

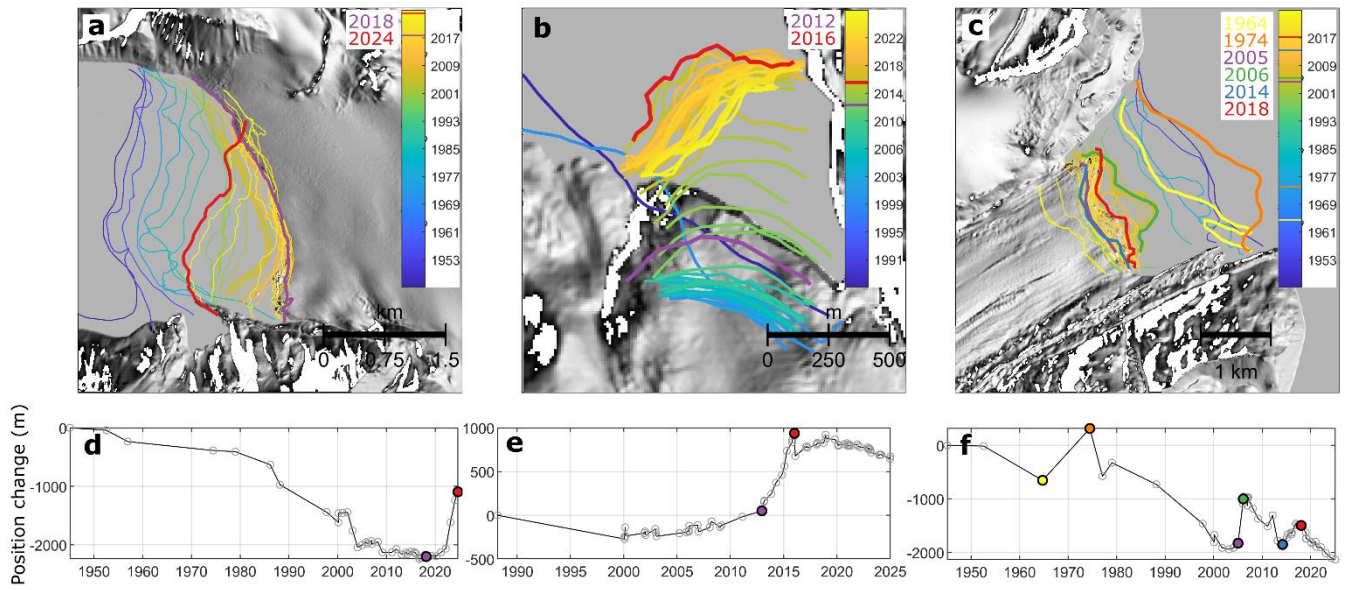


Figure S1. Long-term terminus position change of (a,d) Whisky Glacier, (b,e) Kotick Glacier and (c,f) Gourdon Glacier. Terminus traces in panels (a-c) are overlain on a hillshade of the 10 x 10 m REMA mosaic (Howat et al., 2022a). Terminus position changes in panels (d) to (f) are measured along a central flowline. REMA data courtesy of the Polar Geospatial Center.

