

Line 5: Remove "s" in ice cores.

Corrected.

Line 9: I still do not think that "markers" is a good description, and "age-difference" is still also a misleading term to use here. A marker is related to either an event or an age, not to a certain number of years between two horizons. "Markers of age-difference" indicates that the age in some particular point is different from some other age estimate, which is not the case (and I believe it is incorrect use of a hyphen, too, but that is a minor detail). You are yourselves using another meaning of "age difference" in figures 5-7, which illustrates the potential of confusion. If you are not willing to use "duration" (which is exactly what the number of counted layers between two horizons is, as you also say yourselves on page 5 line 15), what about "age span" or "layer-counted intervals"? Or find a smart way to replace "marker" by "constraint" or something similar.

We now use the term « duration » all along the manuscript.

Line 15: ... which will still not be an "exercise" ... when this paper is published, the method will be used to derive new chronologies, not to make exercises. Thus, you can say that the use of "exercise" is appropriate in line 16 because no new chronology is released with this paper, but not in line 15.

Replaced by « dating experiment ».

Line 25: "1-8 years for counting of 20 annual layers" has been changed to "about 0-4 years for counting of 20 annual layers", which is line with the GICC05 data file. However, the average relative counting error seems more relevant than the absolute range of uncertain years per 20-year interval.

Replaced by :

«... with an average relative counting error of 0 to 20%.»

Line 26: "Since the layer counting is not independent from one interval to another, the final uncertainty on the GICC05 chronology cumulates the counting error (Maximum Counting Error (MCE))". See the comments to the same sentence in the last review - it is still not correct and the grammar needs to be fixed. It may be better explained in section 2.3 but it needs to make sense here, too.

Replaced by :

« The uncertainty of the GICC05 age scale however cumulates the counting error, and the Maximum Counting Error (MCE) maximizes this uncertainty since it assumes that the layer counting error is fully correlated from one interval to another. »

Page 3:

Line 12: "Permits" is not correct. The constraint forces it.

Replaced by : « It forces a coherency within 5 years between the NGRIP AICC2012 chronology and GICC05 »

Page 5:

Line 6-7 and 9: "counted errors" -> "counting errors"

Corrected.

Figure 1 and 3:

Is there only supposed to be one orange line on Figure 1, and is it identical to the GICC05 curve?

I get the feeling that Figs. 1 and 3 shows essentially the same, namely that you can feed Datices with bad background scenarios, and it still converges to GICC05. That's a lot of room to spend on that.

On Figure 1, there are several orange lines. Each blue line corresponds to an orange line. Blue lines are the perturbed input age scales, while orange lines are the output age scales (after optimization with Datice). As you mentioned, Figure 1 and 3 both show the convergence to GICC05 even though Datice is fed with bad background scenarios. We slightly reformulated the text to insist on this last point.

Page 8:

The term "analysed chronologies" and "analysed error" seem really strange to me, as they indicate that the background chronology and counted chronologies have not been analysed. Could you think of a more appropriate word? "Modelled", "generated", "output" or similar ...

We would prefer to keep this terminology because it is the now widely adopted terminology in Data Assimilation since the paper of Ide et al, 1997. The adjective « analysed » refers to the analysis as opposed to the background. We add the citation Ide et al, 1997 in the manuscript.

Page 10:

What do you mean by "older than GICC05"?
And why is "disymmetry (rather asymmetry) of their probability distribution" expected?

We reformulated the text.

Page 12:

This way to describe the annual layer counting is a bit confusing as the summation takes place from annual cycle p to q, implying that the annual cycles are numbered (and thus dated) prior to the dating of the core. I can see what the authors are trying to do, but I do not think the highly complex nomenclature (which is expressing exactly the same as the text at the top of page 12) is adding to the clarity.

The indices p and q rather refer to identified cycles which are not yet measured as annual cycles, since some annual cycles are certain and others uncertain. The $n_i \pm \sigma_i$ provides the final measurement and the dating. We would like to keep this nomenclature because other equations are based on it.

To make the distinction between « identified cycles » and « annual cycles », we slightly changed the text as follows :

If the *i*th **cycle** is identified as **certain annual cycle**, the layer is counted as a full year with a zero error. Otherwise, for an uncertain *i*th annual cycle, the layer counts for half a year plus or minus half a year. For each cycle numbered with index *i* from top to 60 ka, one can introduce the two following variables n_i and σ_i in order to record the counting of layers and its error:

Page 13:

Line 3: "Over which time window should we sample the GICC05 markers of age-difference?" Do you simply mean to ask how many years there should be in each counted interval? Not clear!

We reformulated the text as follows :

« Over which time window should we define our GICC05 markers of duration? Shall we apply markers of duration on a 20 yrs time window or choose another sampling rate (i.e., 20, 40, 60 yrs time window)? »

Similarly to the comment above for page 12, the lower part of page 13 is a very complicated way to write up how the errors would sum up in the situations of no or full correlation, neither of which are realistic. Essentially the same discussion is repeated on page 14 for 20-year intervals rather than on annual scale, so the text could be shortened from page 12, line 4 (or 11), to page 14,

line 14.

Alternatively, the link between the proposed formal definition (which is based on Gaussian distributions representing every single certain and uncertain year) and how the authors use the publicly available 20-year binned GICC05 depth-age relation and MCEs, is needed.

Page 14:

Line 13: "Consequently" is not correct. In the source papers, the assumption of setting $MCE/2 = \sigma$ was not directly linked to the error summation strategy.
Line 22: "1. Either we believe that the full error correlation assessed over the 20yrs time-window between annual layers cuts-off." I simply do not understand what this means. This is a good example of why a language make-over preferably by a native English speaker is needed.

We have fully rewritten this part and checked / corrected the language in many places in the manuscript.

Page 15:

Line 11: "very distinct inputs" ... do you mean "very different inputs"?

We replaced « distinct » by « different ». This part is now in Appendix.

Line 17: See, this is a real model development and improvement. Thank you!

Page 16:

Eq. 26: Why this form?

The chosen form must meet some requirements to really define a correlation function and to further enable to construct an observation error covariance matrix that is symmetric positive definite.

Line 9: "exercises" ... will not be exercises, but serious work.

Corrected.

Fig. 4

It is really difficult to derive any useful information from this graph if reproduced in less than full page width, and even then, the dashed lines are very hard to decipher.

Are there no constraints keeping the absolute age close to GICC05 in these runs? It seems amazing that the different runs agree with 20 years or so especially then the "analysed errors" are a factor of 3 different between the different experiments. When comparing to figure 2 of the first version of the manuscript, the difference is striking. In the first version, the length of each counted interval had a direct and large influence on the modelled chronology (i.e. the 100 y and 200 y curves on figure 2 were more than 100 years apart at 1900 m), while in the present manuscript, the difference between the 100 y and 200 y curves in figure 4 is an order of magnitude smaller. Only the modelled error bars are significantly different.

What has changed?

There is a major difference between this revised version and the version that has been submitted initially. In this version, all the experiments performed to validate the implementation of duration constraints have been performed with only one core (NorthGRIP). In the previous version, we displayed only 5 cores experiments, hence the differences. We however modified the legend and we hope that it helps to read this graph.

Page 21:

Last section: Another advantage is that all deep Greenland cores are available on GICC05.

Page 22:

Line 18: "There is no unique way to define the correlation ..." suggested

alternative:

"There is no objective way to choose the best representation of the correlation ..."

Corrected.

And please replace "exercises" with "experiments" or similar.

Corrected.

References:

The WAIS paper "Members, 2014" needs fixing.

OK.