Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2017-44-RC1, 2017

Open Access Earth System Science Data Discussions

Interactive comment on "Speleothem stable isotope reference records for East-Central Europe – Resampling sedimentary proxy records to get evenly spaced time-series with spectral control" *by* I. G. Hatvani et al.

Anonymous Referee #1

Received and published: 30 August 2017

Dear Editor,

The manuscript 'Speleothem stable isotope reference records for East-Central Europe - Resampling sedimentary proxy records to get evenly spaced time-series with spectral control' by Hatvani et al. is pointing at an important aspect of palaeoclimate time series, namely, statistical analyses of un-evenly spaced time series. However, these statistical analyses often require evenly spaced time series. Therefore, in case of un-evenly palaeoclimate time series, various approached are used to equalize the temporal resolution of the palaeoclimate time series.

This manuscript illustrates on the base of published modern speleothems proxy (d18O and d13C) time series from two stalagmites how un-evenly spaced time series can be made evenly spaced to (in their case) an annual resolution using a cubic spline interpolation. Furthermore, the authors discuss the difference between the frequency spectrum (derived by REDFIT[1] and REDFIT-X[2]) of the un-evenly and evenly spaced speleothem proxy time series. From this comparison they derive a 'cut-off' period, the period at which the frequency spectrum of the un-evenly and evenly spaced speleothem proxy time series differs, and use this period to low-pass filter the (newly generated) evenly spaced speleothem proxy time series. This low-pass filtered evenly spaced speleothem proxy time series is than compared to modern meteorological time series such as temperature, precipitation and the index of the North Atlantic Oscillation using Wavelet transform coherency (WTC). Based on these WTC analysis they conclude that a NAO signature is imprinted in the speleothem proxy time series.

Although this study tackles a timely technical problem of palaeoclimate time series, the manuscript has several shortcomings, detailed listed in my general comments. Noteworthy is that similar ideas have been used/developed in other studies and this manuscript should state this. Before these general comments are not addressed I cannot recommend the publication of this manuscript. I also listed detailed comments after my general concerns.

General comments:

As stated in my comment to the editor, I think that this study is very timely, however, I miss a more general review of the palaeoclimate literature on this topic. What has been done so far and how does this study improve our knowledge compared to these studies. This includes on the one-hand palaeoclimate studies that have applied such approaches and on the other hand studies that discuss different smoothing/interpolation techniques. This speleothem-based study [3] is an example. They have used a very similar technique and approach as presented in this study, though there are some minor differences but the idea behind is the very same as for this study. But there are also

other techniques for sedimentary archives, such as from [4]. Furthermore, the authors should provide some more backups for using a cubic spline to fill gabs in an un-evenly spaced time series (e.g. [5] [6]).

What is the rational to use a cubic spline (or any other technique) for increasing (gab filling) the temporal resolution of time series, i.e., generation information? For the illustrated example, the used approach is probably fine for the youngest part of the speleothem proxy time series, with a very high temporal resolution, but the oldest part of the speleothem proxy time series, is much smaller compared to the youngest part. However, what is strikingly illustrated in Figure 1 of this manuscript is that the variability of younger part is much higher compared to the older part. Therefore, don't you assume that the higher variability in the younger part is noise? I think this approach needs a more rigorous test, whether it is adequately working or not by testing it with artificial time series using e.g. an AR-1 or AR-2 model. My suggestion is to generate an equally spaced time series (with known spectrum), which is than un-equally resampled n-times. Use these n un-equally spaced artificial time series to test your approach. Ideally you use different kinds of artificial time series to test your approach, e.g. AR-1, AR-2. For the WTC analysis you may consider to use an artificial time series, which is forced by the observed NAO index – add some noise or regional factors such as temperature – and test your approach again, this time including the WTC. I think these steps are necessary to really quantify the quality of your approach, but also to add new results to this topic (see comment on literature).

Comments:

Line 33: Please change the statement on the dating. The advantage of speleothems is, that they can be precisely dated by speleothems. My suggestion is: they can be precisely dated by U-series techniques (e.g. U-Th) Line 34: I would suggest rewriting part on multiple proxies. My suggestion is: they provide multiple independent proxy that are suitable to reconstruct past climate conditions. Line 36: Fairchild and Baker is not review article but a book. My suggestion is to change review to overview. Line