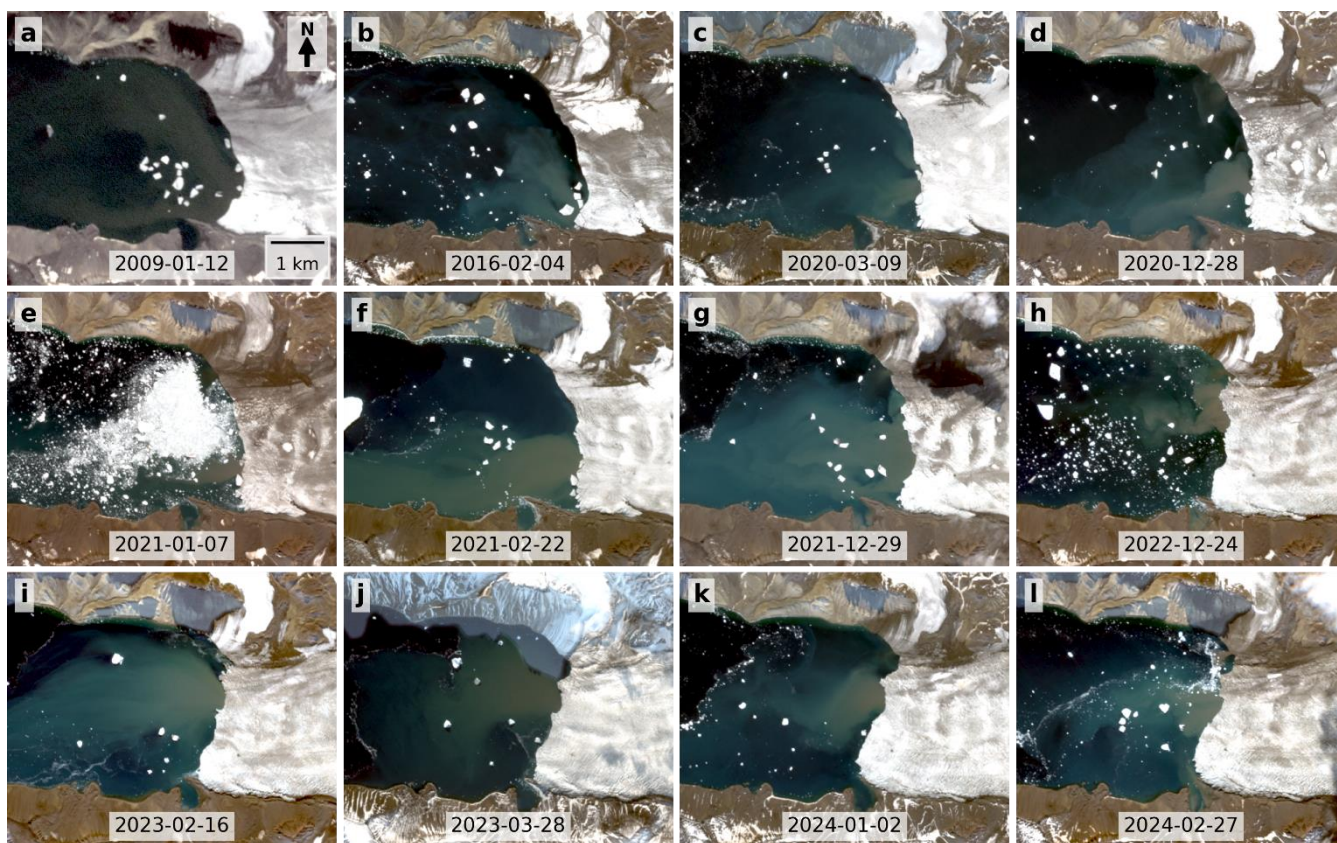


Figure S2. Sediment-laden plumes at the Whisky Glacier terminus. Sentinel-2 data courtesy of ESA Copernicus. Landsat 8 data courtesy of USGS/NASA.

