



How did the Greenland ice sheet respond to abrupt warming at the end of the last Ice Age?

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During the Younger Dryas-Preboreal transition (YD/Pb), 11,700 years ago, temperatures at the top of the ice sheet rose c. 8°C over a period of 60 years, marking the end of the last Ice Age. After slight cooling phase, The Preboreal Oscillation (PBO), 11,500-11,400 years ago, renewed abrupt warming raised temperatures a further 4°C over a few years. The ice margin response to this abrupt warming is here investigated from available onshore and offshore records. During YD most of Greenland was still ice covered, but some areas in the south and east had been cleared of ice already before YD, and contain a record of late glacial change. However, the evidence from these sites leaves a rather confusing picture: In Scoresby Sund, East Greenland, glaciers advanced in YD, but retreat probably did not start until after PBO. Contrary to this, the Kangerlussuaq area to the south apparently saw glacier-melting through YD, but the melting was reduced already before the end of YD. Further to the south (Skjoldungen) a record from the shelf shows no oceanographic change over YD/Pb and PBO. Finally, a lake in the extreme south has the only Greenland record of rapid warming at YD/Pb. From coastal areas in the rest of Greenland 14C dates on marine and organic lake sediments generally don't go back further than c. 11,000 years, indicating that deglaciation did not commence until some hundred years after the YD/Pb warming. There is therefore so far no positive evidence from Greenland that the ice sheet margin responded to the large and fast YD/Pb warming, while it may be the smaller post-PBO warming that triggered large scale ice margin retreat in all parts of the country. This suggests that in spite of the large temperature jump during YD/Pb warming, much of the ice surface remained below freezing point, probably because the warming was mainly in the winter. Only in the extreme south were summer temperatures high enough to melt the ice. In other parts the warming after PBO may have started ice margin recession which proceeded over the next 3-4 millenia at a rate determined by local climate and topography. The rate and amplitude of YD/Pb warming is comparable to the most pessimistic IPCC prediction for Greenland in our century, but took place in a different temperature regime. Still, one lesson that can be learned from history seems to be that different parts of the ice sheet may react very differently to rapid change.