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West Antarctic Ice Sheet retreat from Pine Island Bay during the Holocene: New insights into forcing mechanisms

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The Amundsen Sea sector of the largely marine-based and therefore conditionally unstable West Antarctic Ice Sheet (WAIS) contains enough ice to raise global sea level by ca. 1.5 metres. At present, ice streams draining this sector into the Southern Ocean, especially glaciers flowing into Pine Island Bay in the eastern Amundsen Sea embayment, are undergoing considerable mass loss characterised by major thinning, flow acceleration and rapid grounding-line retreat. Sub-ice shelf melting by relatively warm Circumpolar Deep Water (CDW) upwelling onto the continental shelf is held responsible for these dynamical changes but atmospheric warming in West Antarctica may also have contributed to them. In contrast to the modern situation, the long-term history of the Amundsen Sea sector and the mechanisms forcing its deglaciation during the Holocene are only poorly constrained.

We will present new palaeoenvironmenal data obtained from marine sediment cores collected in Pine Island Bay. The cores targeted shallow sites on the inner continental shelf and successfully recovered sedimentary sequences bearing calcareous microfossils. Radiocarbon ages on these microfossils demonstrate that the grounding line of the WAIS retreated to within ∼100 km of its modern position before ca. 10 kyr BP (thousand years before present), which is consistent with an early WAIS retreat from near-coastal locations in the western Amundsen Sea embayment. Currently, there is no evidence that the grounding line had retreated landward of its modern position during the Holocene. Therefore, the chronological constraints may imply that during the last 10 kyr any episodes of fast grounding-line retreat similar to those observed today were short-lived and rare.

Preliminary geochemical data from benthic and planktonic foraminifera tests in the cores from Pine Island Bay reveals that intense CDW upwelling coincided with and may have forced the deglaciation of the inner continental shelf. Furthermore, we observe a significant change of the benthic foraminifera fauna during the early Holocene, which we interpret to indicate the collapse of an ice shelf covering the inner part of the bay. We speculate that this ice shelf had buttressed ice draining into the eastern Amundsen Sea embayment, and that its removal triggered rapid ice-sheet thinning in the hinterland.