Surface elevation changes of glaciers along the coast of Prudhoe Land, northwestern Greenland, from 1985 to 2018

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In recent decades, the Greenland Ice Sheet has been a major contributor to global sea-level rise as a consequence of accelerating mass loss. Numerous studies have described spatiotemporal heterogeneity in glacier terminus retreat, flow speed variations, surface elevation change in a scale covering the entire ice sheet. However, details of the changes and heterogeneity of individual glaciers remain uncertain. Therefore, detailed investigations in a finer spatial scale are required. Here we show the surface elevation changes of 16 outlet glaciers along the coast of Prudhoe Land, northwestern Greenland, derived from multi-source DEMs (digital elevation models) (1985 (t0) aerial photograph DEM, ASTER DEMs in 2001–2003 (t1) and 2016–2018 (t2)), for the last 30 years.

We observed a mean surface lowering rate of −0.55±0.22 m a^{-1} over the past three decades (t0–t2) for the whole studied glaciers. The most rapid surface lowering (−3.08 m a^{-1}) was observed near the glacier termini (elevation band 0–50 m), and the slowest surface lowering rate (−0.14 m a^{-1}) is found on the elevation band 800–850 m. The rates varied among the periods. The mean rate showed a slightly positive value of 0.14±0.16 m a^{-1} during t0 –t1, and no distinct altitudinal variations was observed in this period. Strongly negative elevation change rates (−1.31±0.19 m a^{-1}) were detected during the second subperiod (t1– t2). The most rapid thinning (−5.47 m a^{-1}) occurred near the frontal areas (elevation band 0–50 m), and slower but significant thinning at a rate −0.57 m a^{-1} was observed inland areas (elevation band 800–850 m). For individual glaciers, most glaciers have exhibited no significant change or slight surface thickening during the period t0 –t1. Obvious thinning happened only in the frontal areas of Tracy, Farquhar, Sharp and Sun Glaciers. During the period t1– t2, all the studied glaciers experienced thinning in different magnitudes. Tracy (−3.91±0.12 m a^{-1}) and Farquhar (−2.91±0.15 m a^{-1}) Glaciers experienced most significant thinning, while Heilprin Glacier, adjacent to Tracy, showed a moderate thinning rate (−0.51±0.12 m a^{-1}). Interestingly, there is no obvious change at Verhoeff Glacier both in t0 –t1 and t1– t2. Outlet glaciers terminating in Inglefield Bredning showed a mean thinning rate of −1.07 ±0.18 m a^{-1}, which was 67% greater than those of glaciers terminating in Baffin Bay (−0.64 ±0.24 m a^{-1}) during t1–t2.

The elevation changes are generally correlated with atmospheric and oceanic warming in the region. Nevertheless, considerably large heterogeneity was observed among individual glaciers, which may be attributed to the control of the fjord bathymetry and glacier bed topography on the submarine melting and ice dynamics.

Keywords: Greenland, Glaicer, Elevation change

