S1 Processing of terminus positions

Many of the published sources (Table S1) have taken care to account for seasonality in terminus position by, for example, sampling at the same time each year, but we do not think this is a hugely important consideration because the long-term changes we are interested in are far larger than the seasonal variability at a given glacier. When we had to convert terminus traces to terminus position (e.g. for the NSIDC positions) we used the bow method (Bjork et al., 2012).

Many glaciers have a terminus position dataset coming from more than one source. In these cases we remove or merge the datasets according to the procedure summarized in Figure S1. Where a dataset has a shorter time period and a lower or similar sampling frequency compared to another dataset, the former dataset is removed. For example, the Carr et al. (2017) and Bunce et al. (2018) datasets are removed in favor of the Cowton et al. (2018) dataset for Helheim glacier (Figure S2). We merge two datasets when a longer record can be made by combining the two. The datasets are merged by calculating an offset during the overlapping period, and then shifting one of the datasets to make a continuous record. The final terminus position record for Helheim thus consists of a merged form of the Andresen et al. (2012), Cowton et al. (2018) and Joughin et al. records (Figure S2). Lastly, glaciers that are known to have a permanent ice shelf/tongue (Petermann, Ryder, 79N), or to surge (Storstrommen) are removed from the dataset.

Source	**Spatial coverage**	**Time period**	**Time period**
Andresen et al. (2012)	Helheim Glacier	1933-2010	Sporadic to annual
Steiger et al. (2018)	Jakobshavn Isbrae	1850-2016	Sporadic to annual
Lea et al. (2014)	KNS	1850-2016	Sporadic to annual
Haubner et al. (2018)	Upernavik	1849-2012	Sporadic to annual
Catania et al. (2018)	15 glaciers, CW Greenland	1953-2016	Sporadic to subannual
Cowton et al. (2018)	10 glaciers, E Greenland	1990-2015	Annual
Moon and Joughin (2008); Joughin et al.	Full ice sheet	2000-2017	$\sim$5 years to annual
Bunce et al. (2018)	276 glaciers, NW & SE Greenland	2000-2015	Annual
Carr et al. (2017)	169 glaciers around Greenland	1992-2010	Decadal

Table S1. Terminus position data sources and characteristics.

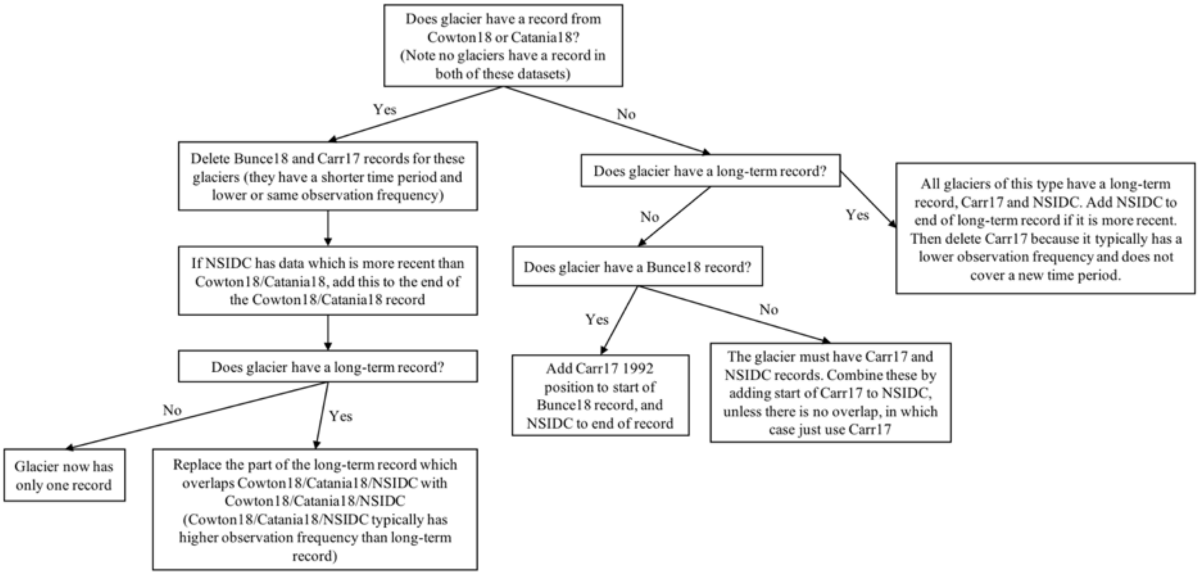

Figure S1. Flowchart describing the merging of datasets where a tidewater glacier appears in two different terminus position datasets.

