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Dynamic changes in outlet glaciers in northern Greenland from 1948 to 2015

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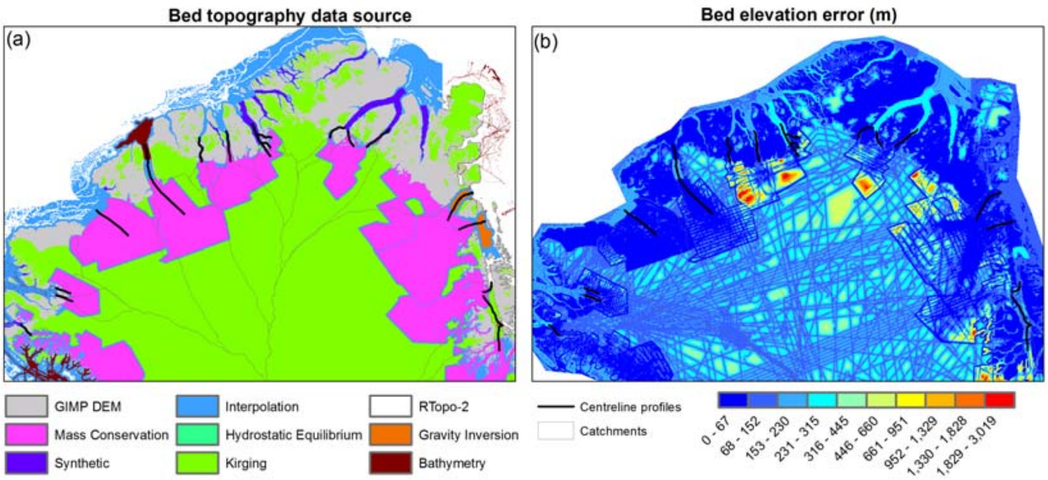
Supplementary Information

1. Data Sources

Supplementary Table 1: List of data sources used in this study. Data is split by usage and shown for each year, links for these data sources are provided in supplementary material.

Year	Data	Resolution	Source
Front Position			
1948	AMS C501 Greenland Topographic Series	1: 250,000	Polar Geospatial Centre
1962–63	Corona Declassified Spy Satellite	-	USGS Earth Explorer
1968/9	USAF Operational Navigation Charts	1:1,000,000	Perry-Castañeda Library, University of Texas
1975–94	Landsat 1-5 MSS	30 m	USGS Earth Explorer
1978	Aerial Photographs	2 m	Danish History Museum (Korsgaard et al., 2016)
1986–87	SPOT–1 Satellite Imagery	10 m	European Space Agency
1992–1999	ERS-1/2 SAR Imagery		European Space Agency
2000–2012	Landsat 7 ETM–Panchromatic band (band 8)	15 m	USGS Earth Explorer Rapid Ice Sheet Change Observatory
2013–2015	Landsat 8–Panchromatic band (band 8)	15 m	USGS Earth Explorer
Ice Velocity			
1991/92	ERS 1 winter velocity	500 m	Greenland Ice Sheet CCI project (Nagler et al., 2016)
1995/96	ERS 2 winter velocity	500 m	Greenland Ice Sheet CCI project (Nagler et al., 2016)
2000/01 **2004/05–2009/10**	MEaSUREs Greenland Annual Ice Velocity from InSAR (Version 2)	500 m	National Snow and Ice Data Center (Joughin et al., 2015)
2011–2013	MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from InSAR (TerraSAR-X)	100 m	National Snow and Ice Data Center (Joughin et al., 2011)
2014–2016	Sentinel-1 SAR velocity	500 m	Greenland Ice Sheet CCI project (Nagler et al., 2016)
Surface Elevation Change			
1996–2011	ERS1, ERS2 and ENVISAT 5-yr means	5 km	Greenland Ice Sheet CCI project (Sørensen et al., 2015)
2011–2015	Cryosat 2 Surface Elevation Change v2 2-yr means	5 km	Greenland Ice Sheet CCI project
Surface elevation, Ice thickness, bed topography			
Nominal date 2007 (Data collected between 1993–2014)	Ice surface elevation Ice thickness Bedrock elevation	150 m	National Snow and Ice Data Center IceBridge Bed Machine (Morlighem et al., 2014)
1978	Surface Digital Elevation Model	25 m	NOAA National Centers for Environmental Information (Korsgaard et al., 2016)
Climate-ocean data			
1948 - 2015	Air Temperature - DMI Automatic Weather Stations	-	Danish Meteorological Institute (Vinther et al., 2006)
1979–2016	Sea Ice Concentrations from Nimbus-7 SMMR	25 km	National Snow and Ice Data Center (Cavalieri et al., 1996)

