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Climate of the Past Discussions

Interactive comment on "COnstructing Proxy-Record Age models (COPRA)" *by* S. F. M. Breitenbach et al.

Anonymous Referee #1

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General Comments

The authors present an age-depth modelling approach (COPRA) designed for climate archives, which age uncertainties are symmetrical and might provide the possibility to form annual layers. An outlier analysis is included and the program can deal with age inversions. During the age modelling the program translates age uncertainties of the proxy record into proxy uncertainties. The authors argue that this step is justified in order to obtain a time certain, "true" time scale, which allows comparison with other records. In its present form COPRA is suited to determine age-depth relationships for stalagmites. The approach is tested on an artificial time series and on two unpublished stalagmites from the Georgian Caucasus and Southern Belize.

To my opinion the outlier detection and age-depth model routine (MC approach) is

not new and nothing special, as honestly admitted by the authors and should be improved in follow-up versions of COPRA. What makes their method suitable for publication in CP is the integration of laminar counted sections of the stalagmites into the age-depth model. In very recent literature laminar counted sections are included in stalagmite age models (Scholz et al., 2012, CPD, http://www.clim-past-discuss.net/8/909/2012/cpd-8-909-2012.pdf ; Dominguez-Villar et al., 2012, Quaternary Geochronology, http://dx.doi.org/10.1016/j.quageo.2012.04.019), each with their own stalagmite-specialised method. Therefore, establishing a general method, which is able to fit one or more floating laminar counted sections to dated depths, is valuable work and deserves publication. However, before I can advise to consider this manuscript for publication, the authors are kindly asked to address my points, listed below.

Specific Comments

P2373; l 20-25: I really like the idea to translate the age errors into proxy errors. However, I doubt that it will be possible to compare records better with this approach. For me, the error bands produced in the according figures look similar to what I would expect if the proxy signal would be plotted with age errors. Unfortunately, there are relatively few studies available, which present their data in a time uncertain domain (one exception is e.g. Blaauw et al. 2007, Holocene, 17, pp 283-288). Both error bands, addressing either only proxy errors or only age errors, look pretty similar to my opinion.

Related to this: If I understand your uncertainty-transfer method (P2380; l 2-9) correctly, I can not agree with the error bands shown in Figure 6 and 9. How is it possible that the error in the proxy is larger than the highest measured value (e.g. Fig. 9 at 36ka the upper limit exceeds the measured values by several tenth of a permil, the same with the low values of the lower error band right before the hiatus)? Please, explain this behaviour in more detail.

A further (small) note on this topic (P2392, l 28): I agree, that with large age (or proxy)

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errors it is not possible (and shouldn't be tried) to make some statements about the high frequency variability of the proxy or to compare the record with other records on short time scales. However, one can say with confidence that there are high frequency variations. This is more than "cannot say anything with confidence". If you have a laminar counted section it is even possible to make statements about the frequency of the proxy variations, although the 'true' age of the section is not well constrained and comparison with other records is still difficult.

P 2378, l 17: 100 MC simulations seems to be too less for me. Is there an explanation why this number is used? I recommend to use at least 2000 as default value. This is a number Efron and Tibshirani (1993, An Introduction to the Bootstrap. Chapman & Hall, New York) suggested for MC simulation in order to suppress simulation noise. Is this small number the reason, why both age-depth realisations in Figure 6a provide such large differences at the oldest part of the artificially constructed archive? The inclusion of the layer count section at the top of this stalagmite should not have a strong influence on the errors at the other end of the stalagmite. The same enlargement of the error envelope is present at about 100 mm distance from top in YOK-G (compare Fig 9a and b).

P 2384; l 15-21: I agree that this is one possibility to fit the floating laminar counted part. However, my concern with your approach is that the result is biased by the kind of interpolation of age-depth model A. e.g. if the laminar counted section reveals a relatively linear growth history, but the user decided to apply a spline between dated depths. An alternative would be to calculate the least square only between the laminated section and the dated depths. I admit that this causes some trouble when no age is measured within the laminar counted section. Do you have any arguments, why you choose an integration procedure as described?

Related to this point: Do you take the age errors of A and B into account for the least squares calculation? Do you assign an error to the vector A0 and do you add this error to the laminar counted error? At this point, I don't request the authors to modify

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their code according to the aforementioned question, but I think that it is necessary to briefly mention these points and maybe they could be considered for further stages of development of the software.

Section 3.1.1: In your description of the artificial record construction (and Fig. 6a) it seems that the midpoint of the dating uncertainty always reflects the “true”, prescribed age. It is highly unlikely that all dating points of a real archive are perfect like this. Other age-depth modelling studies construct their artificially constructed age models in a more reliable way (first there is the growth history and than the “measured” ages at certain depths are randomly determined – often with large deviations from the “true” growth history, see e.g., Scholz and Hoffmann (2011) – although the randomisation of ages do not have to be as sophisticated as described therein). To my opinion it would be fair enough to test COPRA on an artificial age-depth model, constructed with dating points that are not as perfect as in the present manuscript version. I think in this way we all could learn more about the performance of COPRA.

Section 3.1.2, 3.1.3: This is the first publication of the dates of both stalagmites. Therefore, it is essential that the Th/U ages are explicitly given in a table (not necessarily in the paper, but at least as supplementary material). I would appreciate if you can state if the given errors are 1 sigma or 2 sigma. Usually Th/U dates are given with 2 sigma uncertainty, but with respect to figure 8 a lot of the 100(?) MC realisations (more than five) plot outside the given age errors. Therefore, I assume you show 1 sigma errors in your figures.

Section 3.2.1; 3.2.2; 3.2.3: Please provide information on the parameters used for the construction of the age-depth models (e.g., Number of MC simulation, kind of interpolation, . . .)

Technical Comments

P2371; l 4: Unfortunately it is not entirely true that ‘available modelling algorithms do not allow incorporation of layer counted intervals’. Very recently Dominguez-Villar et

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al. (2012, Quaternary Geochronology, http://dx.doi.org/10.1016/j.quageo.2012.04.019) published an approach.

P2373; l 8-9: It is not true that StalAge is able to construct age models for lake sediments and ice cores, since StalAge accounts only for Gaussian age uncertainties and calibrated 14C ages are not Gaussian distributed.

P2374; l 6: Please, state already in this line, which kind of interpolation COPRA provides.

P2375; l 19-24 and P2391; l 23): I would prefer, if you could remove all text passages where you mention that COPRA can build age models for 14C dated archives. In general, calibrated 14C ages are highly asymmetric and COPRA can, at its present state, not deal adequately with such uncertainty distributions.

P2376; l 15-17: This sentence sounds somewhat weird.

P2377; l 1: Please, be more specific and explain what 'proper treatment' means.

P2378; l 4: Please, delete 'small' since the error has not to be small.

P2378; l 11-12: It seems to me that you speak in both lines of the depths of the proxy profile. Therefore, I suggest to use already in this line another index (not 'i' as this is attributed to the depths of the age determinations). Maybe it is appropriate to use 'j' instead as you did on the next page.

Section 2.3.2: Formally, I do not see a difference in the terms 'outlier' and 'non-tractable reversal'. Both describe the same problem in the same way. Please, rearrange this section accordingly or provide more information how to differentiate between both anomalies.

P 2385; l 4: Please delete '(not shown in Fig. 3)'.

P 2386; l 15: Why do you ascribe an error of 1mm at the top? This reads strange, since it suggests that you do not know were the top of the stalagmite is.

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Fig. 5: Why seems the red layer count started at about 28 mm and stopped at about 53mm? The section where counting is possible should not change - only the number of counted layers/years could change.

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