

Interactive comment on “Past surface temperatures at the NorthGRIP drill site from the difference in firn diffusion of water isotopes” by S. B. Simonsen et al.

Anonymous Referee #2

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This paper by Simonsen and co-authors is presenting a new and elegant way of reconstructing paleotemperature profiles from high-resolution ice core data set of both $\delta^{18}\text{O}$ and δD records. The method is based on the differential diffusion length of the two water isotopes ^{18}O and deuterium. The diffusion signal recovered from ice cores is used to derive information of past temperature changes being the diffusion process dependent on firn temperature. Subsequently, the method is applied to a high-resolution section of the NorthGRIP ice core covering the last deglaciation. The new method is here compared with a previously published borehole isotope temperature reconstruction. Some discrepancies are shown during the Allerod period while a general good agreement is found in the remaining part of the record.

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The paper is well written and well balanced among its different parts and is suitable for the journal. However, I recommend its publication only after the revisions listed below.

Before the detailed comments, I have some general comments.:

- May the difference in the Allerod period be due to uncertainties in reconstructing past snow accumulation changes (layer thickness) in a climate period characterized by fast changes in atmospheric circulation?
- In the text there is some confusion in the timescale used (below) and the differences between GICC05 and ss09sea timescales.
- Have the high-resolution isotopic data been corrected for past $\delta^{18}\text{O}$ seawater changes?
- Since this method is highly dependent on accumulation rate, the feasibility of applying this method to other ice core sites (Antarctica for example) and the limits of the method should be discussed.

Detailed comments:

Page 923, line 5: There is also another method that has been used by Masson-Delmotte et al. (2005) in the GRIP ice core by considering the deuterium excess record and so the effect of changes in moisture source temperature and seasonality effects. Please, add something about this.

Page 923 line 23: may you add something (very short) about the definition of firn? it will help those readers not used to glaciological terms.

Page 927, line 16: may you define b2k?

Page 931, lines 2-3: See my comments above regarding the effects related to accumulation rate changes and strain rate. Probably, these effects are less important for NorthGRIP where the accumulation rate changes in the past are better defined. However, when ice flow models coupled with firn densification models are used for dating

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an ice core, where the inputs parameters like accumulation rate and temperature are deduced from the isotopic profiles, can this new method be used? May you provide some comments on this?

Page 931 lines 11-20: it is not very clear which is the difference between this new version of ss09sea timescale and GICC05. And which are the implications for the accumulation rate record?

Page 932, line 14: is Fig 2 instead of Fig3?

Page 933, line 6: change temperate to temperatures.

Page 933, line 9: I would say that the temperatures seem even higher than during the Bolling period! The resolution of the two data sets (I mean, differential diffusion T data and borehole isotope T data) in figure 4 does not seem similar. ... Cannot the borehole T be calculated from the new high res data? And, possibly, what about the Tsite reconstruction taking into consideration deuterium excess (see Masson-Delmotte et al., 2005)?

Page 933, line 16: what about the uncertainties in accumulation rate in a climate period characterized by fast climate changes?

Page 934, line 21-22: perhaps the authors may add something about the new laser spectroscopy methods allowing for high-resolution measurements.

Page 934, line 23-to the end: in the conclusions paragraph some discussion on the feasibility of applying this method to other ice core sites as well as on the limits of the method should be added.

Figure 1: This figure is not very readable. In the captions, please change doted to dotted.

Figure 2: the x axis should be "Surface Temperature (°C)".

Figure 3: The legend and the curve colours of the upper part figure should be changed

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... there are two reds curves. . . In the figure caption it should be added a comment to explain the temperature record (borehole isotope temperature. . .) reported in the bottom part of the figure.

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