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Holocene glacial oscillations in the Tyroler Valley, NE Greenland

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Understanding the long-term oscillations of the Greenland Ice Sheet (GrIS) margins during the last millennia is necessary to frame the recent observed changes within the natural variability of glacial response in Greenland. Geomorphic evidence left by GrIS outlets can be used to reconstruct the evolution of glaciers during past warm and cold phases. Here, we analyze the Holocene ice-marginal fluctuations along the Tyroler Valley (74ºN, 22ºE), within the Northeast Greenland National Park. Currently, this U-shaped valley is ice-free, and the front of the Pasterze glacier (GrIS outlet) is located 10 km inland from the head of the fjord, with two tributary piedmont glaciers (Kloft and Copeland) also extending over the valley floor. Glacial landforms left by these glaciers were accurately mapped, and the area was extensively surveyed for identifying the best glacial surfaces for Cosmic-Ray Exposure (CRE) dating. The chronology presented in this study relies on a new dataset of 15 ^{10}Be CRE ages together with one Optically Stimulated Luminescence (OSL) age from fine-grained (lacustrine) sediments. CRE ages confirm that the main valley recorded a rapid deglaciation between 10 and 8.5 ka. However, lateral and frontal moraines of the two tributary glaciers indicate that the Holocene deglaciation was not continuous, and the long-term shrinking trend was interrupted by several phases of minor glacial re-advances. The larger piedmont glacier (Copeland) occupied the valley floor during the major advances, damming the river and allowing the formation of a proglacial glacial lake upvalleys. A CRE age from the polished bedrock in the opposite slope of the Copeland glacier front indicate that the major Holocene glacial advance occurred at the onset of Neoglacial cooling (~6 ka). The multiple moraine ridges of the piedmont glaciers reported ages spanning the Little Ice Age (LIA). CRE results confirm two major glacial advances at ~0.55 ka and ~0.25 ka. As a result of these LIA advances, the proglacial lake formed again as confirmed by the OSL date of lacustrine sediments that yielded an age of 0.53 ± 0.06 ka.

In summary, we provide new evidence of the relative stability of GrIS outlets in the area, which advanced during the Neoglacial and the LIA. Since then, the current glacier fronts have been rather stable and remain close to the LIA moraines.