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Climate of the Past Discussions

Interactive comment on "Comparison of Holocene temperature reconstructions based on GISP2 multiple-gas-isotope measurements" *by* Michael Döring and Markus Christian Leuenberger

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Doring and Leuenberger conducted an important study for testing various reconstruction methods from nitrogen and argon isotope data in trapped air in Greenland ice cores. As the temperature reconstructions from this methodology may provide the most accurate temperature from the past, further advancements are critical. However, the paper is not very well organized and too bulky and very difficult to read, although it may be useful for thesis. Please reorganize and shorten the paper and only provide important figures and findings. Also, it requires further works to get better perspectives as shown below. Therefore, I recommend major revision.

1. For the verification of the method, it is essential to obtain new nitrogen and argon data from other sites in Greenland with similar quality of Kobashi et al. (2008). Many questions asked in this paper can not be answered by simply calculating the same data again and again. Kobashi et al. (2015) provided NGRIP data for the past 2000 years, although the data quality was not as good as Kobashi et al. (2008). Of course, getting new data is not easy, but at lest should discuss what is necessary to clarifies some questions in the future studies.

2. Goujon et al. (2003) and Schwander et al. (1997) are not state of the art models. The study of firn desification should have advanced much further by now. At least, literature review should be provided for what are the current issues on the understanding of firn densification in different time scales, If possible, try to use "the state of art" firn densification model to calculate temperature. In the paper, discussions are very confined in small literatures. Further discussions on the uncertainties of firn densification should be done as well as isotopic fractionations in firn and ice cores.

3. Kobashi et al. (2017)'s method is innovative because it does not directly use firn denfication model to calculate surface temperature (it uses the model for heat diffusion). In addition, only dNexcess is pure temperature proxy. d15N or d40Ar are not temperature proxy if firn model cannot adequately model desification process in the time scale you are concerned. In the paper, it is repeatedly said d15Nexcess is problematic, but it is also possible that firn model is not correct in the time scale of decades to centuries.

4. The paper only uses d15N and d40Ar for temperature, but many temperature proxies are available from the same core or other cores or around Greenland. It is essential to combine all data to draw conclusions. In particular, I strongly recommend to look at the past 1000 years, which has the highest quality in Kobashi et al. (2008) data. Please make a plot Kobashi et al. (2011), d15N temperature reconstruction (your data), borehole temperature reconstruction, and global or European average temperatures for the past 1000 years, etc. If the data is noisy (unreal), it will not correlate with other climate data.

5. Your temperature calculation for d15Nexcess target is very confusing with Kobashi et al. (2017). Kobashi et al. (2017) uses totally different method linking with d15N, So, please clarify that your temperature calculation for d15Nexcess is different from Kobashi et al. (2017).

References: Kobashi, T., Box, J.E., Vinther, B.M., Goto-Azuma, K., Blunier, T., White, J.W.C., Nakaegawa, T., Andresen, C.S., 2015. Modern solar maximum forced late twentieth century Greenland cooling. Geophys. Res. Lett. 42. https://doi.org/10.1002/2015GL064764 Kobashi, T., Kawamura, K., Severinghaus, J.P., Barnola, J.-M., Nakaegawa, T., Vinther, B.M., Johnsen, S.J., Box, J.E., 2011. High variability of Greenland surface temperature over the past 4000 years estimated from trapped air in an ice core. Geophys. Res. Lett. 38. https://doi.org/10.1029/2011GL049444 Kobashi, T., Menviel, L., Jeltsch-Thömmes, A., Vinther, B.M., Box, J.E., Muscheler, R., Nakaegawa, T., Pfister, P.L., Döring, M., Leuenberger, M., Wanner, H., Ohmura, A., 2017. Volcanic influence on centennial to millennial Holocene Greenland temperature change. Sci. Rep. 7. https://doi.org/10.1038/s41598-017-01451-7 Kobashi, T., Severinghaus, J.P., Kawamura, K., 2008. Argon and nitrogen isotopes of trapped air in the GISP2 ice core during the Holocene epoch (0-11,500 B.P.): Methodology and implications for gas loss processes. Geochim. Cosmochim. Acta 72. https://doi.org/10.1016/j.gca.2008.07.006 Goujon, C., Barnola, J.-M. and Ritz, C.: Modeling the densification of polar firn including heat diffusion: Application to close-off characteristics and gas isotopic fractionation for Antarctica and Greenland sites, J. 10 Geophys. Res. Atmos., 108(D24), n/a-n/a, doi:10.1029/2002JD003319, 2003. Schwander, J., Sowers, T., Barnola, J. M., Blunier, T., Fuchs, A. and Malaizé, B.: Age scale of the air in the summit ice: Implication for glacial-interglacial temperature change, J. Geophys. Res., 102(D16), 19483– 19493, doi:10.1029/97JD01309, 1997.

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