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Climate of the Past Discussions

Interactive comment on "Spatial and temporal oxygen isotope variability in northern Greenland – implications for a new climate record over the past millennium" *by* S. Weißbach et al.

Anonymous Referee #1

Received and published: 13 July 2015

The manuscript presents a stacked record of ice cores collected in Northern Greenland, most of them spanning the last 1000 years. The stacked record represents a tremendous work and clearly deserves publication. However I suggest some major revisions in the treatment of the analysis of the climate signal before the manuscript potentially can be accepted for publication.

The authors should also indicate how the data will be made available after manuscript has been published.

Major revisions

Section 2: Given that two co-authors were also co-author on the recent paper presenting the stacked ice core record from the NEEM shallow ice paper (Masson-Delmotte et al. 2015) I find it odd not to include this nearby isotope record in this study. Given the high signal-to-noise ratio of that stacked core it might make sense to compare the individual NGT cores with this ice core.

Page 2346 L 15-19: It is unclear to me how the authors have taken into account layer thinning when assigning the depth-age model. Please explain in details the model used.

P2347 L3: What is the dating uncertainty for the period between 1100-500 years? Later (p. 2349) the authors decide apply a running mean of 5 years – it is unclear to me why 5 years were chosen and not 10 years given that the uncertainty is estimated to be 10 years. I suggest that the authors discuss and quantify the effect of this dating uncertainty on the correlation coefficients discussed on pager 2349. Please consider to use a 11-year running mean to filter out the solar cycle instead.

P. 2347 L15-24: Please explain the model used to account for thinning.

P. 2348 L3-6: Given that you are using mean annual isotope values from ice cores with very low accumulation you will need to argue why diffusion does not alter the mean annual isotopic value. I would suggest that the best approach to do this would be to calculate the maximum diffusion length found at each site and compare this with the mean annual layer thickness.

P2349 L3-11: You need to remove the linear regressions from the figures, which are not statistical significant. Showing these fits does not make sense if they are not statistical significant. I suggest that you carry out a multivariable linear regression as well. I don't believe that showing the linear regression between the isotopic value and the longitude reveal any useful information. Instead I suggest that you use a relevant metric instead of the longitude. For example you could use the distance between the ice core site and the ice divide as a relevant metric, which is more physical appropriate than the

longitude.

P 2350 L5-9: I'm pretty sure that the pattern, which you show in Figure 5 is called the EOF while the temporal component of the EOF/PC analysis is called the PC. Under all circumstances you should give error bars on the eigenvectors to show that the first two EOF/PC components are independent of each other. Secondly you should also show the temporal component of the first 2 PC's

P2351 L3-6: As argued above it would make sense to also compare the your NG-stack with the NEEM stack.

P2352 L1-14: What is the argument for not using the isotope-temperature relationship derived by Masson-Delmotte et al. 2015 for present day conditions, but instead use isotope-temperature relationship for glacial-interglacial conditions?

P2355 L6-12: Please consider the fact that for the cores located to the east you likely have higher fraction of winter accumulation compared to summer accumulation. This likely means that variations in amount of summer accumulation would increase the noise, and thereby decrease the inter-core correlation. You could also consider using an 11-year running mean, as you have indicated earlier that uncertainties for some part of the cores were 10 years.

P2356 L 3-8: You need to support your statement about the spatial pattern of temporal variability with some kind of analysis.

P2356 L24-27: It is not clear to me how you based on Figure 4D, which does not show a significant correlation between d18O and accumulation can draw the conclusion that your data are consistent with the hypothesis that the foehn effect causes an anti-correlation between d18O and the accumulation rate.

P 2357 L 12-21: You need to explain the model parameters, which you tune and how you set up the model to simulate your data. Otherwise I suggest removing this section.

P2357 L28-P2358 L2: It is hardly surprising that you have a high correlation between

PC1 and the NG stack as you use the same dataset to produce both records. You might also want to clarify that you refer to the temporal component of EOF/PC1 and not the spatial component shown in the figure. As mentioned above I strongly suggest that you show both the spatial and temporal component of the EOF/PC analysis.

P2358 L1-2: I understand where your 22% comes from – however I do not think that it is correct to claim that only 22% of the NG-stack variability is caused by a regional climate signal. One could make the claim that by making the NG-stack you smooth out most of the influence from deposition noise hence all the variability in the NG-stack is caused by climate one way or the other. When reading your sentence I am left with the answer 'what is the remaining 78% variability in the NG stack?'

P2358 L11-13: This is a circular argument – you calculate the PC's based on the same cores, which make up the stack.

P2359 L 1-4: What is the correlation for SON and DJF? What are the p-values?

P2359 L10-13: Please quantify the similarities with the stack of Masson-Delmotte et al. 2015.

P2359 L22-23: Wouldn't it be possible to reach this conclusion base on the PC1 and PC2 instead of having to separate the cores into subjectively chosen groups?

P2361 L10-13: To support this hypothesis you might want to consider comparing your Stack I (the cores to the east of the divide) with the LOMO-core, as you have argued for these cores to be dominated by a winter precipitation signal.

P2363 L1-17: The analysis of the response from volcanic eruptions on the isotopic signal presented in this section need to be supported by a statistical analysis otherwise I suggest to remove this section.

P2365 L13-19: to support your hypothesis that the year 1420-event is related to sea ice decline you will need to argue why you do not have a positive anomaly in the d18O record for year $\sim$1590 and year $\sim$1700 where sea ice is at a significantly lower level

than at 1420.

P2366 L23-25: This sentence needs to be restructured. You need to point out that you are referring to mean annual d18O values (I presume this is the case). You need to point out that you mean that 12% of the spatial variability is due to ice sheet topography. As argued above it is hard to understand how 78% of a stacked ice core record can be due to random noise not related to the climate. As shown by White et al. 1997 a significant part of a single core compare to a stacked record is noise – however they estimate ∼40% common variability between the individual cores and the stacked record. It does seem that you are mixing temporal and spatial variability together here. Please correct appropriately.

Minor revision

P2343 L15: Add reference Merlivat and Jouzel 1979

L16: Add reference Jouzel and Merlivat 1984

L21: Add reference Fisher et al. 1985

L22: Add reference Pinzer et al. 2012, Steen-Larsen et al. 2014, Johnsen et al. 2000

L24: Add reference White et al. 1997, Masson-Delmotte et al. 2015

P2345 L21: Please provide detailed information about which cores and which part of the core were samples with what resolution.

P2348 L14: Please explain that the calculated SD is the standard deviation of the mean annual isotope values (I presume this is the case)

P 2349 L17-20: You might want to compare the inter-core correlation coefficients with those derived by White et al. 1997 and Masson-Delmotte et al. 2015

P 2357 L 15: Change enormous to significant

P 2358 L 28: may be - > maybe

P2364 L 11: Change ‘the temperature records’ to ‘the isotope records’

Interactive comment on Clim. Past Discuss., 11, 2341, 2015.