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Dynamic Antarctic ice-sheet response to deglacial meltwater pulses

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Reconstruction of the last global sea level rise faces uncertainties because only a few robust data evidences are available for Antarctic ice sheets. Deglacial dynamics have mostly been inferred from shallow-water cores on the shelf, where decisive changes are either erased by grounding ice or occur in condensed, lithologically complex successions with partially reversed and generally unreliable 14C ages. Previous modeling studies reconstruct a late ice-sheet retreat starting around 12 ka BP and ending around 7 ka BP with a large impact of an unstable West Antarctic Ice Sheet (WAIS) and a small impact of a stable East Antarctic Ice Sheet (EAIS). However, new findings from two deepwater cores from the Scotia Sea challenge these reconstructions and call for a principal revision of the Antarctic deglacial history.

The well-dated sites (Weber et al., 2012, Quaternary Science Reviews) provide the first integrative and representative record of Antarctic Ice Sheet instability. They are located in the central transport route of virtually all Antarctic icebergs, the so-called Iceberg Alley, and demonstrate a highly dynamic Antarctic Ice Sheet during the last deglaciation with eight distinct phases of enhanced iceberg routing, dubbed Antarctic Ice Sheet Events (AIE), in contrast to existing models of a late and monotonous ice-sheet retreat which implied only little contribution to the last, natural, sea-level rise 19,000 to 9,000 years ago. We found the first direct evidence for an Antarctic contribution to Meltwater Pulse 1A in the flux rates of ice-rafted debris.

Using an ensemble of transient deglacial model simulations we could show that increased export of warmer Circumpolar Deep Water towards Antarctica contributed to Antarctic Ice Sheet melt by ocean thermal forcing (Weber et al., Science, in review). These new findings hold the potential to substantially revise and improve our understanding of the transient response of the ice sheet to external and internal forcings, and the contributions to the postglacial isostatic adjustment as well as to the last, natural, sea-level rise. Our results will also help improving projections of future sea-level rise by implementing enhanced ocean thermal forcing.