Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-128-RC1, 2020

Climate of the Past Discussions
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EGU

Interactive comment on "How precipitation intermittency sets an optimal sampling distance for temperature reconstructions from Antarctic ice cores" *by* Thomas Münch et al.

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Received and published: 6 November 2020

1 General Comments

This manuscript investigates the possibility of selecting an optimal set of ice core locations to best reconstruct the temperature record at a target Antarctic site. They use an isotope enabled climate model to derive what they term a "sampling correlation structure" of sampling locations from concentric rings radiating out from a target site. Their findings that the optimal reconstruction can be obtained by combining a local core with another 500-1000km away to decrease the noise in the records due to precipitation

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intermittency is particularly interesting.

The paper itself is quite well structured, however, I think it would benefit from including the details of the conceptual model earlier into the main text of the paper when the decorrelation length scales relating to the sources of noise are introduced. A diagram would also be of great help. It is probably beyond the scope of this paper but I would have liked the authors to comment on the relative importance of the different sources of noise in the isotopic signal and which ones are dominant depending on location in Antarctica (eg coastal vs inland).

I found some of the discussions of study regions and target regions quite confusing and could do with some clearer explanations. I also thought a motivating example with actual ice core data at one of the target sites to demonstrate the reduction in noise would be very helpful, and would be useful in quantifying how much improvement in the temperature reconstruction is obtained with additional cores when all the other confounding factors are included in the isotope signal. They state that including these sources of noise, eg isotope diffusion is outside the scope of this study, but and I would like to see how the results hold up when the real data is included.

The authors are clear in the assumptions going in to the conceptual model and the analysis overall. They are also clear on the limitations of trying to use this optimal sampling correlation structure in the real world.

Overall, the manuscript is written clearly, and is of good quality and is of scientific interest, especially to the ice coring an palaeoclimate community. I have listed a few specific comments below that I believe would help improve the readability of the paper and recommend publication once these issues are addressed.

2 Specific Comments

Lines 13-14: Remove final sentence as I didn't see the application of this technique to anything other than temperature reconstructions from ice cores discussed.

section 2.3.3: Some motivation and justification for the sampling scheme of rings and selection would be helpful. It was also not clear at times if N was referring to the number of grid cells, or rings and also is presumably different to N_{grid} mentioned later on line 32 onwards.

section 3.1 I would have liked to see what level of significance is attached to each correlation coefficient reported.

Fig 2: (And other figures) Use of diverging colour map for only positively increasing correlation or lengths scales is a bit distracting. Consider only using reds for instance.

Fig 3. This is an important figure in that it shows the precipitation weighting being important in the correlation. I would like to see some indication of where these correlations are significant to (eg $p<0.05$). It would be nice to see another map explicitly showing the difference in correlation coefficients between the two, as it looks to be some regions where there is no difference at all.

3.3 Optimal ice-core sampling structures line 187 "we compute the mean of correlation results obtained between a target site temperature and individual grid cells in order to reduce local variability in the model data" Is this what you really mean, averaging the correlations? This seems like a strange thing to do if you are looking to maximise the correlation overall?

I would also like more comment on how much of the regional difference is lost by averaging to only get a function of radial distance. As the DML and Vostok results differ and you suggest there are regional differences. Surely the correlations are not radially uniform?

Fig 4. It would be also useful to have the concentric circles marked around the target sites. Can you also comment on why the locations shift when more cores locations are added? That is, is the location in the N=1 case also included in the N=3 case as it looks as though they have moved slightly. These segments don't seem to correspond to the regions mapped out by the black polygons in Fig. 1 so it is not clear to me what the study regions actually are. Does it mean that the cores in the N>1 cases can be from outside of those black polygons too as appears to be the case here?

Fig 5. The black dashed line indicating the exponential fit is not included in the figure legend, only the caption. The dots in the plot don't appear to be at the expected 0, 250, 500km marks, but are a bit offset, is this deliberate? Again, I question the averaging step around the whole 250km rings, but it would be nice to see the spread in the correlation as a function of distance too. I am confused at what is meant by "all respective target sites in the DML and Vostok region", how are there more than one target sites for each region, are these different that the two crosses shown in Fig. 4?

Fig 6. These are interesting and show the clear difference for the precipitation weighted δ^{18}O and T_{2m} for DML, but why is the Vostok case relegated to the appendix? The fact that they are different is an interesting result.

Fig 7. The way this figure is arranged, is the top row, marked rank 5, that which has the max correlation, or is the rank 1 row the highest correlation row? I find it very curious that in the Vostok region the optimal arrangement comes with no local sites in many of the cases

line 220: Suggests that regional differences play a part here and I would like a comment on what those differences are (elevation, distance from coast etc?)

Line 232: Does the averaging have an effect on the significance of the correlations?

Fig. 8 (b) I assume the colours on the histogram are the same as in (a), but please add the legend anyway. Can you comment on the low correlation outliers for the EDML

case.

Section 4.1 I found most of the discussion very clear and thorough, but re-iterate that a good schematic diagram to illustrate the length scales in the conceptual model would be very useful.

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