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Automatization of an inverse surface temperature modelling procedure for Greenland ice cores, developed and evaluated using nitrogen and argon isotope data measured on the Gisp2 ice core

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In order to study Northern Hemisphere climate interactions and variability during the Holocene, access to high resolution surface temperature records of the Greenland ice sheet is an integral condition. Surface temperature reconstruction relies on firn densification combined with gas and heat diffusion [Severinghaus et al. (1998)]. In this study we use the model developed by Schwander et al. (1997). A theoretical δ15N record is generated for different temperature scenarios and compared with measurements by minimizing the mean squared error (MSE). The goal of the presented study is an automatization of this inverse modelling procedure. To solve the inverse problem, the Holocene temperature reconstruction is implemented in three steps. First a rough first guess temperature input (prior) is constructed which serves as the starting point for the optimization. Second, a smooth solution which transects the δ15N measurement data is generated following a Monte Carlo approach. It is assumed that the smooth solution contains all long term temperature trends and (together with the accumulation rate input) drives changes in firn column height, which generate the gravitational background signal in δ15N. Finally, the smooth solution is superimposed with high frequency information directly extracted from the δ15N measurement data. Following the approach, a high resolution Holocene temperature history for the Gisp2 site was extracted (posteriori), which leads to modelled δ15N data that fits the measurements in the low permeg level (MSE) and shows excellent agreement in timing and strength of the measurement variability. To evaluate the reconstruction procedure different synthetic data experiments were conducted underlining the quality of the method. Additionally, a second firn model [Goujon et al. (2003)] was used, which leads to very similar results, that shows the robustness of the presented approach.

References:
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