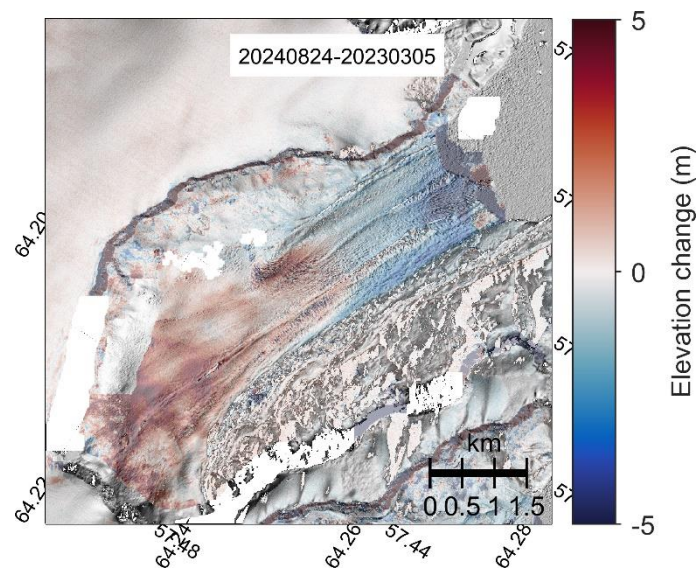


Figure S3. Rate of Gourdon Glacier ice surface elevation change between 2023-03-05 and 2024-08-24, where positive is thickening. Calculated using co-registered REMA strips, overlain on a hillshade of the 2024-08-24 strip. REMA data courtesy of the Polar Geospatial Center.

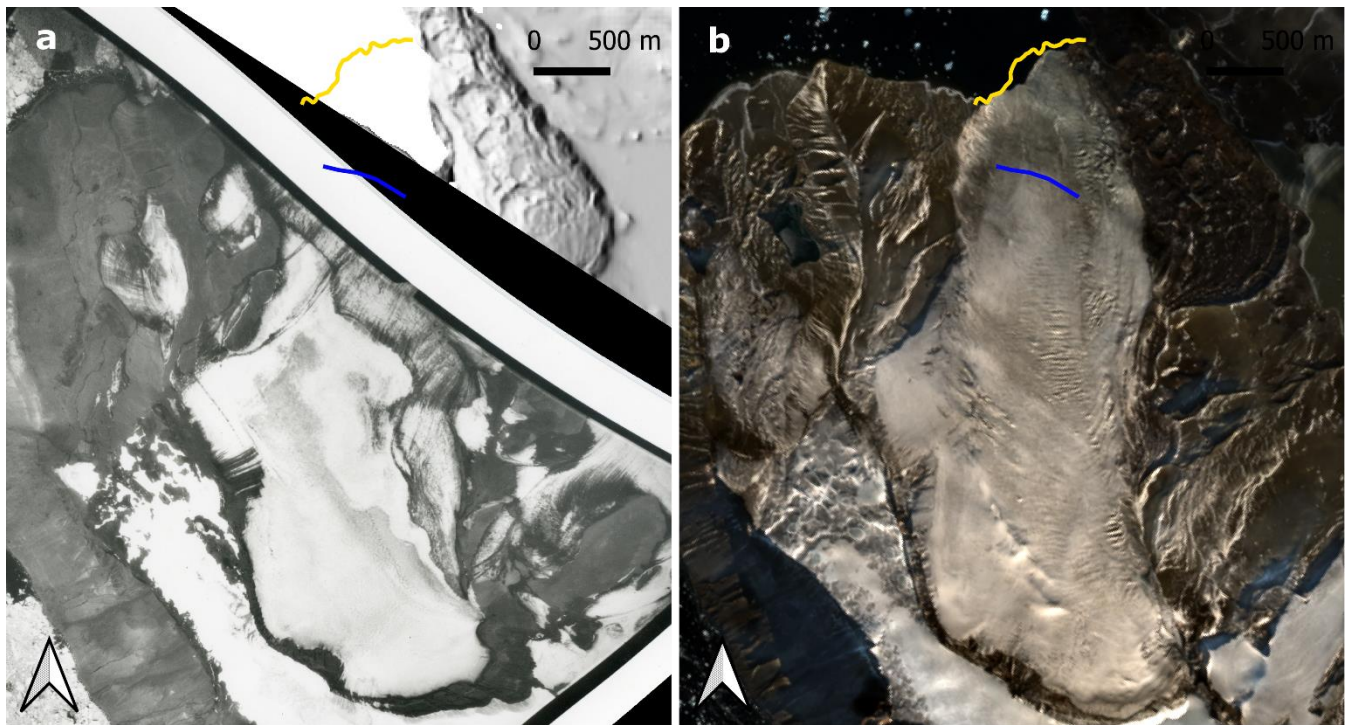


Figure S4. (a) Aerial image acquired by the British Antarctic survey in 1979. (b) Sentinel-2 true colour composite acquired on 2024-03-25, for comparison. Blue and yellow lines show the terminus positions on 2004-01-31 and 2017-03-30, respectively. Sentinel-2 data courtesy of ESA Copernicus.

