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Palaeotemperatures based on differential smoothing in isotopic firn diffusion

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The most frequently used proxy for past temperatures in Greenland and Antarctica is based on the measured general stable isotopic profiles.

In this contribution we introduce an entirely new method to constrain past temperatures from high resolution stable isotope measurement of glacier ice. The method utilizes known differences that occur in the smoothing of oxygen 18 and deuterium isotope profiles during firnification. This effect is manifested as different diffusion lengths for $HD^{16}O$ and $H_2^{18}O$ in the ice. The in situ difference of the squared diffusion lengths depends on the temperature and accumulation rate during deposition of the layer and the total subsequent thinning of the strata in question. The in situ diffusion lengths can be estimated by using power spectral methods on the measured profiles. Accurate ice flow or thinning model for the core and precise annual layer counting, which is available now for the NGRIP and GRIP iuce cores, provide the accumulation rate when the layer was deposited and the original diffusion lengths by backwards strain correction. The firn diffusion model then gives the past temperatures from the estimated diffusion lengths and accumulation rates.This method can be applyed on the GRIP and the NGRIP cores back to 40 kyrs. BP. Further down in the core the diffusion lenghts are only affected by ice diffusion which can be further studied by using the spectral metods mentioned above.

Several twin isotope high resolution data series will be discussed and we confirm i.a. the very cold Last Glacial Maximum temperatures found by borehole thermomtry for

the Greenland GRIP and the NGRIP cores which is also discussed. Data from deeper, 70 to 80 kyr old strata, where ice diffusion dominates the smoothing, reveal some details about the diffusivities of the $HD^{16}O$ and $H_2^{18}O$ molecules in glacer ice.

This method of palaeoclimatic reconstruction is also applicable in Antarctic ice cores for much older strata than possible in Greenland ice cores.