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Supplementary Materials for

Arctic sea ice export as a driver of deglacial climate

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Ocean Model

All numerical model simulations were performed using the Massachusetts Institute of Technology general circulation model (MITgcm); a three dimensional, hydrostatic, primitive equation model (Marshall et al., 1997) The model was configured to simulate glacial conditions (see Hill and Condron, 2014) and the majority of experiments were performed with a mean horizontal grid spacing of 280-km with 15 vertical levels, ranging in thickness from 50m near the surface to approximately 690m at the maximum model depth. An additional simulation was performed under modern-day boundary conditions to establish the difference between modern and glacial Arctic ocean circulation, and captures the physical (T & S) properties of the modern day Arctic ocean very well (Figure S1; Steele et al., 2001). Finally, simulations studying the impact of meltwater outburst floods on Arctic sea ice export were performed at an eddy-permitting (18-km) spatial resolution using a limited-area Arctic/North Atlantic grid configuration, based on Condron et al., (2009) (Figure S2).

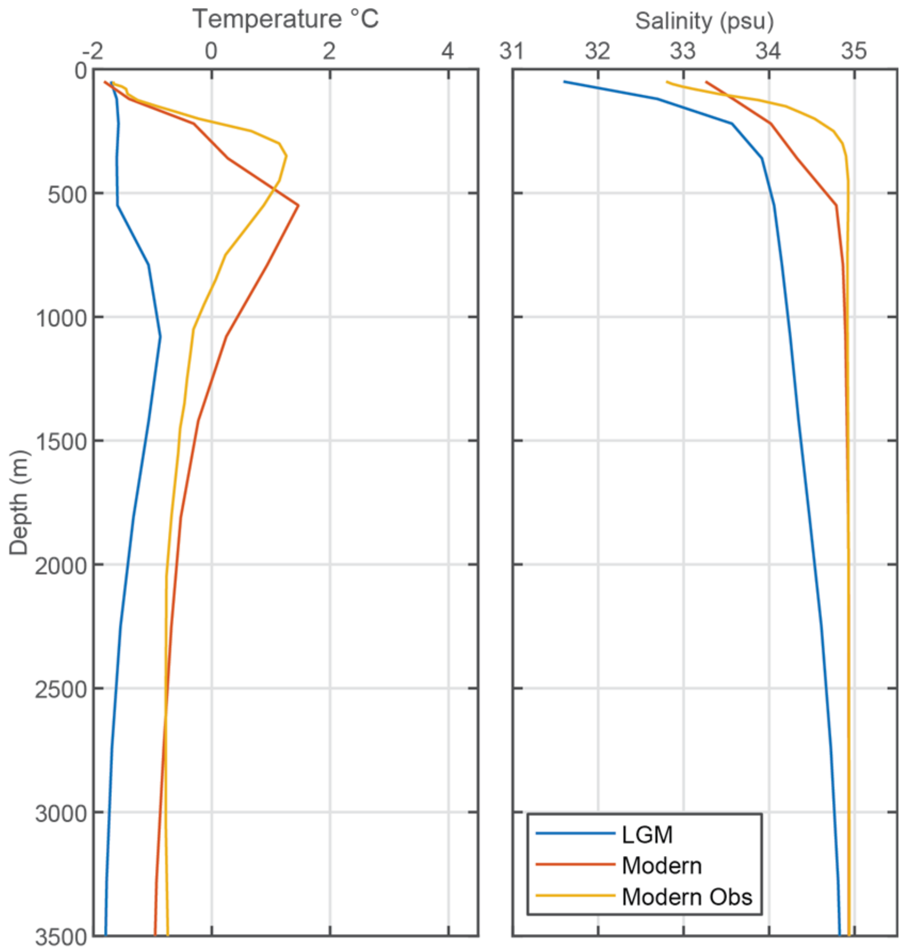

Fig. S1: Vertical profiles of mean ocean temperature (A) and salinity (B) in the eastern Arctic basin, as marked by the yellow arrow in Figure 1 of the main manuscript. In the modern Arctic, the simulated warm Atlantic Layer is observed between 500m and 1000m depth with temperatures of up to ~1.5°C (red line), which is in good agreement with observed data from this region (orange line) created using annual mean oceanographic data from the Polar Science Center Hydrographic Climatology (PHC) climatology (Steele et al., 2001). During the LGM (blue line) this layer was ~2.5°C colder and 500m deeper.