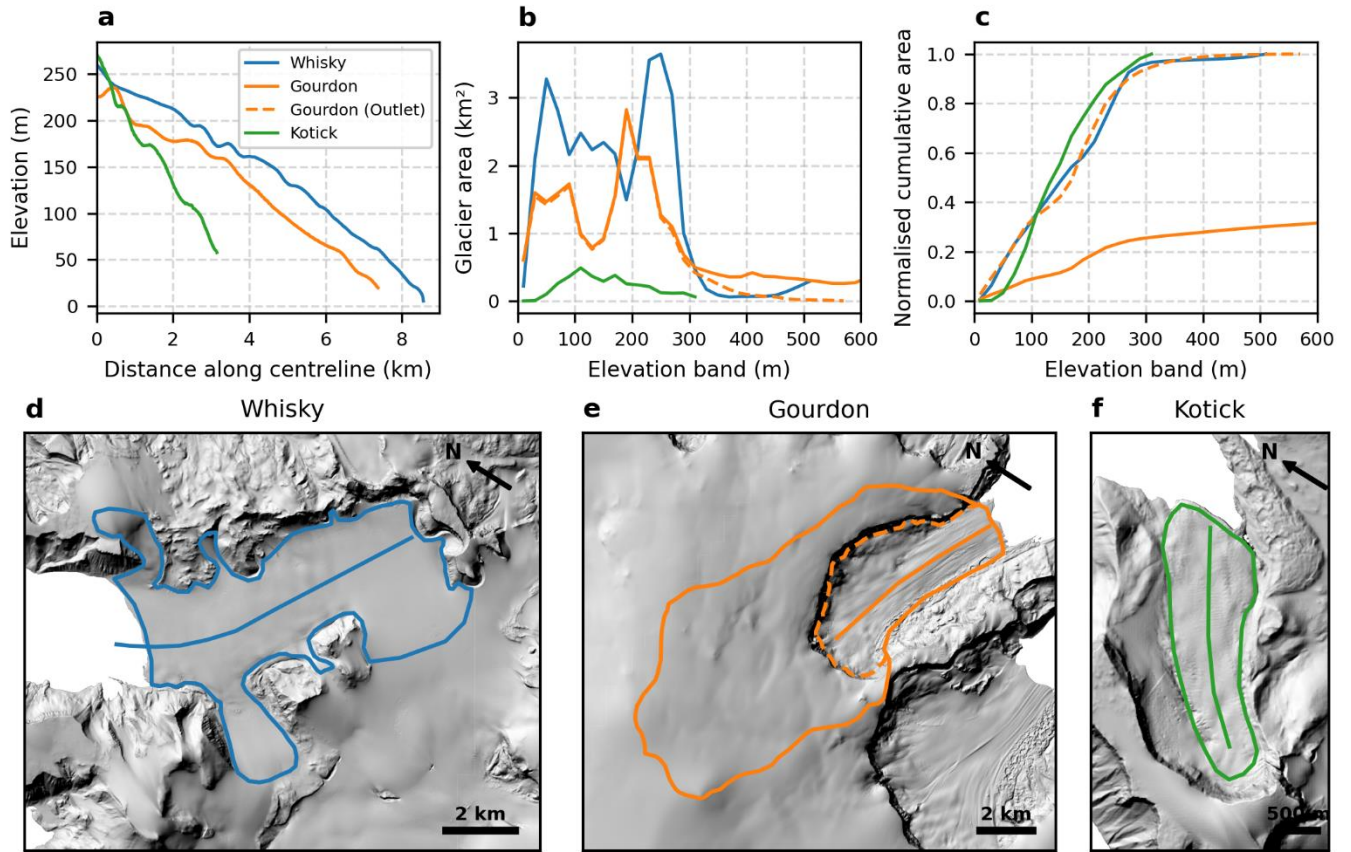


Figure S5. Elevation and hypsometry of Whisky Glacier, Gourdon Glacier and Kotick Glacier. (a) Elevation profiles along the centerlines of each glacier shown in panels (d), (e) and (f). (b) The area of each glacier in 20 m elevation bands within the glacier outlines shown in panels (d), (e) and (f). (c) The cumulative area of each glacier by elevation band, normalised by the area of the basin. Panels (d), (e) and (f) show the approximate outline and centerline of each glacier overlain on a hillshade of the REMA