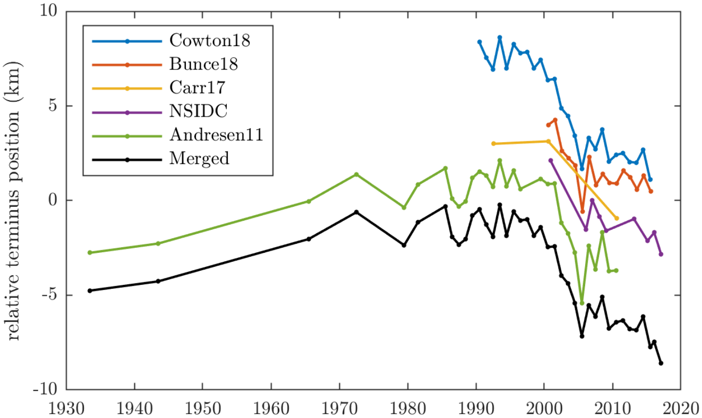

Figure S2. Example of terminus position dataset merging for Helheim Glacier, SE Greenland. Note that the absolute terminus position is arbitrary.

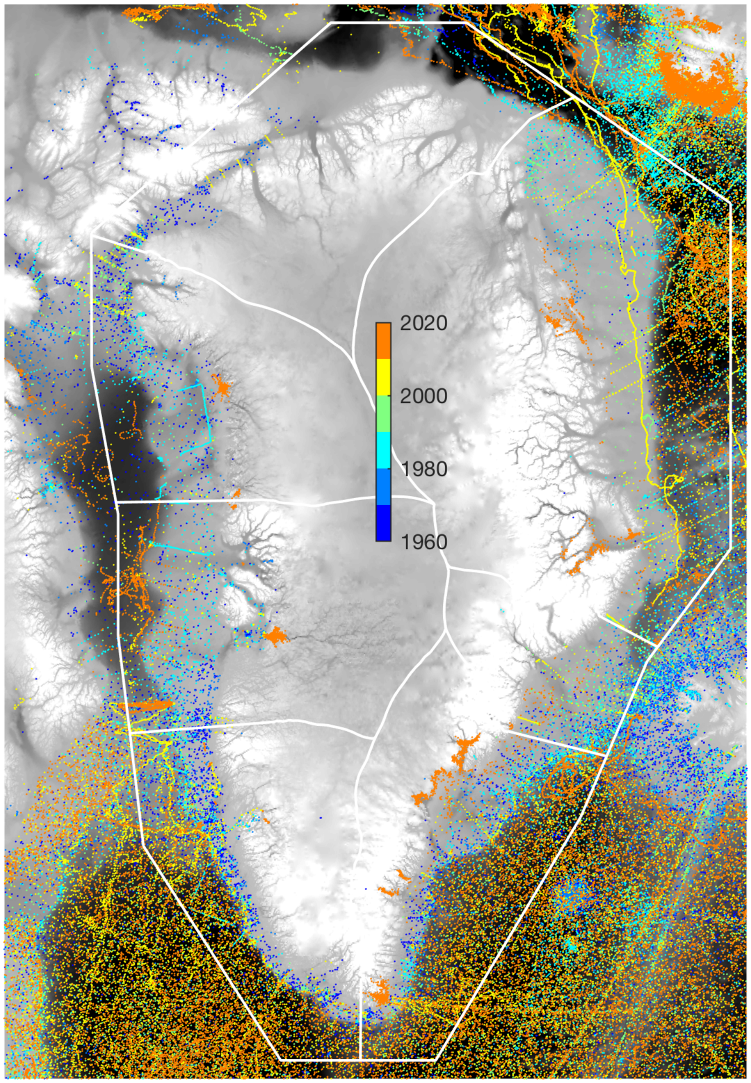

Figure S3. Locations and times of EN4 profile data (Good et al., 2013), on which the gridded product we use to generate our thermal forcing time series is based. Coverage is good throughout the time series in the southern half of Greenland, but poorer in the northern and western regions.

