

## ***Interactive comment on “Revisiting the absolute calibration of the Greenland ice-core age-scales” by L. Skinner***

**Anonymous Referee #2**

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general comments

This paper compares the new counted ice core time scale (GICC05) with the radiometric dating of speleothem and coral records. This comparison involves assumptions about synchronous climate changes in different parts of the world as well as assumptions about 14C reservoir ages in the upper layers of the oceans. Luke Skinner concludes that variable reservoir ages as well as errors in the ice core time scales have to be considered to obtain agreement between the time scales.

I think this is a well-written and interesting paper. One can have different opinions about the conclusions of the paper but there are indeed differences between the different time scales if the common assumptions about 14C reservoir ages and climate

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correlations are made. However, this paper makes mainly the GICC05 time scale responsible for the differences. In addition to identifying possible problems in the ice core time scales, the discussion should be more open to alternative explanations as, for example, variable reservoir ages (not only at the Iberian margin site) and potentially problematic stratigraphic correlations. If these things are addressed I think that this interesting discussion should be accepted for publication in *Climate of the Past*.

#### Specific Comments:

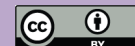
In the introduction Luke Skinner concludes that "a definitive "absolute" glaciological age-scale for Greenland might still elude us". I think this depends on the demands one has for such a time scale. All time scales have their errors. Especially the counting of ice core layer depends on certain assumptions but, nevertheless, the counting of the GICC05 time scale was an effort to accurately include the errors. The error treatment might be misleading since the uncertainties in the ice core dating might not be statistical errors but they could also represent systematical errors. Therefore, I think that Luke Skinner should consider the "maximum counting error" of the GICC05 time scale. I have the impression that the various dating methods could agree with the GICC05 time scale when the maximum counting error is taken into account.

Figure 1: As acknowledged by Luke Skinner there seems to be some freedom for adjustments of the correlations between climate at the Iberian margin and Greenland especially from 15000 to 30000. The IRD events are used as additional constraints especially during MIS2. Nevertheless, it would be interesting to have an estimate of the age uncertainties of this synchronization and to include this into the discussion. The same questions arises for the Shackleton time scale that uses two fix points to correct the ss09sea ice core time scale. One of those fix-points is GI3. However, GI3 looks very different in the Iberian margin sediments than in GRIP d18O (much longer). How much of the time scale differences can be attributed to this potentially problematic matching of the climate records?

Page 795 Line 27: "5 independent Greenland age-scales". Which 5 scales are meant? GICC05 should be truly independent. However, earlier time scales are partly based on modeling (using fix-points). Therefore, I am not aware that there are so many completely independent time scales. The long-lasting efforts to date the Greenland ice cores should not be used to their disadvantage.

The discussion around figure 2 might be a bit misleading. The 14C-based approach to re-date the ice cores (Shackleton time scale) will by definition lead to a good agreement between the 14C calibration data sets and 14C dates on this adjusted time scales. This is especially true around the fix points but it will also likely improve the agreement for the rest of the record (I think Shackleton et al. (2004) would have used more points for adjustments if this was not the case). In addition, the 14C calibration records might suggest a too optimistic picture of the 14C calibration before 15000 yr BP. For example, the Cariaco data provided another calibration before it was re-dated and there are several other records that do not show such a good agreement with the re-dated Cariaco and Coral data set. However, I agree that Luke Skinner probably picked out the two most likely 14C calibration records at the moment. However, I see the danger of the reinforcement syndrome. Records that agree well with the supposedly best data are favored and thus reinforce a potentially problematic record. This is illustrated in line 13 on page 796 "It is noteworthy that the Huliaco chronostratigraphy reproduces the same history of atmospheric 14C change as predicted independently by paired U-Th/14C dates performed on tropical corals.". I am questioning the independence since the first calibration effort using the Cariaco data did not show such a good agreement. So my conclusion of figure 2 would be the following: The Coral data, the re-dated Cariaco data (after the Coral data was published) and the Iberian Margin data, which was partly adjusted to the Coral data, agree very well.

Page 797 line 4: I don't understand why GICC05 should be "missing time" between GIS2 and GIS8. According to the discussion by Luke Skinner it should miss time from 15000 to 30000 yr BP? It seems that from 30000 yr BP backwards (GIS4) GICC05

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includes more years than SFCP04?

Figure 3 is an interesting comparison of 14C dates from the Cariaco basin and the Iberian margin on supposedly the same time scale. However, the correlation between the 2 climate records seems to contain considerable uncertainties that are not discussed by Luke Skinner. In addition, the reservoir ages in the Cariaco basin are assumed to be constant. However, there are indications that these also changed in the past especially during rapid climate change which are exactly the periods that are used for synchronization of the records. Both of these uncertainties should be included in the discussion. Nevertheless, figure 3 is very interesting. If I understand it correctly it suggests that back to 24 kyr BP the GICC05-SFC04 difference can be explained by reservoir age changes. The differences between reservoir-age corrected SFC04 and GICC05 from 24 to 37 kyr BP are in the order of 1 ky or less. The maximum counting error of GICC05 is in the order of 600 to 1400 yr. Taken these two things together seems to indicate that there is actually not a real contradiction between the two time scales. The paper by Luke Skinner can indeed help to point to periods where the ice core time scales might contain too few and too many years. It seems that this can be resolved within the uncertainty limits given by the GICC05 time scale. I think this should be investigated in more detail in a revised version of the paper.

Figure 5 seems to reinforce the point I made earlier. The agreement between the different records (not the one on the GICC05 time scale) is presented as a convincing argument for the time scale problems of GICC05. However, the agreement between the records is again partly due to a selection of records and time scales that seem not completely independent: Cariaco is placed on the speleothem age scale that produces similar D14C values as the coral data. The Iberian margin data is put on basically the same radiometric age scale. In addition to this the reservoir correction of the Iberian data is done via the Cariaco data. In this case it seems obvious that the Cariaco D14C and the Iberian margin D14C agree since they are placed on the same time scale and the difference are attributed to reservoir age differences. So figure 5 does not really



contain new information.

To the disappearing layer discussion: If missing/disappearing layers would be a problem one would need an additional explanation for the fact that the different time scales come closer together around the Laschamp geomagnetic excursion (which is a real external time maker and surprisingly most of the time scales agree well around this period).

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