DEM 10 x 10 m mosaic (Howat et al., 2022a). The glacier basin outlines were based on those described in Cook et al. (2014). For Gourdon Glacier, an outline (dashed orange) excluding the upper plateau was included for comparison, in case of loss of ice mass transfer between the plateau and outlet. REMA data courtesy of the Polar Geospatial Center.

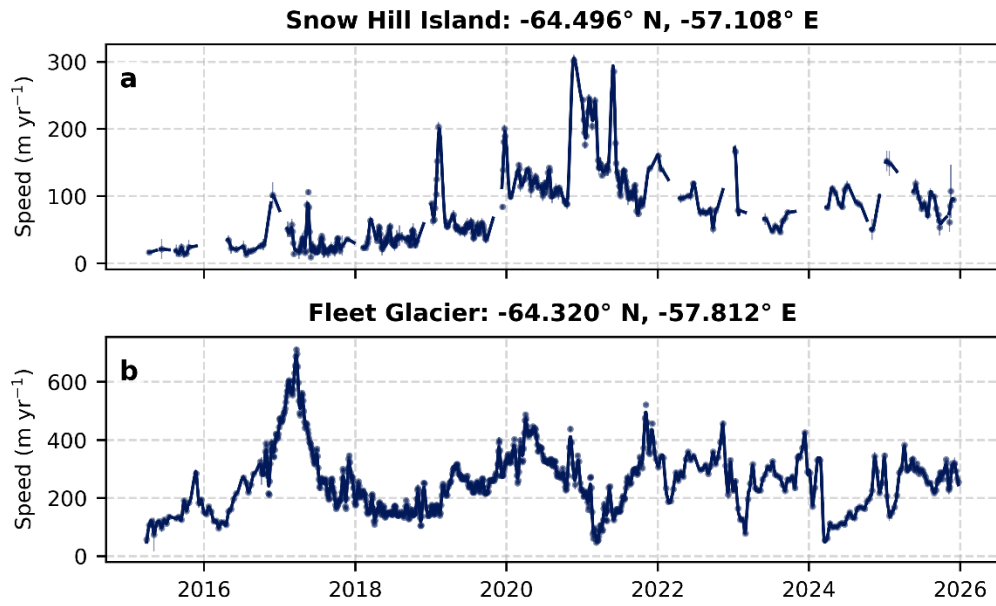


Figure S6. Candidate surges of (a) an unnamed glacier on Snow Hill Island from 2019 to 2023 and (b) Fleet Glacier on James Ross Island from late-2016 to late 2017.

