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Interactive comment on “Miniature radiocarbon measurements (< 150 µg C) from sediments of Lake Åżabińskie, Poland: effect of precision and dating density on age-depth models” *by* Paul D. Zander et al.

Paul D. Zander et al.

paul.zander@giub.unibe.ch

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Response: Thank you for the helpful comments and suggestions to improve manuscript. We have responded to comments in the pdf of the manuscript (see supplement). Here we address the most important comments in more detail.

This paper intends to show that a chronology of a sequence is all the better constrained the more dates it contains. It also aims at showing that even on the basis of a very small sample and therefore with lower precision, a new ^{14}C dating is always better than no ^{14}C dating. These conclusions are intuitive for all of us, but this paper has the merit of demonstrating it. That's why I would recommend publication pending some improvements. Indeed, the paper fails to show that results are independent of the software (OxCal) used and of the way to consider the floating chronology. Clear description of differences between OxCal's models (V-Sequence, T_Sequence…) and the rationale behind the choice are also missing. This will be useful for all readers who are not familiar with OxCal. A test considering another chronological software (such as Bacon or BCal amongst others) should strengthen the demonstration. It is no clear to me why authors chose to work with constant uncertainties instead of real measurement uncertainties. These comments and others are gathered on the manuscript itself (provided as supplement thereafter).

We will revise the manuscript to expand on the description of the two OxCal sequences used (P-Sequence and V-Sequence) and the rationale behind those choices. We feel the OxCal V-sequence is the best available tool to integrate varve count data with radiocarbon ages into a single age estimate with uncertainty. We have considered other techniques could be used to assign calendar ages to the floating varve chronology. One could choose a dated level within the core and tie the varve count to the radiocarbon based age at this level. A disadvantage of this technique is the assumption that the tie point age is correct (not subject to contamination or depositional lag). Additionally, when considering the uncertainty of the tie point age and the varve count uncertainty, the varve chronology would have very large errors (Figure ECR1). Another considered method is to use least squares minimization to fit the floating varve count to all of the radiocarbon ages. This technique yields very similar results to the OxCal V-sequence, verifying that the best-age estimate result is not dependent on the choice of statistical routine. Figure ECR1 will be added to the manuscript to more clearly show how the varve counts relate to the ^{14}C ages and the V-sequence best age-estimate. The OxCal V-sequence is preferable to other techniques because all uncertainties are incorporated into the statistical model, and it allows for the possibility that master varve count *may include errors (within the counting uncertainty).*

Regarding the choice of age-modelling software, we expect that the key conclusions and results of the study are not dependent on the chronological software. Each modelling software may yield slightly different results (or even the same software can easily yield different results if one uses different parameters). However, the general patterns that are essential to the conclusions of the paper (e.g. more ages yield better age models) are expected to hold true for any widely used Bayesian age-depth modelling routine. To demonstrate that our results are not dependent on the use of OxCal, we created age-depth models using Bacon (Blaauw and Christen, 2018) for one iteration of the simulated radiocarbon dating scenarios. We set the acc.rate=8 (average accumulation time through the section) and thickness = 5 cm, all other parameters were the default setting. The results from the Bacon models are highly similar to the models produced using the same ages in OxCal. See Figures below.

Finally, the comment about using measurement uncertainties rather than a constant age uncertainty in ^{14}C years BP is well taken. We chose to work with a constant uncertainty for simplicity, and because over the period of our studied section (2.1-6.8 ka), the effect of age on uncertainty is relatively small. However, we recognize that the effect of sample age on the uncertainty is important, and should be mentioned in the manuscript. In the revised version of the manuscript we will clarify and emphasize that not only mass affects radiocarbon age uncertainties, but also the age of the sample. We will also include information about our measurement uncertainties in F^{14}C. We have modified Figure 1 to include 2 versions of the plot- one with uncertainty in years, and one with uncertainty in F^{14}C. Through this figure readers can see expected uncertainty in years (for samples ranging in age from 2000-7000 cal BP), which is more intuitive for readers who are not accustomed to working with F^{14}C values. Additionally, the more widely applicable F^{14}C values are also given for radiocarbon experts or those working on older samples.

Figure Captions:

Figure ECR1: All radiocarbon ages and their 95% calibrated uncertainties plotted versus the varve count. The gray bands show the varve count tied to the combined calibrated age of the uppermost ^{14}C ages (at 732.5 cm) with dark grey indicating the uncertainty calculated from the three replicated varve counts and light gray representing the uncertainty of the tie point. Dashed green is the varve count fit to the ^{14}C ages using least squares minimization of the offset between the varve age and the calibrated combined ^{14}C ages at each sampled depth.

Figure ECR2: Revised Figure 1 from submitted manuscript to demonstrate the relationship between sample mass C and age uncertainty in in terms of years and F^{14}C.

