



## **Fluctuations of the Greenland Ice Sheet since the last ice age: comparisons of the response of marine and land-terminating ice margins to Holocene climate changes**

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Fluctuations of the margins of the Greenland Ice Sheet (GrIS) in response to Holocene climate change may be used as a proxy for how they may respond to future climate change. Here, we present records of Holocene fluctuations of the margins of the GrIS in southeastern and southwestern Greenland based on geomorphic mapping and  $^{10}\text{Be}$  dating of boulders on moraines and boulders on bedrock. We show that in southeastern Greenland the marine-terminating outlet glaciers retreated from the outer coast between 10.4 and 9.4 ka and responded rapidly to early Holocene warming, retreating up-fjord at a rate of  $\sim 70\text{-}100\text{ m yr}^{-1}$ . These rates are comparable, or higher than, modern retreat rates of 30-100 m yr<sup>-1</sup>. In contrast, the terrestrial margin of the GrIS in the Kangerlussuaq region of southwestern Greenland retreated only  $\sim 25\text{ m yr}^{-1}$  throughout the early and middle Holocene. These data indicate that forcings such as warm ocean waters, fjord geometry, fjord bathymetry and ice dynamics are potential mechanisms that caused differences in retreat rates between marine and terrestrial-terminating margins of the ice sheet. Additionally, they show that the margins of the GrIS responded sensitively to Holocene climate change.