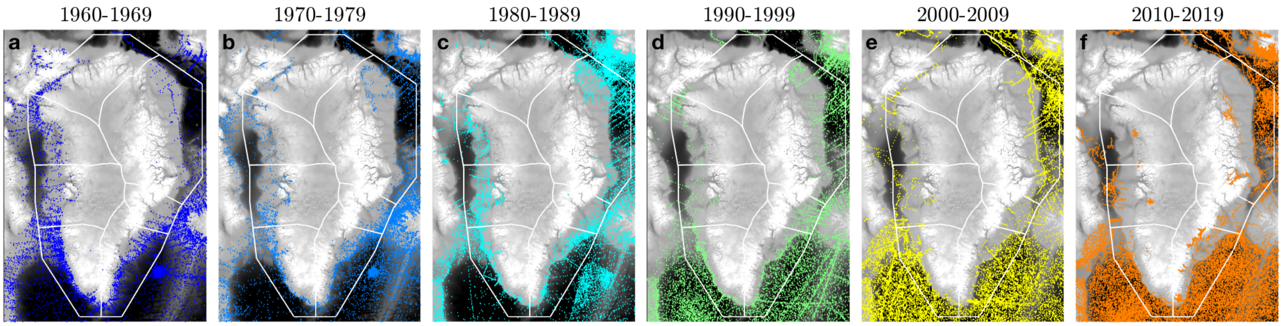

Figure S4. Locations of EN4 profile data (Good et al., 2013) by decade entering the gridded product we use to generate the sector ocean thermal forcing.

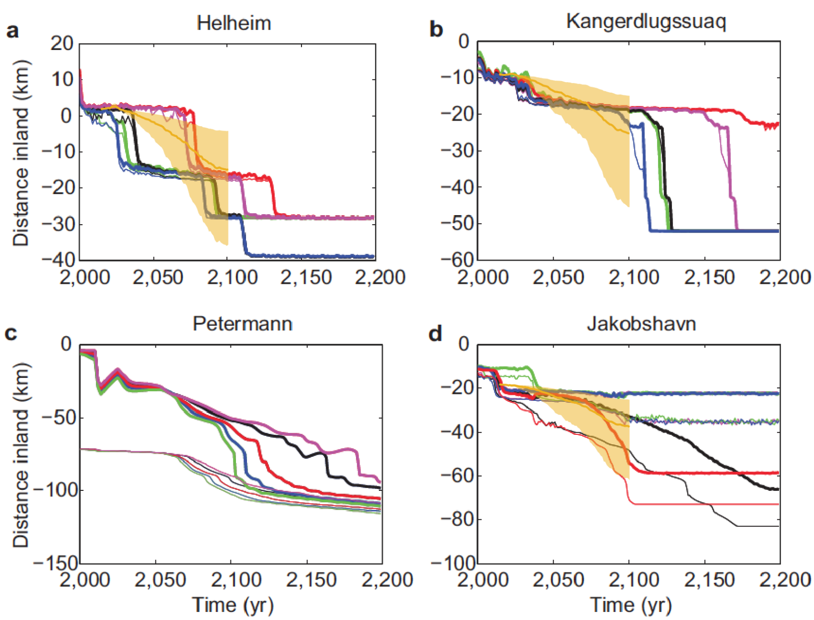

Figure S5. Comparison of projected retreat under RCP8.5 in this study (yellow lines and shading) versus Nick et al. (2013) (all other lines). The thick lines from Nick et al. (2013) indicate the position of the calving front while the thin lines indicate the grounding line; these lines may differ significantly if the glacier has a large ice shelf (e.g. Petermann). Ice shelves have not been considered in our study and so we do not attempt a comparison on Petermann glacier. The 5 different lines from Nick et al. 2013 on each plot are 5 different model parameter combinations.

