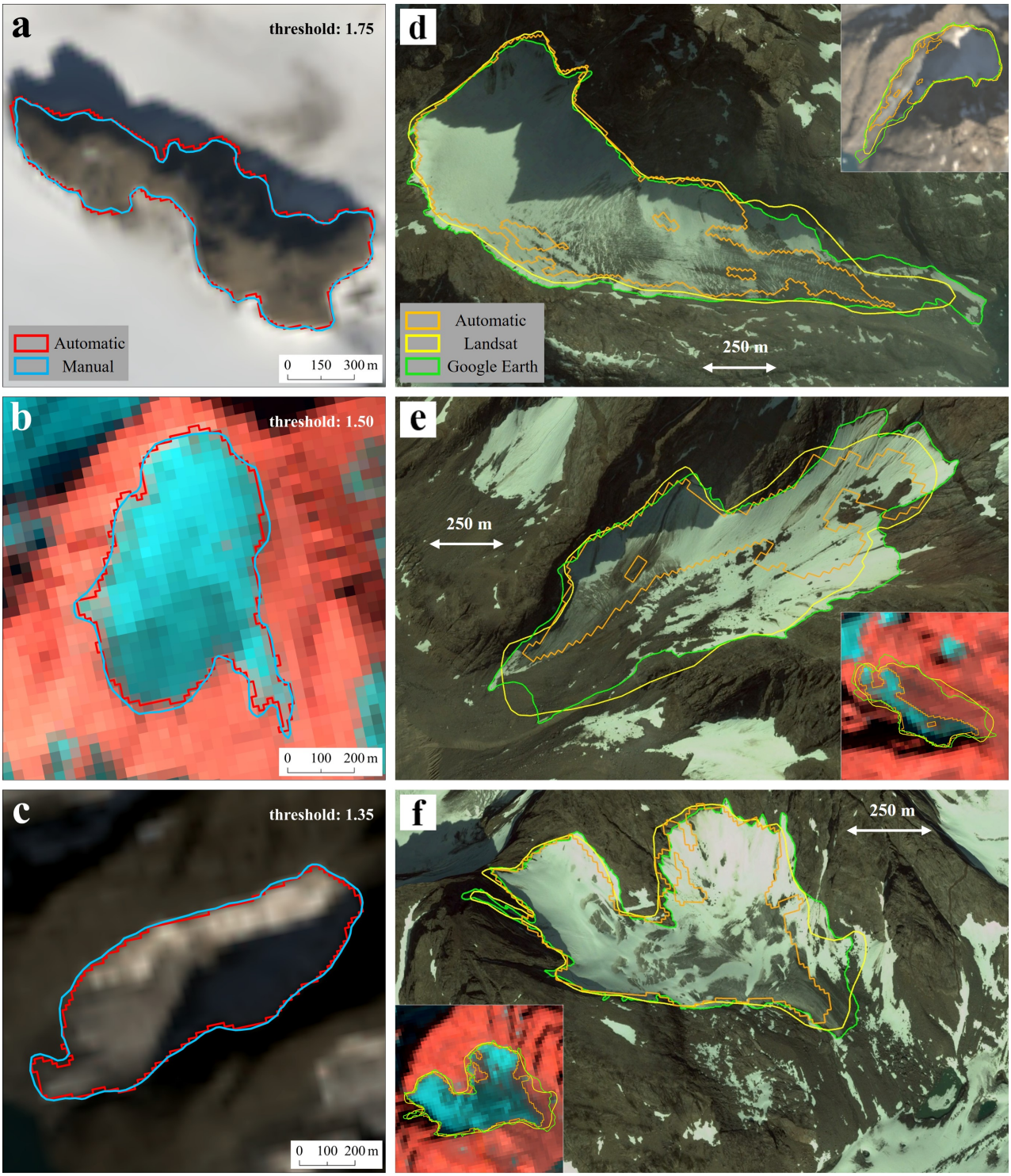

Fig. S1. Precision verification of glacier boundaries in the region around Kangerlussuaq Fjord. (a) (b) (c) Comparison of manual and automatic mapping results: the mean deviations between the three pairs of glacier boundaries are about 8 m, 10 m, and 10 m, respectively. (d) (e) (f) Comparison of Google Earth mapping results and Landsat results which are manually improved from automatic classification results: the mean deviations of three pairs of glacier boundaries are about 21 m, 20 m, and 17 m, respectively. The six glaciers give in order 3.0%, 5.0%, 5.9%, 1.6%, 2.8% and 3.3% area deviation.

