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Climate of the Past Discussions

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 #1

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General Comments:

This paper presents a new method to interpret the temperature signal in d18O and dD of water in ice cores. It is an interesting development of the use of water stable isotopes to determine local temperature, and could be very successful in well chosen sites. This method depends a lot on the accurate knowledge of the densification of the firn, and the associated strain rate on the scale of cm. However, the consequence of the choices of a densification model, or the accurate knowledge of the accumulation are not discussed quantitatively.

This is a well written paper, and I recommend it for publication, provided that a dis-

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cussion of the uncertainty in the accumulation/strain rate/densification of the firn is discussed more quantitatively.

Specific Comments:

section 2.1 line 15, figure 1.c: I am asking for clarification: If the Z_c is different below 50m depth for the cases with and without seasonal cycle, is it just an offset due to what happens above? The seasonal cycle in temperature is not really noticeable below 50m, so adding in the seasonal cycle would not have a large effect.

section 2.1, p. 925, line 19, equation 8: Can you give a reference for this equation?

section 2.2, p 927, line 16: '38ky b2k' b2k is not a widespread acronym and should be spelled out at least once

section 2.2, p. 927, line 15: you refer to fig 2, but I think you meant fig. 3. There are other places where you refer to the wrong figure 2/3, for instance page 932 line 14.

section 4, p. 931, line 15-20: It would be interesting to use a few of the various ice flow models you mention, and see how they affect your results quantitatively. At least, you should justify why you chose to use ss09sea (I presume it is the most up to date).

section 4, p. 932, line 14. I think you mean figure 2, not 3.

section 4, general: The differential diffusion in the firn depends a lot on the densification on the firn, and the depth of pore close off. The paper only comments lightly on the densification model used, and the parameterisation used for pore close off. (section 4, page 930-931). The uncertainty in our knowledge on the pore close off depth may give a large error in the determination of the differential diffusion length, and it would be good to give some numbers for it, even with a very crude estimate of 2 different parameterisations, or 2 different versions of the accumulation/strain rate, or by adding a 10% error (or something else realistic) in the accumulation rate.

Section 5: It is indeed surprising that the Allerod does not match the d18O data. Have

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you looked at what the noble gas thermometer d15N/d40Ar says? It would alert you on a potential bias due to a very shallow, or abruptly changing lock-in zone in the same ice core your data come from.

figure 1a: The dotted line is barely readable, and it does not add much to your point. I suggest you get rid of it.

figure 1c: Are you sure the wiggles are real and not due to the sampling of your model?

figure 3: Maybe you could add an error bar envelope on your diffusion lengths, or delta diffusion lengths, mirroring what you did for figure 4.

figure 4, page 942: - It would be useful to write on the figure (or initial), the Youger Dryas, Bolling and Allerod periods.

- The NGRIP isotope borehole thermometry curve does not have the same spectral content (it is more smoothed) as your new data. Since you have d18O data, maybe you could produce a curve with the same spectral content as your data. It would make the comparison more fair. If it makes the figure too busy, maybe we can find a happy medium. I find it hard to compare the 2 records between e.g. 12 and 13 ka.b2k with this much smoothing.

Technical Corrections:

Abstract line 5: '2 stable water isotopes 18O and D': 2 pairs of stable isotopes, 18O/16O and D/H.

Abstract line 9: make 2 sentences out of it. Suggestion: surface temperature. It results in a diffusion length longer than if if the firn was isothermal.

page 931 line 5: you are missing the verb. annual layer thickness IS much smaller. . .

figure 2: x-axis is miss-spelled: temperaturE

Interactive comment on Clim. Past Discuss., 7, 921, 2011.