

Supplementary materials

Table S1. Literature review of the existing DEM products covering Antarctica or Antarctic Peninsula

DEM product	Coverage	Data source	Temporal coverage	Posting	Absolute vertical accuracy
RAMPv2 DEM (Liu et al., 2001)	Antarctica 60 °S–90 °S	cartographic data; remotely sensed data; survey data	1 January 1940 to 1 January 1999	1 km, 400 m, 200 m	Rugged mountainous areas: 100 m; Steeply sloped coastal regions: 15 m; Ice shelves: 1 m; Gently sloping interior ice sheet: 7.5 m
GLAS/ICESat 500 m Laser Altimetry DEM of Antarctica (DiMarzio et al., 2007)	Antarctica 63 °S–86 °S	GLAS/ICESat laser altimetry profile data	1 February 2003 to 30 June 2005	500 m	Ranging from less than 1m to tens of meters
New 1km DEM of Antarctica from combined radar and laser data (Bamber et al., 2009; Griggs and Bamber, 2009)	Antarctica North of 90 °S	ERS-1 radar and GLAS/ICESat laser altimetry data	ERS-1 RA data: 1991 to May 1995; GLAS/ICESat data: February 2003 to March 2008	1 km	Ice shelves: 1 m; Grounded ice sheet: 2 m – 6m; Steep sloping margins: greater than 20 m.
SPOT 5 Reference Images and Topographies (SPIRIT) DTM (Korona et al., 2009)	Selected polar regions at 81.15 °N–81.15 °S	SPOT 5 stereoscopic images	July 2007 to April 2008	40 m	6 m
ASTER GDEM (ASTER GDEM Validation Team, 2009, 2011; Abrams et al., 2020)	Global DEM 83 °N–83 °S	visible and near-infrared satellite data	March 2000 to November 2007	30 m	10 m

Improved ASTER GDEM (Cook et al., 2012)	Antarctic Peninsula (63 °S–70 °S)	ASTER GDEM	March 2000 to November 2007	100 m	4 m
Bedmap2, surface DEM (Fretwell et al., 2013)	Antarctica 60 °S–90 °S	ASTER GDEM, SPIRIT DTM, satellite radar and laser altimetry data, the Ohio State University DEM	The vast majority of data were collected in the last two decades	1 km	30 m (rising to 130 m over mountains)
CryoSat-2 Antarctic DEM 2012 (Helm et al., 2014)	Antarctica North of 90 °S	CryoSat-2 satellite radar altimetry data	January 2012 to January 2013	1 km	90 % of the area of ice sheets: 3m ± 15m.
CryoSat-2 Antarctic DEM 2017 (Fei et al., 2017)	Antarctica North of 90 °S	CryoSat-2 satellite radar altimetry data	December 2012 to January 2015	1 km	Domes: 1 m; Ice shelves: 4 m; Interior ice sheet: 10 m; Rugged mountainous and coastal areas: 150 m.
CryoSat-2 Antarctic DEM 2018 (Slater et al., 2018)	Antarctica North of 88 °S	CryoSat-2 satellite radar altimetry data	July 2010 to July 2016	1 km	9.5 m
TanDEM-X global DEM (Wessel, 2016;Rizzoli et al., 2017)	Global DEM 85 °N–90 °S	TanDEM-X bistatic stripmap InSAR data	December 2010 to January 2015 (for global acquisitions); April to November of 2013 and 2014 (for acquisitions at Antarctica)	12, 30 and 90 m	10 m
REMA DEM (Howat et al., 2019)	Antarctica North of 88 °S	submeter resolution optical, commercial satellite imagery	September 2008 to August 2014	Less than 10 m	less than 1 m

Table S2. Statistics of DEM height differences between the laser points and the TDM DEMs after each iteration of correction over the local sample area in Fig. 11. All height units are in meters. Height differences calculated as DEM elevation minus laser height.

		Elevation range	Num. of points	Mean	RMSE	90 % quantile
LVIS 2015	After 1st correction	1000–1500	20	4.1	9.5	10.0
		1500–2000	43496	0.8	9.5	10.0
	After 2nd correction	1000–1500	20	6.0	3.3	10.0
		1500–2000	43496	1.6	6.3	9.0
	After 3rd correction	1000–1500	20	6.0	3.3	10.0
		1500–2000	43535	1.6	4.7	8.0
ATL06 2019	After 1st correction	1000–1500	50	-5.6	28.4	3.0
		1500–2000	1606	-6.8	17.7	5.0
	After 2nd correction	1000–1500	49	-1.6	3.7	3.0
		1500–2000	1607	-2.3	6.7	5.0
	After 3rd correction	1000–1500	49	-1.5	3.5	3.0
		1500–2000	1607	-1.3	4.6	5.0

Table S3. Statistics of DEM height differences between the laser altimetry points and the corrected TDM DEMs after each iteration of correction over the Hektoría and Green Glaciers area in Fig. 12. All height units are in meters. Height differences calculated as DEM elevation minus laser height.

		Elevation range	Num. of points	Mean	RMSE	90 % quantile
LVIS 2015	After 1st correction	>=500	3411178	9.1	21.0	32.8
		15–500	1414822	13.3	15.2	34.3
		500–1000	993509	12.9	21.4	38.5
		1000–1500	278735	6.8	33.2	36.0
		1500–2000	642262	-3.8	20.0	11.0
		>=2000	81850	0.9	7.8	6.0
	After 2nd correction	>=500	3412383	5.8	11.4	16.5
		15–500	1435731	8.1	8.5	17.0
		500–1000	977007	5.9	12.3	17.0
		1000–1500	272967	5.5	18.3	20.0
		1500–2000	641855	1.2	10.6	11.0
		>=2000	84823	1.1	6.0	6.0
	After 3rd correction	>=500	3412552	5.0	10.5	14.5
		15–500	1439149	7.2	8.0	16.0
		500–1000	974766	4.4	11.4	13.5
		1000–1500	272005	4.7	17.4	18.0
		1500–2000	641497	1.5	9.5	10.0
		>=2000	85135	1.4	5.0	6.0
ATL06 2019	After 1st correction	>=500	20464	12.4	20.9	37.0
		15–500	7987	22.7	22.1	49.0
		500–1000	6912	12.9	14.1	29.5
		1000–1500	887	2.5	18.9	12.0
		1500–2000	4351	-4.4	16.2	5.0
		>=2000	327	1.0	4.9	4.4
	After 2nd correction	>=500	20490	9.2	13.4	26.5
		15–500	8045	15.6	14.8	34.3
		500–1000	6874	9.5	10.1	18.5
		1000–1500	878	3.2	10.2	11.0
		1500–2000	4366	-1.3	7.7	5.0
		>=2000	327	1.3	3.2	4.4
	After 3rd correction	>=500	20507	8.7	12.87	25.8
		15–500	8081	14.7	14.5	34.0
		500–1000	6856	8.7	10.2	18.0
		1000–1500	872	3.5	7.6	10.9
		1500–2000	4372	-0.9	6.6	5.0
		>=2000	326	1.2	3.2	4.0

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