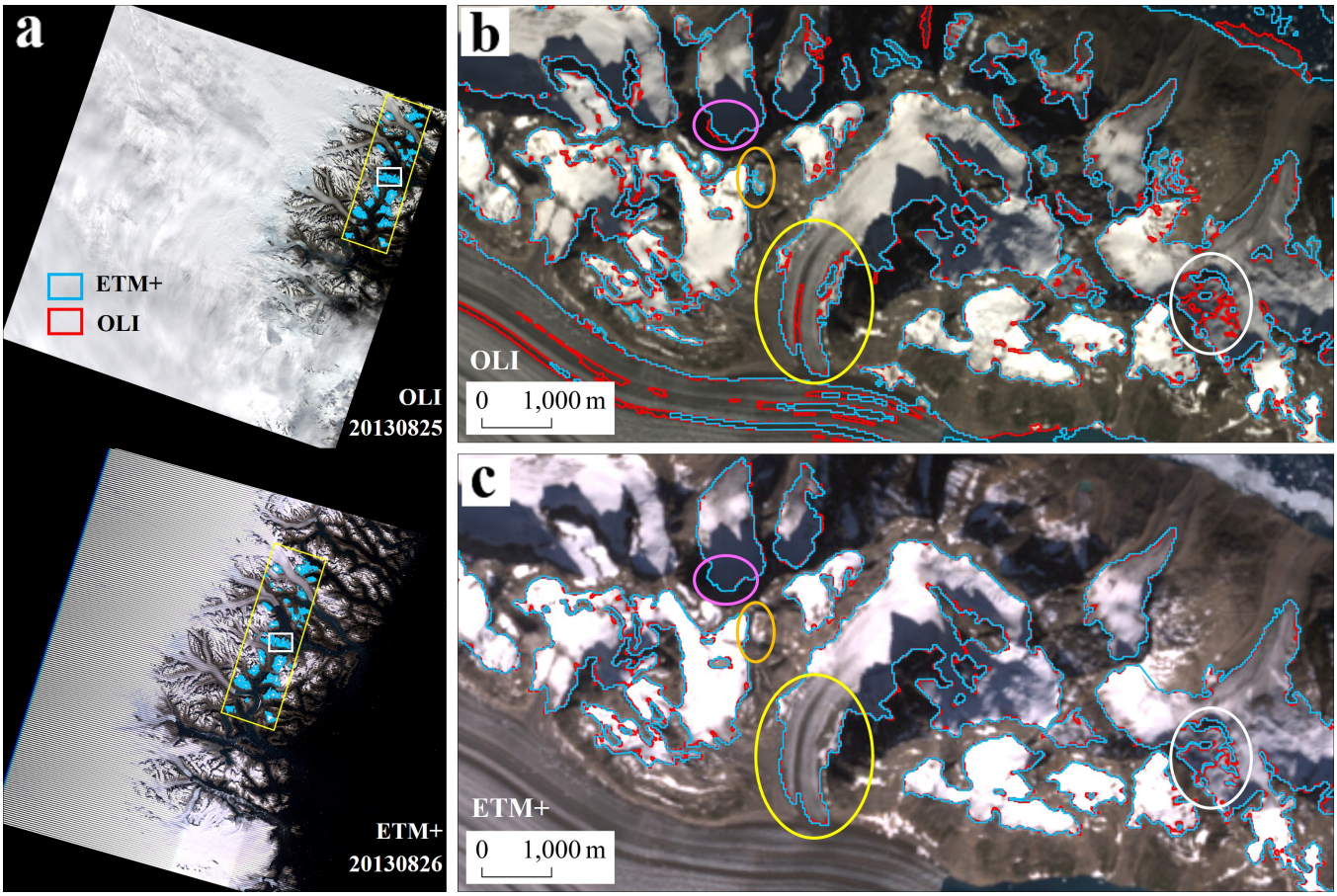

Fig. S2. Comparison experiment of glacier mapping with ETM+ and OLI methods in SE Greenland. (a) A common scene (63.0°N, 42.3°W; yellow box) without stripes in the ETM+ image and without clouds in the OLI image were selected for the experiment. The white box corresponds to the scene subsets (b,c). 84 glaciers in common scene were separated from original outlines and used for the comparison. (b) Qualitative comparison of ETM+ and OLI original glacier outlines. (c) Rules for processing the original glacier outlines in (b) for quantitative comparison: 1. Extra snow patches or ice attached to ETM+ glaciers are excluded (orange circle); 