

## アイスコア中の気泡を使って見積もった過去4000年の グリーンランド表層温度の高い変動

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### High variability of Greenland surface temperature over the past 4000 years estimated from trapped air in ice core

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Greenland recently incurred record high temperatures and ice loss by melting, adding to concerns that anthropogenic warming is impacting the Greenland ice sheet and in turn accelerating global sea-level rise. Yet, it remains imprecisely known for Greenland how much warming is caused by increasing atmospheric greenhouse gases versus natural variability. To answer this need, we reconstruct Greenland surface snow temperature variability over the past 4000 years at the GISP2 site (near the Summit of the Greenland ice sheet; hereafter referred to as Greenland temperature) with a new method that utilises argon and nitrogen isotopic ratios from occluded air bubbles. The estimated average Greenland snow temperature over the past 4000 years was  $-30.7\text{ }^{\circ}\text{C}$  with a standard deviation of  $1.0\text{ }^{\circ}\text{C}$  and exhibiting a long-term decrease of roughly  $1.5\text{ }^{\circ}\text{C}$ , which is consistent with earlier studies. The current decadal average surface temperature (2001-2010) at the GISP2 site is  $-29.9\text{ }^{\circ}\text{C}$ . The record indicates that warmer temperatures were the norm in the earlier part of the past 4000 years, including century-long intervals nearly  $1\text{ }^{\circ}\text{C}$  warmer than the present decade (2001-2010). Therefore, we conclude that the current decadal mean temperature in Greenland has not exceeded the envelope of natural variability over the past 4000 years that seems to include part of the Holocene Thermal Maximum. Notwithstanding this conclusion, climate models project that if anthropogenic greenhouse gas emissions continue, the Greenland temperature would exceed the natural variability of the past 4000 years sometime before the year 2100.

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\*Deceased.