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Centennial-millennial scale variations in Western Antarctic Ice Sheet discharge and their relationship to climate and ocean changes during the late Holocene

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The Western Antarctic Ice Sheet (WAIS) may be highly sensitive to future warming and to ocean driven changes in subsurface melting. Understanding this sensitivity is critical as WAIS dynamics are a major source of uncertainty in sea level rise and regional climate projections. Although there is increasing evidence that WAIS discharge has varied on centennial to multi-millennial timescales since the last glacial period much less is known about its most recent (late Holocene) behavior. This period is particularly important as a baseline for delineating natural and anthropogenic influences and understanding potential coupling between climate, ocean circulation, and WAIS discharge.

Here we present high-resolution records of WAIS discharge together with co-registered signals of surface and deep ocean physical property changes in a multicore taken from the southern flank of the North Scotia Sea Ridge (53˚ 31.813 S; 44˚ 42.143 W at 2750m water depth) spanning the past 4000 years. The site is situated just south/east of the polar front beyond the reach of seasonal sea ice and its potentially confounding influence on the ice-rafted debris (IRD) signal but still influenced by icebergs mostly originating from the WAIS. Our record of IRD from core GS08-151-02MC provides a centennially resolved record of iceberg supply from which we infer Antarctic ice-sheet dynamics and variability, while we use the oxygen and carbon isotopic composition of benthic (*U. peregrina)* and planktonic (*N. pachyderma* (s)) foraminifera to give (regional) information on past polar deep water and surface water temperatures, circulation and nutrients. Our results show higher amount of IRD between 4200-1800 cal yr B.P. This is in agreement with paleoclimate records reconstructing the onset of the neoglacial, sea ice expansion at about 5000 cal yr B.P. in the Atlantic sector of the Southern Ocean, and glaciers advancing in South America. The strongest IRD peak of the past millennium, which is otherwise a period of generally low IRD, coincides with Little Ice Age at 600 cal yr B.P. The local surface water hydrography appears relatively stable over the past 4000 years with the planktonic δ^{18}O signal indicating centennial-millennial scale changes of typically $\leq$1˚C (Δ0.22‰) and notably smaller in amplitude than the regional warming observed over the past century. The lack of correlation between surface water physical properties and IRD in the downcore records, suggests that IRD is not reflecting iceberg survival but rather changes in the supply (WAIS dynamics) or routing. Consistent with this interpretation, IRD covaries with climate on the Antarctic Peninsula (from JRI ice core) over the past 4 kyr with cooler conditions and lower amounts of IRD over much of the past two millennia than occurred earlier in the neoglaciation. Both records indicate a recovery with warming and increased IRD prior to industrialization. This relationship is consistent with the hypothesis that climate and specifically ocean temperatures were important for modulating WAIS discharge rates over the past few millennia.