

Sensitivity of last glacial maximum climate to sea ice conditions in the Nordic Seas

Øyvind Byrkjedal^{1, 2}, Nils Gunnar Kvamstø^{1, 2}, Marius Meland^{1, 3} and Eystein Jansen^{1, 3}

(1) Bjerknes Centre for Climate Research, University of Bergen, Allegaten 55, 5007 Bergen, Norway

(2) Geophysical Institute, University of Bergen, Allegaten 70, 5007 Bergen, Norway

(3) Department of Earth Science, University of Bergen, Allegaten 41, 5007 Bergen, Norway

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Abstract Published reconstructions of last glacial maximum (LGM) sea surface temperatures and sea ice extent differ significantly. We here test the sensitivity of simulated North Atlantic climates to two different reconstructions by using these reconstructions as boundary conditions for model experiments. An atmospheric general circulation model has been used to perform two simulations of the (LGM) and a modern-day control simulation. Standard (CLIMAP) reconstructions of sea ice and sea surface temperatures have been used for the first simulation, and a set of new reconstructions in the Nordic Seas/Northern Atlantic have been used for the second experiment. The new reconstruction is based on 158 core samples, and represents ice-free conditions during summer in the Nordic Seas, with accordingly warmer sea surface temperatures and less extensive sea ice during winter as well. The simulated glacial climate is globally 5.7 K colder than modern day, with the largest changes at mid and high latitudes. Due to more intense Hadley circulation, the precipitation at lower latitudes has increased in the simulations of the LGM. Relative to the simulation with the standard CLIMAP reconstructions, reduction of the sea ice in the North Atlantic gives positive local responses in temperature, precipitation and reduction of the sea level pressure. Only very weak signatures of the wintertime Icelandic Low occur when the standard CLIMAP sea surface temperature reconstruction is used as the lower boundary condition in LGM. With reduced sea ice conditions in the Nordic Seas, the Icelandic Low becomes more intense and closer to its present structure. This indicates that thermal forcing is an important factor in determining the strength and position of the Icelandic Low. The Arctic Oscillation is the most dominant large scale variability feature on the Northern Hemisphere in modern day winter climate. In the simulation of the LGM with extensive sea ice this pattern is significantly changed and represents no systematic large scale variability over the North Atlantic. Reduction of the North Atlantic sea ice extent leads to stronger variability in monthly mean sea level pressure in winter. The synoptic variability appears at a lower level in the simulation when standard reconstructions of the sea surface in the LGM are used. A closer inspection of storm tracks in this model experiment shows that the synoptic lows follow a narrow band along the ice edge during winter. The trajectories of synoptic lows are not constrained to the sea ice edge to the same degree when the sea ice extent is reduced. Seasonally open waters in the Nordic Seas in the new reconstruction apparently act as a moisture source, consistent with the current understanding of the rapid growth of the Fennoscandian and Barents Ice Sheets, during the LGM. The signal from the intensified thermal forcing in the North Atlantic in Boreal winter is carried zonally by upper tropospheric waves, and thus generates non-local responses to the changed sea ice cover.

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Øyvind Byrkjedal
Email: Oyvind.Byrkjedal@bjerknes.uib.no
Phone: +47-55582594
Fax: +47-55589883