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The Early Twentieth Century Warming and Winter Arctic Sea Ice

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The Arctic featured the strongest surface warming over the globe during the recent decades and it was accompanied by a rapid decline in sea ice extent. However, little is known about Arctic sea ice change during the Early Twentieth Century Warming (ETCW) during 1920-1940, also a period of a strong warming, globally and in the Arctic. Here, we investigate the sensitivity of Arctic winter surface air temperature (SAT) to sea ice during 1875-2008 by means of simulations with an atmospheric general circulation model (AGCM) forced by estimates of observed sea surface temperature (SST) and sea ice concentration. The Arctic warming trend since the 1960s is very well reproduced. In contrast, ETCW is hardly captured. An inspection of the forcing data revealed that sea ice extent does not strongly vary during ETCW. AGCM simulations with observed SST but fixed sea ice reveal a strong dependence of winter SAT on sea ice extent. In particular, the warming during the recent decades is strongly underestimated, if sea ice extent varies only seasonally. This suggests that a significant reduction of sea ice extent may have also accompanied Early Twentieth Century Warming, highlighting a potentially important role of anomalous sea ice extent in Arctic surface warming. This is also supported by analysis of control experiments with coupled GCMs that are capable to simulate strong natural multi-decadal variations of winter sea ice extent primarily caused by the Atlantic Meridional Overturning Circulation variability.