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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.

Anonymous Referee #1

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SUMMARY The manuscript describes the results of a case study in which radiocarbon ages obtained using gas-source technique are compared with radiocarbon ages of the conventional graphitized samples; both types of samples come from a number of selected depth intervals in a lake sediment core. Because this core supposedly has a relatively well resolved varve-based chronology (albeit floating and not shown in this manuscript), the authors integrate varve counts and two types of radiocarbon ages into a simulated 'best age estimate' model. They further demonstrate a series of exercises in generating the synthetic age-depth distributions with a purpose of illustrating the

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effect of sampling density and sample size (mass carbon) on age model precision. According to the authors, the main idea of the work is an evaluation of how reliable gas source radiocarbon ages on miniature samples are for constructing age models. This is important for those lake records which lack enough datable material for the conventional radiocarbon analyses. The implications highlighted by the authors include (a) how to "improve sampling strategies" (the more age determinations the better, just as one may expect); and (b) what are the "expectations of age uncertainty". Among the benefits of skipping the graphitization step when using gas-source technique the authors cite "reduced cost", but there is no comparison provided for the respective costs for the two types of the techniques used.

NOTES The manuscript leans excessively toward theoretical evaluations of 'how things would be if...' and misses a discussion of several key points, which are named but not explored: depositional lags, outlier dates, examples of sample size effect on the radiocarbon date uncertainty as applied to a real core. This happens because the authors chose to (a) treat all their dates as equally good/likely; (b) use the 'best age estimate' for the sequence using everything at once, that is, they combined 3 varve count series + miniature+ regular + graphitized + gas source radiocarbon dates to make a single 'best age estimate'. No wonder there are no outliers if all these things are bundled together. As a reader, going from the Introduction to Discussion I expected to see the Figures showing step by step how overlapping varve-based chronologies look like first and how their cumulative error changes with depth, then how a certain number of graphitized regular ages help improving these chronologies and errors, and then how adding gas-source ages on the regular-size samples improves this chronology further, and then how adding gas-source ages on the less reliable miniature samples may or may not improve it even further. Instead, I see a single red line as 'best age estimate' from the very start and then 9 software-generated arbitrary age-depth scenarios. One does not need a sediment core to generate these latter graphs. Depositional lags for organic fragments are discussed in a purely theoretical way. There appear to be three different varve chronologies, why not show each one of them and see which dates support which one (if any)? A test for potential age outliers would be more robust in this case. Supposedly, as admitted by the authors, the younger the portion of the studied sequence, the more robust is the varve-based chronology. Why not take advantage of this and have a closer look at the potential depositional lags in the most reliable upper portion of the record? What if the varve-only age models were used to compare with gas only and/or graphite only ages? The importance of mass for the reliability of the dates is stressed a number of times by the authors, but their Figures are not informative enough to illustrate this. For example, when discussing age offsets, why not show symbols of different size somehow proportionate to sample mass in Figure 3 and provide respective error bars for each of the dating points? If the sample mass is so important for the age date and bigger is definitely better (as shown in Fig.1), then is it really a good approach to consider all the dates equal in constructing the 'best age estimate'? If the authors found room for nine simulated graphs in the manuscript, I think it would be beneficial to see two-three age-depth graphs using best dates, small-sample dates, and then all dates for comparison. The section 4.4 "Recommendations..." is a disappointment as it states a number of trivial basic things about radiocarbon dating, which can be found anywhere and which are not supported by the data the authors present. For example: "we are convinced... that miniature samples... are better than bulk" – convinced based on what? There is no data presented to support this level of certainty. Indeed, it would have been a really nice test if they were to analyze at least couple bulk samples from the same horizons to see how they compare with those on sieved fragments. "Dating small amounts... is preferable to pooling ...", "a rule of thumb is..." – again, there are no data in the paper supporting this conclusion. It appears that these didactic statements are pasted from elsewhere. "If ages do not agree well ... youngest ae is most likely to be correct" - what about applying this principle to their own data set and showing how it works out in their studied portion of the lake record? It appears that in the paper the authors cite, Bonk et al. (2015) did just that and identified a number of outliers. Finally, the argument of 'cost reduction' for gas-source ages as compared to graphitized samples is used a

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number of times in the manuscript. Indeed, costs are lab-specific, however, it would be of interest to have at least some estimate in % since the authors repeatedly bring this issue up themselves. I suggest substantial revisions, not “major” but at the same time not “minor” or technical either.

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