Evidence of a dynamic ice sheet system in Filchner Trough until the early Holocene

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Abstract

The past ice sheet conditions in the southern Weddell Sea Embayment (WSE) are only poorly known. Studies from this area have led to two contradicting scenarios of maximum ice extent during the Last Glacial Maximum (LGM). The first scenario is mainly based on terrestrial data indicating only very limited ice sheet thickening in the hinterland and suggests a grounding-line position on the inner shelf. The alternative scenario is based on marine geological and geophysical data and concludes that the LGM grounding line was located on the outer shelf, about 650 km further offshore than in the other scenario. Three hypotheses have been brought forward to explain these two apparently contradictory scenarios. A) An ice plain was present on the shelf that enabled a large ice extent while maintaining little ice thickness in the hinterland. B) The maximum grounded ice advance lasted for a short period only and was probably caused by a short-termed touch down of an ice shelf on the outer shelf, which did not cause sufficient ice sheet thickening in the hinterland to be traced today. C) Due to an ice flow switch, Filchner Trough was fed by an area further to the west where ice had thickened at the LGM. Besides the poorly constrained LGM ice extent, studies suggest a complex development of its retreat speed and drainage pattern in succession of the LGM that needs to be further constraint. For example, radar data from ice rises in the southwestern hinterland of the WSE suggest that ice flow switches occurred as late as the Mid-Holocene and cosmogenic exposure ages indicate an early Holocene ice sheet thickness in the Ellsworth Mountains comparable to that of the LGM.

We investigated multibeam bathymetry data (*ATLAS Hydrosweep DS3*), acoustic sub-bottom profiles (*ATLAS Parasound P-70*) and marine sediment cores collected from Filchner Trough during RV "Polarstern" expedition PS96 in Dec 2015-Feb 2016. Our key finding is a previously unknown stacked grounding zone wedge (GZW) located on the outer shelf. This GZW shows that the Filchner palaeo-ice stream stabilized at this position at least two times. Two sediment cores were recovered seaward of the GZW and on top of the lower part of the GZW, respectively. Radiocarbon dates from these cores indicate that (i) the GZW was formed in the Early Holocene and (ii) grounded ice did not extend seaward of the GZW at the LGM. Hence, our data provide evidence that the grounding line in Filchner Trough experienced dynamic changes in the Holocene and that no linear ice sheet retreat occurred within this trough after the LGM.

Keywords: Weddell Sea, Grounding Zone Wedge, Dynamic Ice Sheet, Early Holocene