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Greenland ice sheet variability during the Holocene

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Understanding the present state of the Greenland ice sheet is important for reliable estimates of the future mass loss and contribution to sea level changes, yet its stability in our warming climate is not well known and the understanding of its variations during previous warm periods is limited. Paleoclimatic records from ice cores provide constraints on the climate and ice thickness (Vinther et al 2009), but is limited to a few ice cores from the central areas and they reach only back to approximately 125 kyrs ago. Here we present results from a study of the evolution of the Greenland ice sheet through the Holocene (Nielsen et al. 2018). We use a suite of different ice-core-derived climate histories for the Holocene to investigate the evolution of the Greenland ice sheet through the deglaciation, the Holocene thermal maximum and up to present day. The Holocene thermal maximum was a period 8–5 kyr ago when annual mean surface temperatures in Greenland were 2–3°C warmer than present-day values. We use climate histories based on new interpretations of the isotope records (Gkinis et al. 2014), which results in a more pronounced thermal maximum compared to previously used climate records. Furthermore, our records inform of snow accumulation rates in the early Holocene. Our studies show that the Greenland ice sheet retreated to a minimum volume of up to $\sim$1.2 m sea-level equivalent smaller than present in the early or mid-Holocene, and that the ice sheet has continued to recover from this minimum up to present day. Climate records without a pronounced thermal maximum in the early Holocene result in smaller ice losses continuing throughout the last 10 kyr. In all our runs, the ice sheet is approaching a steady state at the end of the 20th century. Our studies show that the Greenland ice sheet evolves in response to climate variations on shorter and longer timescales and that the pattern of the response is complex. Variations in accumulation rate, temperature and sea level influence the ice sheet differently, resulting for example in different timescales and patterns of buildup and retreat of the ice sheet.