

Comment on gchron-2022-22

Natalia Piotrowska (Referee)

Referee comment on "Bayesian age–depth modelling applied to varve and radiometric dating to optimize the transfer of an existing high-resolution chronology to a new composite sediment profile from Holzmaar (West Eifel Volcanic Field, Germany)" by Stella Birlo et al., Geochronology Discuss., <https://doi.org/10.5194/gchron-2022-22-RC2>, 2022

General comments

Scientific significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Geochronology (substantial new concepts, ideas, methods, or data)?

Yes.

The manuscript presents a considerable effort the authors put into transferring the previously obtained chronology for Lake Holzmaar to newly recovered sediment cores. The chronology for Lake Holzmaar is a unique one, with high resolution, based on varve counting, radiocarbon and isotope measurements. The authors carefully evaluate the reliability and accuracy of all the results, and this is one of the strongest points of this work.

The progress presented by this manuscript concerns testing four different approaches to build chronology for HZM19 record in a quantitative way – concerning the precision, accuracy, and comparison with other records for distinct events, like tephra layers and biozone boundaries. Hardly ever this kind of approach is published, and typically only one, “the best” or “the chosen” age-depth model is presented in publications. Usually there is no space to discuss the reasons behind the choice and address questions of age-depth model methodology in papers focusing on proxy-interpretation. As such, I think “Geochronology” is the right journal to publish this kind of study. This manuscript can also be regarded as a guide to future research teams which may face similar challenge in the future.

Scientific quality:

Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?

Yes.

The authors performed the modelling with use of Bacon code - the modern, but well-established tool for Bayesian age-depth modelling. They proved an excellent knowledge and know-how about using the prior information in a process of age-depth modelling, which I know from my experience is not a trivial task. On the other hand, "playing" with priors may sometimes be used in an inappropriate way, e.g. to get the modelled age matching some expectations or get unrealistic precision, but here the authors convinced me they set the parameters to realistic and justified values.

The exhaustive Introduction provides a valuable and complete context of Lake Holzmaar chronology challenges and improvements. Discussion of the results is well-balanced, and based on scientific evidence, also taking into consideration the previously obtained data, with appropriate references. Some minor issues I address in "Specific comments".

Presentation quality:

Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?

The manuscript follows the classical structure (introduction-methods-results-discussion-conclusion), which is appropriate and clear. Some of the figures and all the tables are presented in Appendix, which is fine, although the Fig. A3 is cited 16 times (!) in the manuscript text, and I suggest moving it to the core of the paper. The quality of figures and tables is good, I have some minor remarks – see technical part of the review.

In my non-native-speaker opinion the language reads fluently.

Specific comments

Answering question list provided in a guide for reviewers:

- Does the paper address relevant scientific questions within the scope of GChron? YES
- Does the paper present novel concepts, ideas, tools, or data? YES
- Are substantial conclusions reached? YES
- Are the scientific methods and assumptions valid and clearly outlined? YES in general, for some minor issues please see Specific comment section
- Are the results sufficient to support the interpretations and conclusions? YES
- Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? YES
- Do the authors give proper credit to related work and clearly indicate their own new/original contribution? YES
- Does the title clearly reflect the contents of the paper? YES
- Does the abstract provide a concise and complete summary? YES
- Is the overall presentation well structured and clear? YES
- Is the language fluent and precise? YES
- Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? YES
- Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? YES – see comment about Fig. A3 and Specific comments below
- Are the number and quality of references appropriate? YES; all references are cited and listed.
- Is the amount and quality of supplementary material appropriate? YES

Other specific comments:

Pages 13-14

The ages derived from of ^{137}Cs peaks are clear, I have no doubts about it, but why the slump, clearly present in ^{210}Pb and lithology, is not demonstrated in ^{137}Cs data? If I

imagine cutting the slump section out of the 137Cs profile, it wouldn't look as nicely monotonous as it is now. Do authors have any thoughts on that?

Page 15

In line 377 authors state they excluded two 14C results (HZM-46 and HZM-10.1) from a list of marker layers, due to "inconsistencies in documentation". As such I would expect they are not included in any discussion and conclusion, but then in line 391 HZM-46 is referenced to – I suggest to leave the depth info only in line 391.

Page 18

Line 465-466. I wonder about the reasons for a high noise in Model C, do the authors have some explanation for this observation? My guess would be lot of data with high density per core length, and relatively small uncertainties.

Page 19, lines 495-499

Anchoring of the Section 3 was first mentioned in lines 289-290, here the explanation is provided plus reference to Fig. A4. Honestly, I was not able to understand the reason and way to sum the probabilities for four completely different radiocarbon results. How the ages of HZM5.3, HZM6.1 and HZM7 were shifted to form the PDFs presented in Fig. A4A? Please clarify this part of calculations. Was the age of HZM4.3 not sufficient to anchor the Section 3?

Page 21

If the age of LST is implemented as a marker (as stated in line 530) then it should not be derived from the model (as in line 531). I suggest deleting "and LST" in line 531 or rephrasing this sentence, and still the following paragraph discussing the interval between UMT and LST is valid.

Similar conclusion is provided on page 24, line 615 – please avoid circular reasoning

Page 22

I have a feeling the whole presentation on YD boundaries and duration, and comparison with other records, would benefit from some graphical illustration in addition to numbers cited in text and given in Table A6. Please consider adding such plot.

Technical corrections

Line 10

Abstract, first line "This study gives an overview of different varve integration methods with Bacon." sounds colloquial, I suggest elaborating, consider e.g. "...different methods to integrate information from varve chronology, radiometric measurements in Bayesian tool Bacon..."

Line 79 and elsewhere

Please correct the referenced name to "Bronk Ramsey, 2009" as this is a correct two-part surname for Christopher Bronk Ramsey

Line 149-153

Please include a brief information about the total length of the recovered cores, maybe refer to Fig. 2?

Line 181

Change "Spectroscopy" to "Spectrometry", the correct name for the AMS technique

Line 317

If possible, please enlarge Fig. 2 to full-page scale, would be easier to read

Line 422

Change "+ -" to "±"

Line 444

Inconsistent depth units: here 4.43m, in Fig A3B.: 4429 mm, would be clearer to unify

Line 490

As above, 6.29m in the text and 6312mm in Fig. A3D

Page 20, Fig. 5

Please add markers for hiatus due to technical gap and for LST, similarly to Fig. 6

Page 22

Line 548 – delete double dot

Line 549 – please clarify, which transition do you mean here?

Page 37

Table A6 is difficult to read in its present format, in particular when reader wants to have a quick glance at some specific numbers. Check the line spacing and names of "events" in the first column. If possible, please add horizontal lines dividing the rows.