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Surface temperatures from the North-GRIP core during the last deglaciation based on isotopic diffusion of water molecules in the firn.

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In the North-GRIP ice core a section of 124.7 m has been measured for the isotopic content of both ^{18}O and deuterium in 5 cm sample resolution. Based on the GICC05 time scale this section covers the period from 14830-11547 year b2k. This record of 2494 samples from the last deglaciation is ideal for estimating past surface temperatures based on the difference in smoothing of the stable water molecule profiles δ^{18}O and δD in the firn.

The diffusion of the isotopic signal is shown to be dependent on the temperature in the firn column above the pore close-off, which is directly linked to the surface temperature of the site. In the firn the two isotopic species have different fractionation constants, which results in a slightly longer diffusion length for δ^{18}O than for δD. Below the pore close-off further diffusion is caused by the slow single crystal self-diffusion, thereby the differential diffusion length is only affected by the temperature dependent diffusion in the firn column and the general layer thinning. For a given accumulation rate and temperature the differential diffusion length can be modeled down through the firn column.

Power spectral methods are applied on the isotopic profiles of an ice core section in order to estimate the differential diffusion length. The estimated diffusion lengths need to be corrected for the total layer thinning, to give the diffusion lengths at the pore close-off.

In the NorthGRIP ice core, the past accumulation rate has been determined by annual layer counting back to 60 kyr b2k. This data combined with the corrected diffusion lengths gives the surface temperature record covering the last deglaciation.

This study shows a remarkable correlation with the temperature reconstructions done by combining borehole thermometry methods and the δ^{18}O record, which supports the feasibility of temperature reconstruction from high resolution records of δ^{18}O and δD measured in ice cores.