



Anthropogenic contribution to the intense warming over Greenland in July 2012

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Increasing surface melt is a major contributor to the recent acceleration in mass loss from the Greenland ice sheet (GrIS). Surface melt peaked during the exceptionally warm conditions in July 2012 when virtually the entire surface of the GrIS melted, a rare event that last occurred in 1889. Here we use a large ensemble of climate model experiments to show, for the first time, that the likelihood for the maximum near-surface temperature at Summit, the highest and coldest point on the GrIS, to exceed freezing in July 2012 was significantly increased by around a factor of 3 as a result of anthropogenic warming. The likelihood of melting at Summit in 2012 may have been further enhanced by the increase in summertime atmospheric blocking over Greenland over the past 25 years, which is not reproduced by current climate models. We further show that the occurrence of Greenland blocking increases liquid cloud cover over northern Greenland, a process that enhanced melt at Summit in July 2012. This suggests a connection between the large-scale atmospheric circulation and the local surface energy budget, which is important for understanding climate extremes over the GrIS.