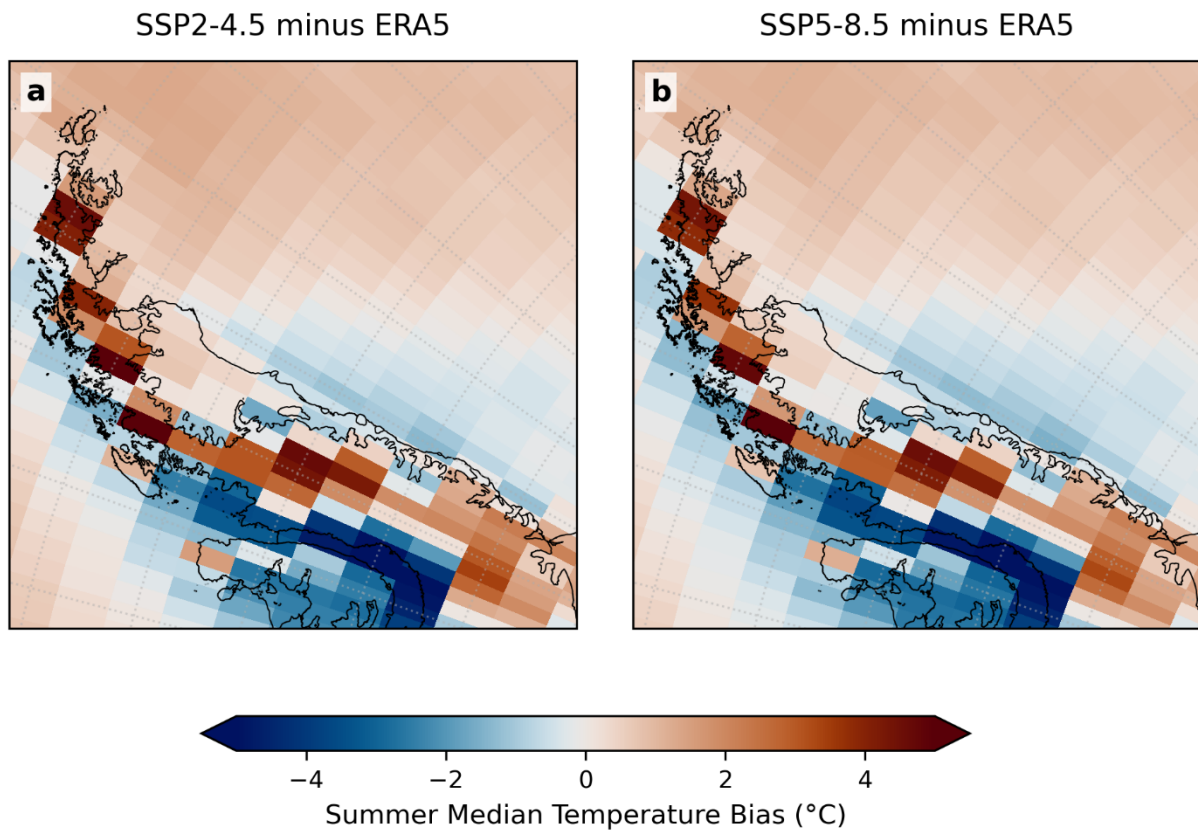


Figure S7. The temperature difference between the CMIP6 ensemble mean and ERA-5 during 2016-2025.

