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# Warm Greenland during the last interglacial: the role of sea ice

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The last interglacial, the Eemian, is characterized by warmer than present conditions in the high latitudes and is therefore often considered as a possible analogue for the climate in the near future. Simulations of Eemian surface air temperatures (SAT) in the Northern Hemisphere (NH), however, show large variations between different climate models and it has been hypothesized that this model spread relates to diverse representations of the Eemian sea ice cover. Here we use version 3 and 4 of the Community Climate System Model (CCSM3 and CCSM4), to highlight the crucial role of sea ice and sea surface temperatures during the Eemian, in particular for SAT in the North Atlantic sector and in Greenland. A substantial reduction in NH sea ice results in an amplified atmospheric warming and, thus, a better agreement with Eemian proxy records. Sensitivity experiments with idealized lower boundary conditions reveal that warming over Greenland is mostly due to a sea ice retreat in the Nordic Seas. In contrast, sea ice changes in the Labrador Sea have a limited local impact. Changes in sea ice in either region are transferred to the overlying atmosphere through anomalous surface energy fluxes. The large-scale warming simulated for the sea ice retreat in the Nordic Seas further relates to anomalous heat advection. Diabatic processes play a secondary role, yet distinct changes in the hydrological cycle are possible. Our results imply that temperature and accumulation records from Greenland ice cores are sensitive to sea ice changes in the Nordic Seas but insensitive to sea ice changes in the Labrador Sea. Moreover, our simulations suggest that the uncertainty in the Eemian sea ice cover accounts for 1.6°C of the Eemian warming at the NEEM ice core site. The estimated Eemian warming of 5°C above present-day based on the NEEM $\delta$15N record can be reconstructed by the CCSM4 model for the scenario that a sea ice retreat in the Nordic Seas coincided with a reduced Greenland ice sheet.