2. Extremely small holes (area < 0.003 km^2) in OLI glaciers were filtered, and dirty ice and debris-covered ice identified by OLI and ETM+ were improved (yellow circle); 3. Rocks not identified in detail by ETM+ were excluded (only where they differed significantly from the OLI results; white circle); 4. The same or close improvements were made for regions with differences in image orthorectification and for regions where the classification results are sensitive to changes in ratio thresholds (magenta circle).

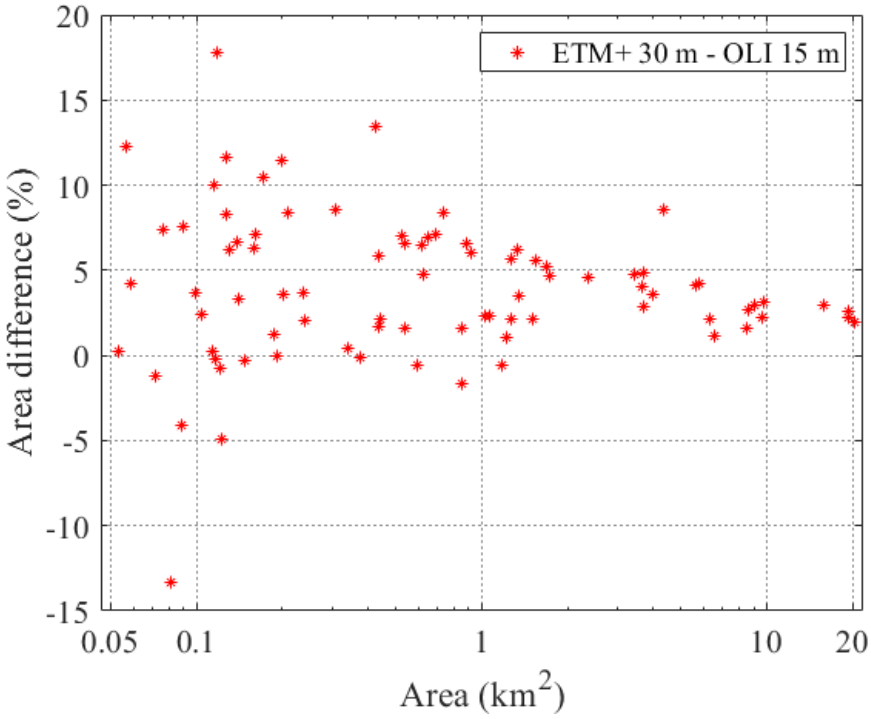

Fig. S3. Relative area differences versus glacier area for 84 selected glaciers. ETM+ 30 m = ETM+3/ETM+5, OLI 15 m = OLI8/OLI6.