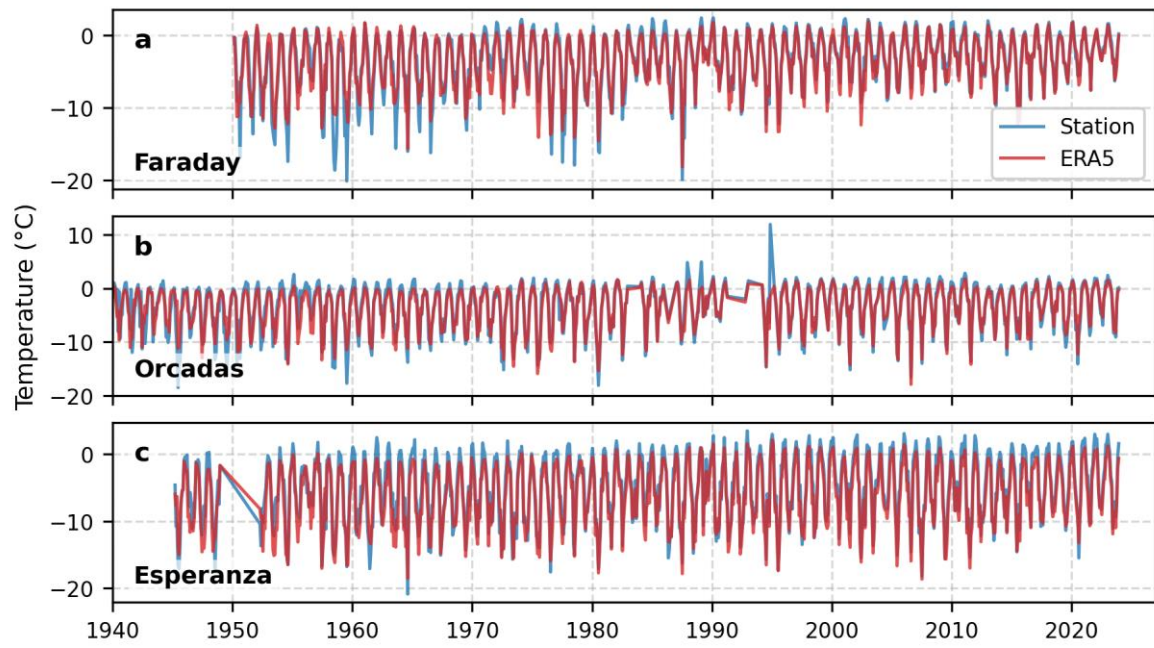


Figure S8. Comparison of monthly ERA-5 (red) and station data (blue) at (a) Faraday/Vernadsky, (b) Orcadas and (c) Esperanza stations

| Probability      | 0.2          |                  | 0.4   |         | 0.6           |                  | 0.8           |                  |
|------------------|--------------|------------------|-------|---------|---------------|------------------|---------------|------------------|
|                  | Trend        | p-value          | Trend | p-value | Trend         | p-value          | Trend         | p-value          |
| <b>ERA5</b>      | -34.4        | 0.425            | 31.3  | 0.104   | <b>91.7</b>   | <b>&lt;0.001</b> | <b>30.8</b>   | <b>&lt;0.001</b> |
| <b>SSP 2.4.5</b> | 136.2        | 0.179            | 16.2  | 0.420   | 27.4          | 0.288            | -73.9         | 0.027            |
| <b>SSP 5.8.5</b> | <b>514.6</b> | <b>&lt;0.001</b> | 16.5  | 0.529   | <b>-217.9</b> | <b>&lt;0.001</b> | <b>-135.5</b> | <b>&lt;0.001</b> |

Table S2. Trends ( $\text{km}^2 \text{ year}^{-1}$ ) in the area of grounded ice on the Antarctic Peninsula exposed to the surging climatic envelope (SCE) for each SCE probability level and climate dataset. The 0.99 level is not included because area values were too small to compute meaningful trends.

| Station   | Overlap            | Station (°C) | ERA5 (°C)    | Bias (°C)    | Trend Station (°C/decade) | Trend ERA5 (°C/decade) |
|-----------|--------------------|--------------|--------------|--------------|---------------------------|------------------------|
| Faraday   | 1950-02 to 2023-12 | -3.50 ± 4.06 | -3.69 ± 3.58 | -0.19 ± 1.42 | +0.445 ± 0.062            | +0.342 ± 0.055         |
| Orcadas   | 1940-01 to 2023-12 | -3.41 ± 4.34 | -3.60 ± 3.72 | -0.18 ± 1.60 | +0.195 ± 0.057            | +0.197 ± 0.049         |
| Esperanza | 1945-03 to 2023-12 | -5.09 ± 4.98 | -6.10 ± 4.65 | -1.02 ± 1.33 | +0.348 ± 0.074            | +0.322 ± 0.069         |

Table S3. Comparison between monthly ERA-5 and monthly station data. The station locations are as follows. Faraday: -65.25N, -64.27E. Orcadas: -60.75N, -44.72E. Esperanza: -63.40N, -56.98E