2. Bed topography error

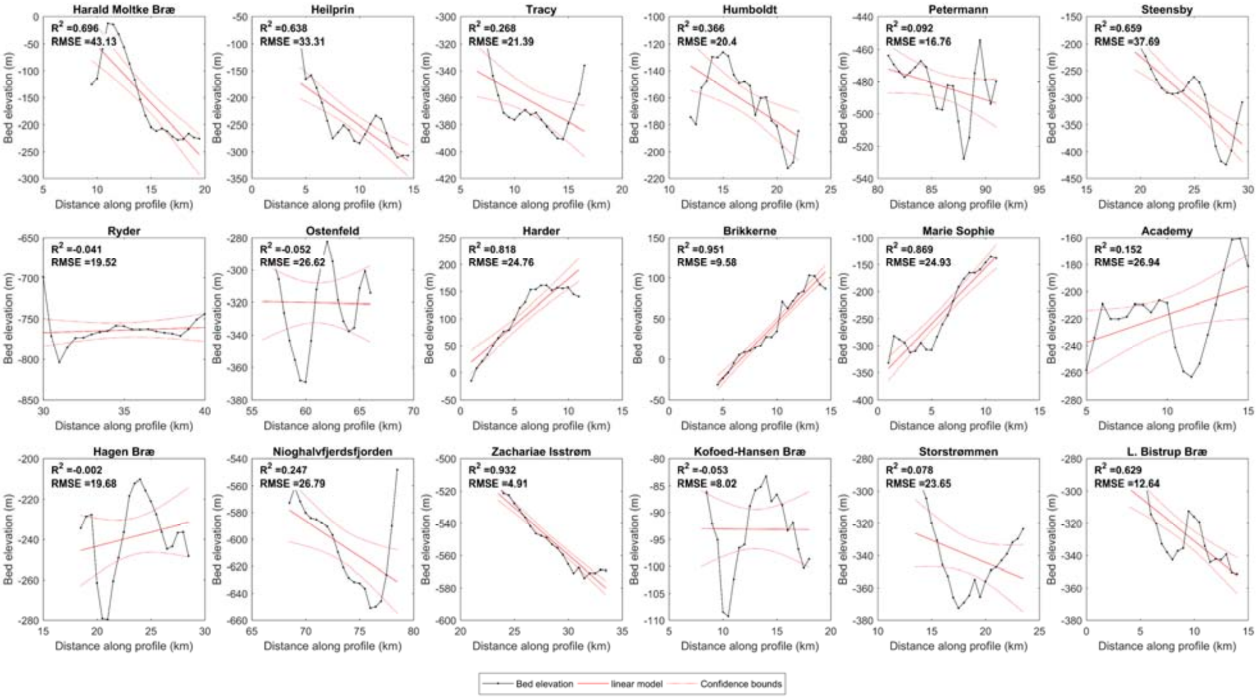


Supplementary Figure 1: (a) categorised source data of bed topography from the BedMachine v3 for northern Greenland (b) bed elevation error (m) map from the BedMachine v3 dataset. Grey outlines show glacier surface drainage catchments, and black lines show glacier centreline profiles.

Supplementary Table 2: Mean elevation error for each glacier across either the grounded portion of the glacier centreline profile, or the seaward (bathymetry) section of the glacier centreline profile.

Glacier	Mean grounded bed topography error (m)	Mean bathymetry error (m)
Harald Moltke Bræ	40.94	252.64
Heilprin	53.62	75.30
Tracy	86.54	184.60
Humboldt	31.36	188.82
Petermann	25.14	111.86
Steensby	44.84	194.99
Ryder	33.88	196.03
Ostenfeld	70.82	283.94
Harder	78.93	143.33
Brikkerne	146.45	236.65
Marie Sophie	87.14	85.82
Academy	46.48	181.31
Hagen Bræ	63.24	245.75
Nioghalvfjerdsfjorden	42.94	15.57
Zachariae Isstrøm	52.59	17.47
Kofoed-Hansen Bræ	215.93	104.88
Storstrømmen	116.07	117.54
L. Bistrup Bræ	112.36	169.52

3. Bed slope direction



Supplementary Figure 2: Bed topography profiles for each of 18 study outlet glaciers in northern Greenland. Bed topography was sampled along glacier centreline profiles and subsampled from the grounding line to 20 km inland to determine the local bed slope direction inland of the grounding line. Each profile was fit with a linear regression model (red). The direction of the linear fit was used to determine if the bed slope was seaward or landward sloping.