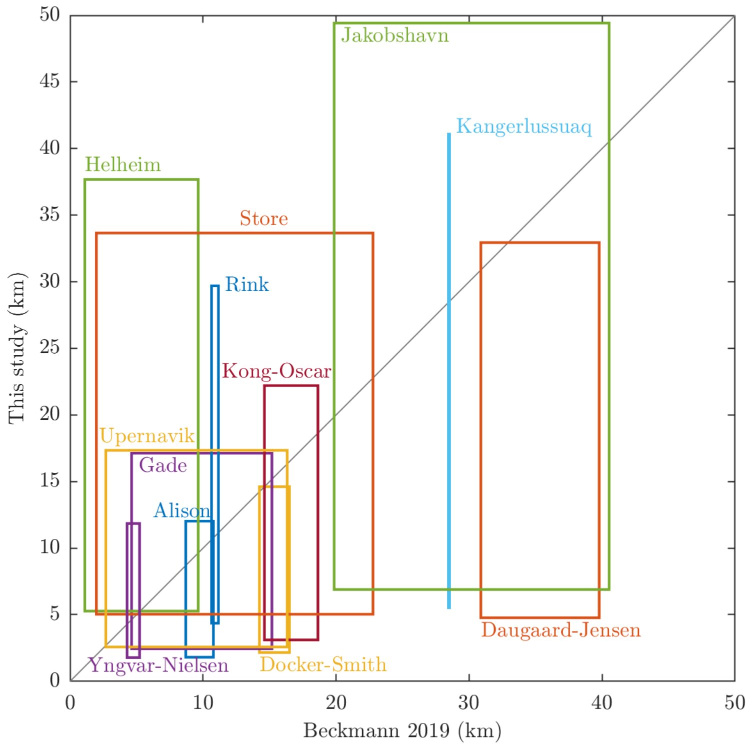

Figure S6. Comparison of projected retreat under RCP8.5 in this study (y-axis) versus Beckmann et al. (2018) (x-axis), for the 12 glaciers indicated and considered in Beckmann et al. (2018). The results for each glacier are plotted as a box where the extent of the box in the x- and y-direction is defined by the interquartile range (25th-75th percentiles). The grey line shows the 1-1 relationship, thus if a box overlaps the grey line, then the projections for that glacier agree within the interquartile range. This is true for every glacier considered, although only just so for Docker-Smith glacier. It must also be said however that the uncertainties on the projections (i.e. size of the box) in both this study and in Beckmann et al. (2018) are generally very large.

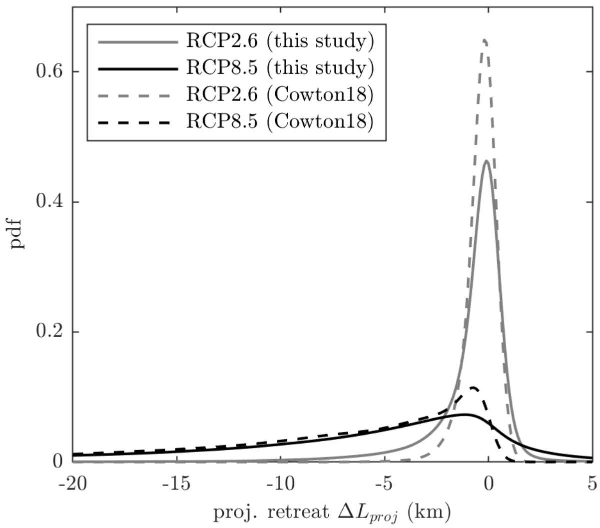

Figure S7. Distributions of projected retreat by 2100 for a low (RCP2.6) and a high (RCP8.5) emissions scenario in the climate model MIROC5 using the parameterisation of this study (solid lines) and that of Cowton et al. (2018) (dashed lines). Cowton et al. (2018) suggest a parameterisation $dL/dt = ad(Q\,\mathrm{TF})/dt$ where $a = -0.018 \pm 0.006$. To generate the distribution of retreat for this parameterisation we assume a is normally distributed with mean -0.018 and standard deviation 0.006, and we then sample from this distribution to give projected retreat as we would for the κ distribution in our study.

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