

Comment on gchron-2022-22

Anonymous Referee #1

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-RC1>, 2022

I have reviewed the manuscript by Birlo et al. entitled "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)". The manuscript compares and discusses four Bayesian age-depth models in Bacon for the same sedimentary sequence, which differ in the chronological information included in the model and initial settings.

Although this is a good methodological exercise, the objectives, methodological implications of this study are not clear to me. I believe the main purpose when applying Bayesian statistics to perform an age-depth model is to combine as much chronological and stratigraphic information as possible to get the best dating and probabilistic estimates of age uncertainties. According to that, the conclusions of the study i) all the Bayesian models improve the accuracy and precision of previous age estimates and ii) Method D (the one which includes more detailed chronological and stratigraphic information) is the best approach, were fairly predictable results. On the other hand, if the main objective is to transfer an existing chronology to a new composite sediment profile as indicated in the title, the high-resolution stratigraphic correlation using marker layers should be enough, especially in varved sediments.

Holzmaar is one of the best studied varved records in the world and ongoing studies of these sediments (e.g. Garcia et al., 2022) are an example of the use of new methodological approaches in palaeolimnology with potential for significant impact on regional palaeoenvironmental and palaeoclimate research. I strongly support the publication of a new improved and robust chronology for this site but, in my opinion, the manuscript needs some changes in the structure and content before publication. Below are my suggestions:

(1) I really think the manuscript would benefit from a better description of the objectives

and I propose two options to do so that, I hope, can help:

Option 1 (the most sensible to me). The main goal is to improve the existing Holzmaar chronology and to transfer it to the new composite profile. In this case, I would focus on a better description of the correlation between the old and new composite profiles. I miss a figure showing the two composite profiles with the position of the marker layers, radiocarbon dates, tephra layer and prior information used in Method D. I would focus on the comparison of the VT-99 chronology, the radiocarbon chronology (Method A) and the integrated Bayesian chronology (Method D) and I would discuss the new chronology (Method D) reporting age uncertainties and new age estimates for the LST, UMT and climatic transitions based on Method D as described in Section 3.2.4. This information might be relevant for other researchers working on this region.

Option 2. The main goal is to discuss the best approach for Bayesian age-depth modelling in varved sediments in general and Holzmaar in particular. This option implies additional work. I would suggest a comparison of Method D in Bacon with a Bayesian age-depth model in Oxcal using the same chronological information. This would allow discussing the pros and cons of the two approaches for varved sediments, which would be a significant contribution to the community.

(2) The structure of the manuscript needs improvements as follows:

Introduction: the introduction does not provide sufficient background information to understand the issue addressed and the significance of this study. I found the missed information in other parts of the manuscript though, so I think this is just to move some paragraph into this section.

- Paragraph 1, 2 and 3 (line 37-61) need to be supported by references.
- Sub-section 2.3.4 "Bayesian age-depth modelling" (in varved sediments?) should be added to the Introduction (line 65). And after that, I would add the sentence in line 94-99. I would provide more details about the main reasons to choose Bacon based on the information about Bacon and Oxcal you give in sub-subsection 2.3.4.
- Information provided in line 70 -82 is duplicated in Section 2.3.1. I suggest to removed it from the introduction.
- Aims and Objectives are not clear (see comment 1 above)

Material and Methods:

- Subsection 2.1 "Regional Settings" should be under an independent section. I suggest a new Section 2 on "Regional settings and the Holzmaar sediment record". which includes

(1) the current subsection 2.1 "Regional settings", (2) subsection 2.2. "Holzmaar lithology" where you provide information about the published lithology from old cores (Zolitscka 1998 a and b) as described in subsection 3.1. And (3) Subsection 2.3 "Previous Holzmaar chronology" which corresponds to the current su-subsection 2.3.1. Material and Methods would be Section 3 then.

- Line 152: please provide information of the length of the cores, how many parallel cores you collected, distance between them and the sediment depths they cover.
- Line 157: please say how many marker layers you have used for correlation
- I would say that Sub-subsection 2.3.2 "Transfer of VT-99 to HZM19" should be part of the results.
- Line 265-266. Reference is needed.

Results and Interpretation:

- It makes more sense to me that the lithozones are described as previous work (see my comment above re a new Section 2). Subsection 3.1 should focus on the correlation of the HZM 99 and HZM 19 composite profile and the transfer of the varve chronology (current subsection 2.3.2). It would be good to see in a figure the two composite profile, the stratigraphic position of the marker layers, radiocarbon dates, hiatus, etc and both the VT-99 varve age-depth profile and a ¹⁴C chronology.
- I would call subsection 3.2 "New chronological information" and make sub-subsection 3.2.3 and new subsection 3.3 "Age-depth modelling".
- Sub-subsection 3.2.4 and sub-subsection 3.2.5 should be subsection 3.5 and 3.4, respectively. Focussing on Method D only (I would delete Method B and C from the manuscript), first describe the improvements in dating and age uncertainty using the best Bayesian model (Method D) with respect to the varve chronology (VT-99) and radiocarbon chronology (Method A) (using the text in sub-subsection 3.2.5). Second, report new age estimates for the tephra layers. As these tephra layers, especially the LST, have been used for synchronising records and the estimation of the duration on the YD in different European sites (e.g Wulf et al., 2013), a revised age estimate with a reduced age uncertainty from HZM might be very useful.