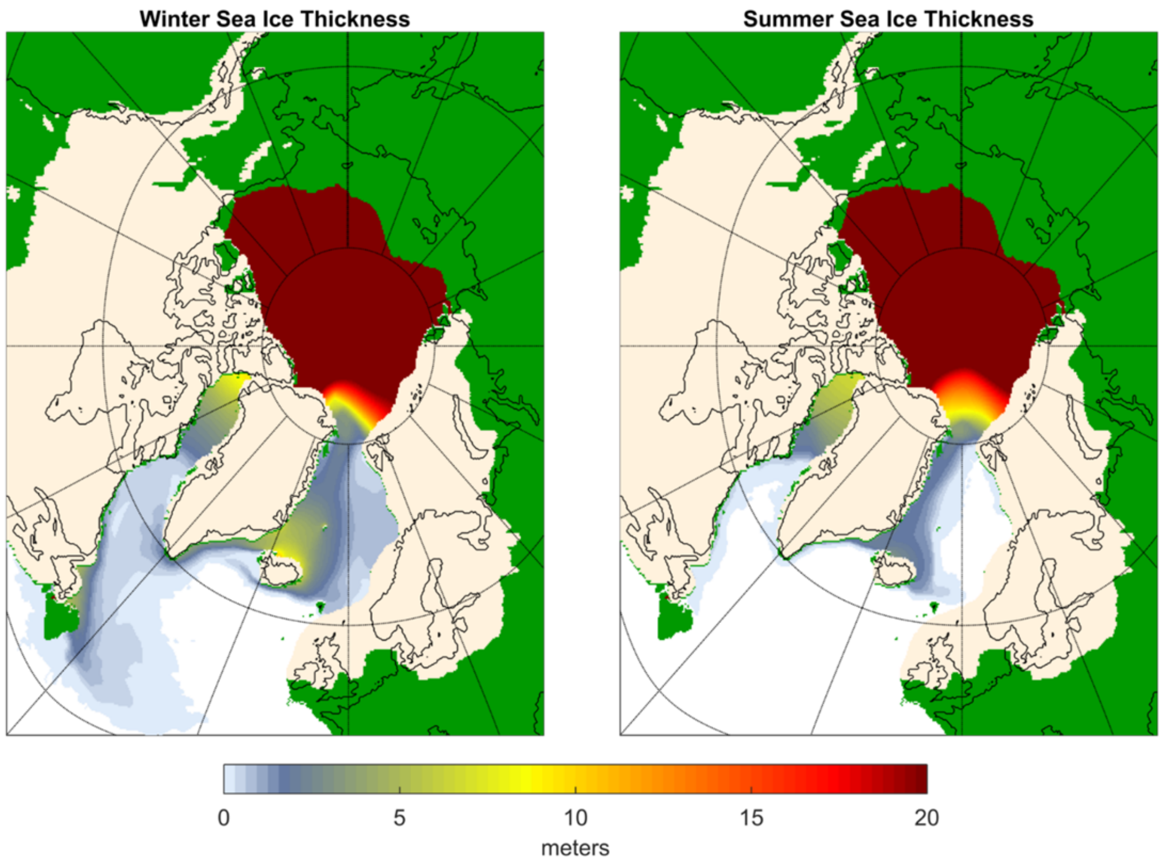

Fig. S2: Sea ice thickness and extent in our regional, high-resolution, eddy-permitting, model configuration. The two panels show mean sea ice thickness during the winter (**left**) and summer (**right**). During the summer, the increased penetration of warm Atlantic Water creates mostly ice-free conditions in the eastern Nordic Seas and along the coast of Svalbard where the West Spitsbergen Current enters the Arctic Ocean through Fram Strait. Note that white areas correspond to regions of the ocean that are ice free; off-white shading highlights the positions of the major Northern Hemisphere ice sheets; and green shading corresponds to ice-free regions of land.

Table S1. A summary of the main model experiments performed using MITgcm to test climate sensitive to the mobilization of Arctic sea ice.

Experiments	Model Configuration	Model Resolution	Details
ATM5yr_a	Global	2.8° (280-km)	TPD enhanced for 5yr (5 m/s wind) followed by 50 yr relaxation. Cycle repeated 5-times
ATM5_b	Global	2.8° (280-km)	TPD enhanced for 5yrs (7.5 m/s wind) followed by 50 yr relaxation. Repeated 5-times
ATM50_a	Global	2.8° (280-km)	TPD enhanced for 50yrs (5 m/s wind) followed by 100 yr relaxation. Cycle repeated 2-times
ATM50_b	Global	2.8° (280-km)	TPD enhanced for 50yrs (7.5 m/s wind) followed by 100 yr relaxation. Repeated 2-times
BS_open	Global	2.8° (280-km)	Bering Strait opened to 50m depth
Mack_flood	regional	1/6° (18-km)	Glacial outburst flood (5 Sv) released from Mackenzie R. (Canadian Arctic) for 1 yr.

Notes: "TPD" refers to the Transpolar drift of Arctic sea ice. In the model, ice movement was enhanced by increasing the near-surface wind speed over the region 80°N-90°N by 20°W-20°E. "BS" and "Mack" refer to the Bering Strait and Mackenzie River, respectively.

References

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