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The recent warming trend in North Greenland

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The arctic is the fastest warming region on Earth, but it is also one where there is little historical data. Although summer warming causes melt, the annual temperature trend is dominated by the winter and fall season, which are much less well documented. In addition, the instrumental record relies principally on coastal weather stations, and there are very few direct temperature observations in the interior dating back more than 30 years, especially in North Greenland, where the current warming trend is the largest.

Here, we present a temperature reconstruction from NEEM (51°W, 77°N), in North Greenland, for the last 100 years, which allows us to put the recent trend in the context of the longer term climate. We use a combination of two independent proxies to reconstruct the temperature history at NEEM: borehole temperature and inert gas isotope measurements in the firn. Borehole temperature takes advantage of the low temperature diffusivity of the snow and ice, which allows the temperature history to be preserved in the ice for several centuries. Temperature gradients in the firn (old snow above the ice) influence the gas isotopic composition: thermal fractionation causes heavy isotopes to concentrate on the cold end of the firn column. We measured the isotopes of inert gases (N2, Ar and Kr), which have a constant atmospheric composition through time, and use the thermal fractionation signal as an additional constraint on the temperature history at the site.

We find that NEEM has been warming by 0.86±0.22°C/decade over the past 30 years, from -28.55±0.29°C for the 1900-1970 average to -26.77±0.16°C for the 2000-2010 average. The warming rate at NEEM is similar to that of Greenland Summit, and confirms the large warming trends in North Greenland (polar amplification) and high altitude sites (tropospheric rather than surface warming). Water isotopes show that the recent past has not met the level of the 1928 anomaly; but the average of the past 30 years has the highest isotope values since 1724, which suggests that the sustained warming of the past 30 years is indeed exceptional.