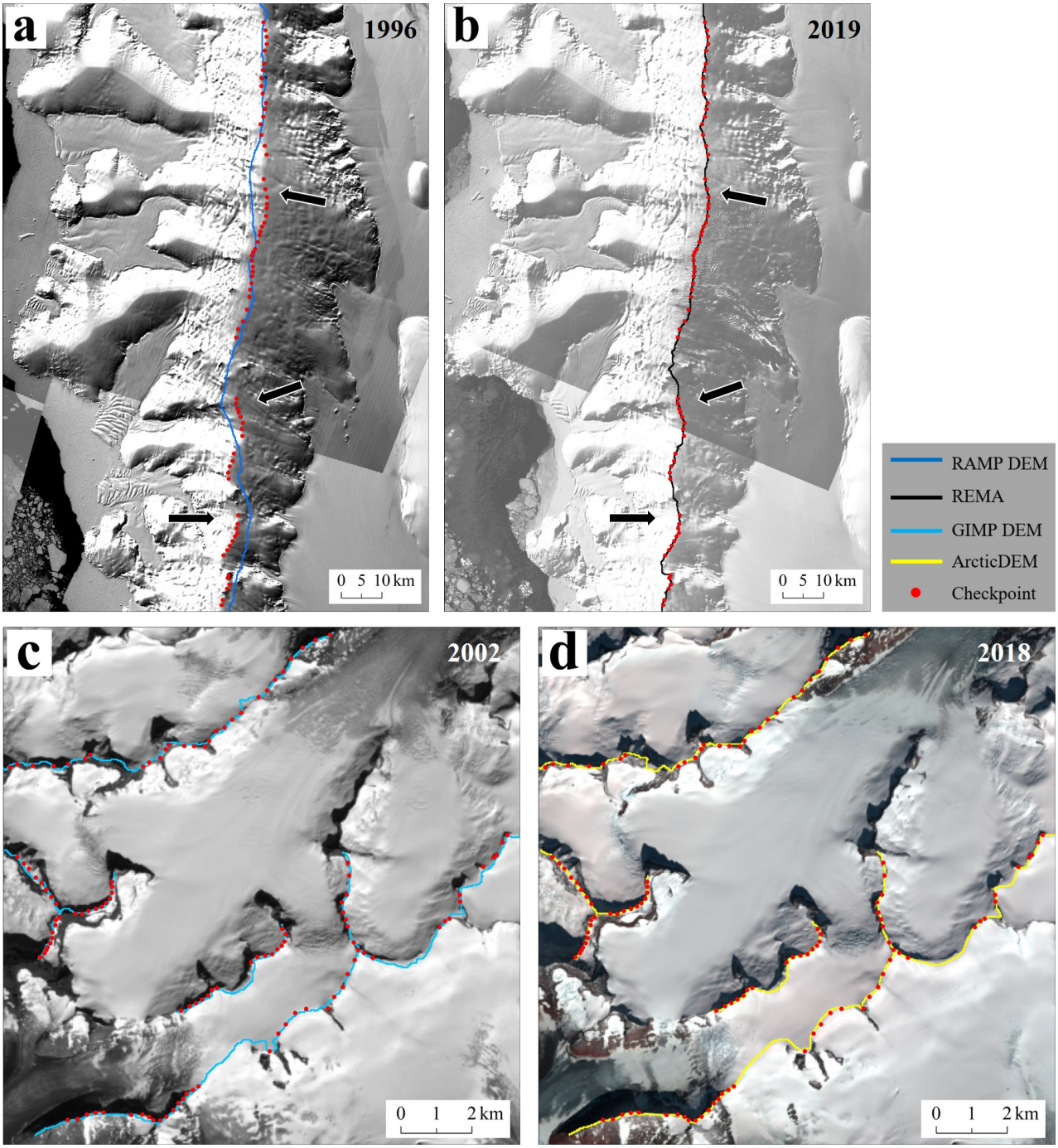

Fig. S4. Comparison of the watershed generation from different DEMs in example areas of Antarctica (72.2°S, 98.5°W) and Greenland (61.0°N, 43.5°W). (a) The RAMP-DEM watershed with contrast-enhanced imagery from 1996 (L17-L18). (b) The REMA watershed with contrast-enhanced imagery from 2019 (L19-L20). Black arrows show the obvious differences between the RAMP-DEM watershed and the REMA watershed. (c) The GIMP-DEM watersheds with imagery from 2002 (L21). (d) The ArcticDEM watersheds with imagery from 2018 (L22). Differences in topographic delineation (except for undetermined accumulation zones) using GIMP DEM and ArcticDEM are not significant. The checkpoints (70 points for Antarctica and 120 points for Greenland) were manually identified, matching the topographic divisions in images from two periods in Antarctica and Greenland, respectively.