Figure ECR3: OxCal age-depth models of simulated ages (iteration 2).

Figure ECR4: Bacon age-depth models of simulated ages (iteration 2).

Figure ECR5: Same as Figure 5 in the submitted manuscript, with overlay of results from Bacon models using the synthetic ages from one single iteration (plotted as red squares). The OxCal results from the same iteration of synthetic ages are plotted as red circles. We propose to include this as a supplemental figure attached to the manuscript to demonstrate that the results are not dependent on the choice of software.

References:

Blaauw, M. and Christen, J. A.: rbacon: Age-Depth Modelling using Bayesian Statistics. R package version 2.3.4. https://CRAN.R-project.org/package=rbacon, , 1–14, 2018.

See supplement for comments on text.

Please also note the supplement to this comment:
https://www.geochronology-discuss.net/gchron-2019-19/gchron-2019-19-AC2-supplement.pdf

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Interactive comment on Geochronology Discuss., https://doi.org/10.5194/gchron-2019-19,

2019.

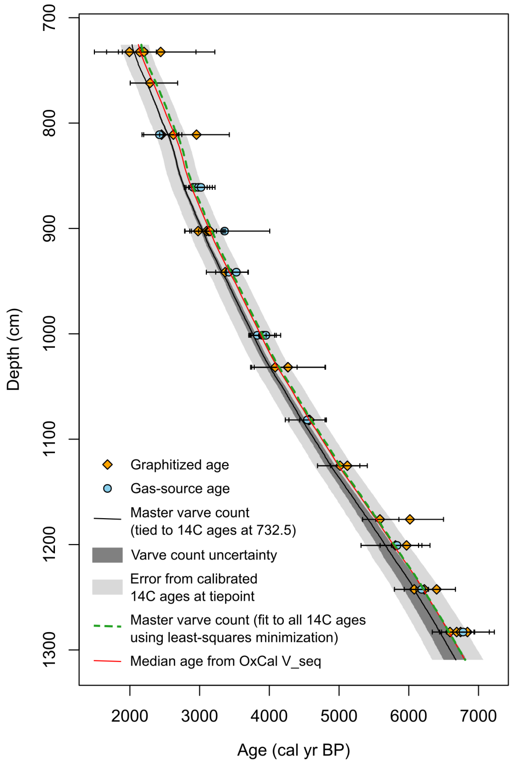

Fig. 1. Figure ECR1

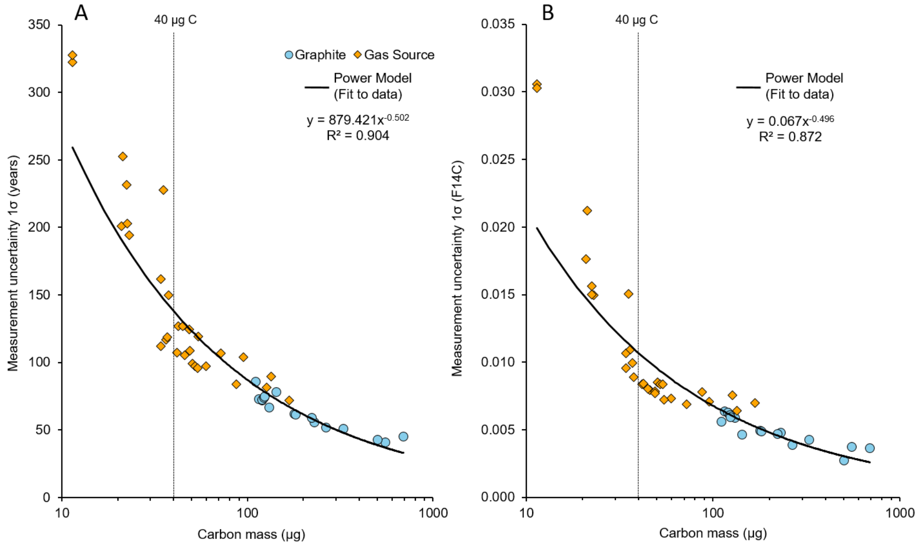

Fig. 2. Figure ECR2

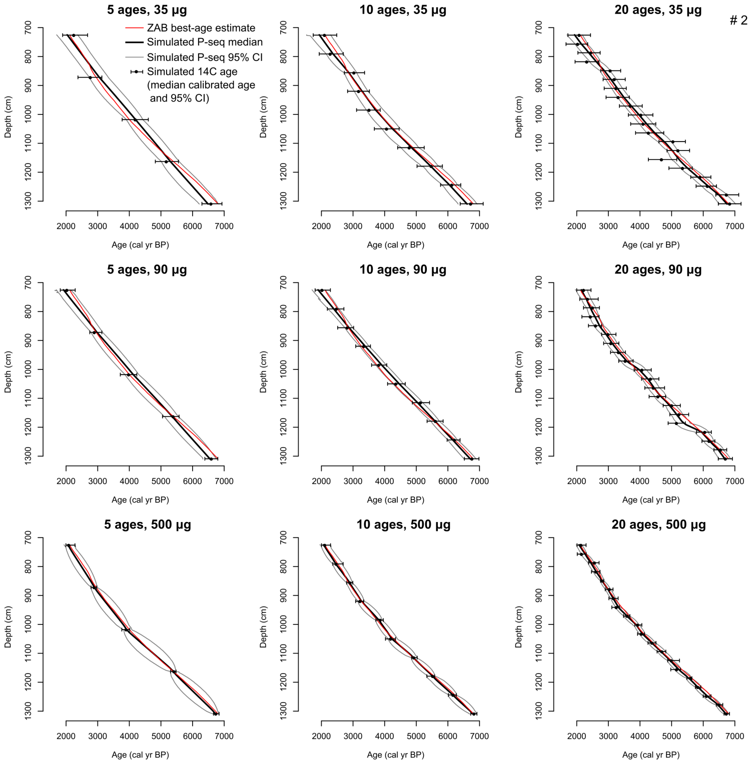

Fig. 3. Figure ECR3

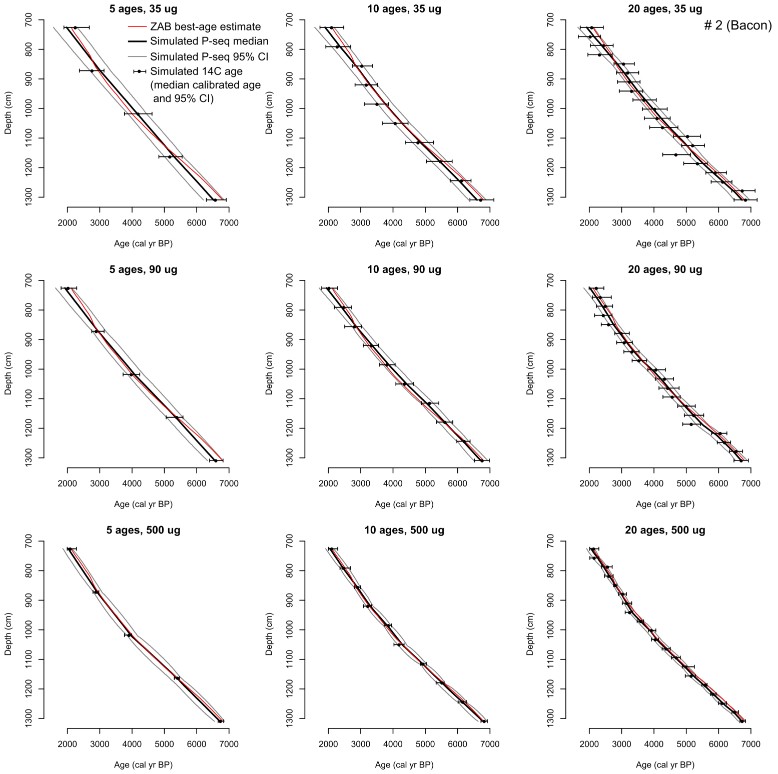

Fig. 4. Figure ECR4

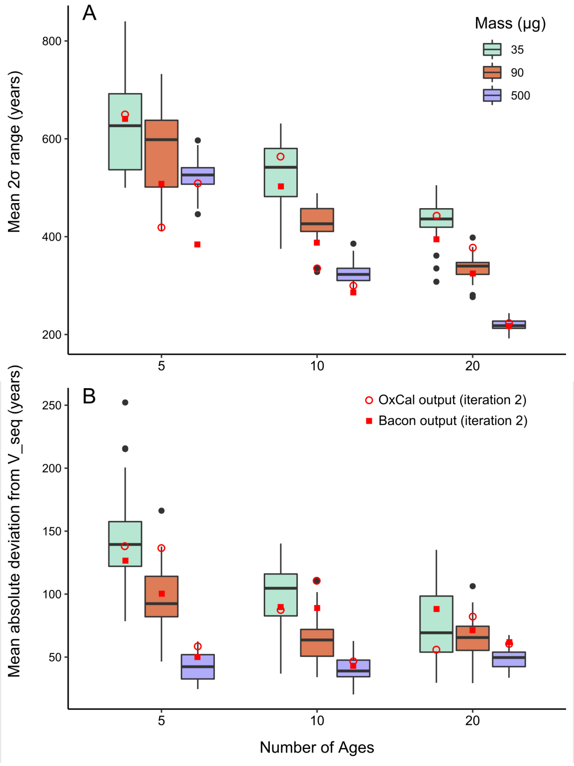

Fig. 5. Figure ECR5