

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2020-401

Anonymous Referee #2

Referee comment on "ShellChron 0.4.0: a new tool for constructing chronologies in accretionary carbonate archives from stable oxygen isotope profiles" by Niels J. de Winter, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2020-401-RC2>, 2021

The paper presents the details of ShellChron, an R package that calculates the inner chronology of seasonally resolved oxygen isotopic records such as those obtained from corals, mollusks or some speleothems. ShellChron does so by calculating a $d_{18}O$ curve combining an assumed sinusoidal temperature curve, a quasi-sinusoidal growth curve, and a paleo-temperature equation, fit onto the $d_{18}O$ record in moving windows. The performance of the model is evaluated using synthetic and real records.

While I acknowledge the importance of the inner chronology issue in the study of seasonal scale processes from paleoclimate records, ShellChron seems like a heavy oversophisticated solution (several hours of calculations per depth-age model) with no clear advantage compared to simple techniques like matching the $d_{18}O$ record with local temperature curve or a simple linear interpolation between seasonal isotopic extrema used as anchor points. The author interprets too positively the test results. In my view, the tests indicate low performance in terms of dating precision despite the high quality of the records (synthetic or real), which questions the usefulness of the whole package.

- It is said in the text that a seasonally varying water $d_{18}O$ curve can be included but it is not clear how to do so in practice.

- A sinusoidal temperature curve is not a valid assumption in many tropical sites where the temperature annual cycle is bimodal. The growth curve is also a strong a priori assumption that cannot be tested. Growth parameters often evolves through ontogeny. Uncertainties estimated by the model do not include the uncertainty related to these assumptions.

- It is finally unclear whether ShellChron requires annual marker to be defined or not. While the text says it is not required (can be used with archives without annual markers),

Figure 2 suggests otherwise, and it is not clear how the moving window size is determined if annual markers are not provided. If annual markers are provided, how is the uncertainty of this date dealt with?

- Figure 1 should be more explicit about input data and output data.

- Figure 2: "simulated parameters" should be defined more explicitly.

- Tests are performed with very high resolution records (>23 datapoints per year), while the resolution in seasonally resolved records is generally limited to 10-12 datapoints per year for cost optimization reasons. The model should be tested with lower resolution records, in accord with real paleoclimate practice.

- Case 1 is almost an ideal case. Surprisingly, the standard deviation of the chronology is more than a month. It seems that a simple linear interpolation would yield a better precision.

- Testing with case 1 and Texel presented in Figure 3 shows that the model produced by ShellChron systematically underestimates the annual cycle amplitude (in contradiction with the text which says that there is no systematic seasonal bias). This is not necessarily a problem for the depth-age model, but this is not supposed to happen based on the calculation description and points to a potential issue in the code.

- The model is doing poorly with the Texel case. The author acknowledges that errors occur because of monthly scale variability, which is actually what happens in the real world. The chronology of the Texel case would be accurately obtained with seasonal anchor points and linear interpolation. I have not entered into the code but it seems that it needs to be improved.

- The author says in the text that the model can be used with speleothems, in contradiction with the testing which concludes that the performance is too low with the speleothem case.

- In the test with real-world records, the performance of the model is evaluated using chronologies reconstructed using simple fit and interpolation method, which seems like an implicit acknowledgement that these simple techniques are superior.