37-39: Please rephrase and split this sentence; it is quite complex and not very reader friendly. What does 'composition' mean here? I would also suggest to use 'determine' instead of 'govern'. Line 39-40: I think you have to distinguish between different proxies in this sentence. From what we know about proxies some are really modified by global processes (e.g. d18O) but others are clearly locally controlled, such as trace elements (TEs). Line 44: I would change 'behaviour' to 'dynamics' or 'climate'. Line 44-45: You don't really get information on speleothem formation processes by cave monitoring but information on speleothem formation. I would suggest to delete processes here. Line 46-48: I think you have to be more specific here, when you refer to seasonality. Readers may not be familiar with cave monitoring and to cave parameter to which you refer seasonality (I think). E.g. seasonality of cave air temperature or wind. Line 56-58: You need to rephrase and improve the English of his sentence. Be more specific on the moving average and what it means for TIME series. Line 60: Delete the 'and' between 'statistical' AND 'time series', because it does not make sense at the moment. You refer to statistical time series analysis. Line 66: I think you should add that these 'common' statistical tools can only be used for evenly spaced time series. Line 66: You should add 'unevenly spaced' before sedimentary records. Line 67: There is 'by' missing. BY using. Line 67: include 'techniques' after non-linear. Line 68: What are 'insufficiently documented methods'? Can you be more specific? Line 72: Where is Baradla Cave located? Line 71-73: This is a very long sentence and I would suggest to split and rephrase it. Line 75: include 'packages' after software. Line 78-79: This last sentence makes no sense in the context of the previous sentence. Line 83: I think it is helpful for the reader to give a short rationale why these two stalagmites were used compared to the other two of the same caves, e.g., from the summary/conclusion of the original study [7]. Line 87-90: How are the age models constructed of these two stalagmites? How large are the age uncertainties? Is it reasonable, based on the age uncertainties' to merge them? Line 90: I think you should use a different symbol for the merged record than Δ, which is used for clumped isotopes and for differences between time series for example. It is okay to use δ here. Line 93: You can delete 'totals'. Line 152-

153: Why do you low-pass filter your data? This is in principle not necessary if you use WTC, because you can neglect any observed coherence (if any) below your threshold frequency. In this case you do not alter the meteorological observations and your interpolated time series and reduces further uncertainties. Line 165: I suppose you mean “In THIS study” not “In the study”. Line 167-168: The fact that other speleothem studies have used the Morlet mother wavelet is no argument. I suggest to delete this part of the sentence. Line 171: What is a “positive signal”? I suggest to rephrase this sentence; be more specific.

Line 174-176: This is a very nice approach, but it needs a more detailed explanation. Maybe show some results and draw the steps you perform until you find the final result. Line 184-186: How about the small periods? There is quite a difference between the original and interpolated time series between 32 and 64 years. Line 188: What is the rational to determine the threshold exactly at 4.5 years? Line 197-198: What is the rational to determine the threshold exactly at 7.5 years? Line 203-205: See my comment on line 152-153. Line 226: What are the primary climate parameters? Although it is stated in Figure 4, please include it in this sentence. Why not write “precipitation and temperature” instead of “primary climate parameters”? Line 226-229: Apart from Kaiser (2001), Lachniet (2009) and Dansgaard (1964) generally explain global phenomena. Is this also the case for local precipitation d18O values? Line 239-241: Are there references for this statement? Line 241-243: What is your definition of “strong”? Does it refer to the Wavelet power or the length of the period during which you observe a significant coherence. However, the coherence between the two NAOi and the interpolated d18O time series is low apart from a 10 year long period in the beginning of the 20th century. Line 244-245: Please state clearly which years you mean or identify these years in Figure 5. Line 252-253: Please state a reference for this or cite Kaiser earlier in the paper. Line 266: Can you show the results of the redfit-x analyses in an additional figure in the supplementary information. Line 269-270: See my comments on low-pass filtering. Line 271: The relationship of what? d18O or d13C? Where are the results of this comparison?

Figure captions:

Figure 3: Please include a detailed description of the arrows. When is the signal in-phase, pointing right? Left? Figure 5: Can you rescale the time axis (figure) of panel b that the time on panel a and b can be compared. This makes it easier for reader to compare the coherence between the two different NAOi and the interpolated d18O time series.

References: 1. Schulz, M. and M. Mudelsee, REDFIT: Estimating red-noise spectra directly from unevenly spaced paleoclimatic time series. Computers & Geosciences, 2002. 28(3): p. 421-426. 2. Ólafsdóttir, K.B., M. Schulz, and M. Mudelsee, REDFIT-X: Cross-spectral analysis of unevenly spaced paleoclimate time series. Computers & Geosciences, 2016. 91: p. 11-18. 3. Cosford, J., et al., East Asian monsoon variability since the Mid-Holocene recorded in a high-resolution, absolute-dated aragonite speleothem from eastern China. Earth and Planetary Science Letters, 2008. 275(3): p. 296-307. 4. Lisiecki, L.E. and P.A. Lisiecki, Application of dynamic programming to the correlation of paleoclimate records. Paleoceanography, 2002. 17(4). 5. Musial, J.P., M.M. Verstraete, and N. Gobron, Comparing the effectiveness of recent algorithms to fill and smooth incomplete and noisy time series. Atmospheric chemistry and physics, 2011. 11(15): p. 7905-7923. 6. Hocke, K. and N. Kämpfer, Gap filling and noise reduction of unevenly sampled data by means of the Lomb-Scargle periodogram. Atmospheric Chemistry and Physics, 2009. 9(12): p. 4197-4206. 7. Demény, A., et al., Recently forming stalagmites from the Baradla Cave and their suitability assessment for climate–proxy relationships. Central European Geology, 2017. 60(1): p. 1-34.

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-44, 2017.