The answers to the questions of Reviewer #2

General Comments

How to deal with uneven time-series is an important issue in paleoclimate which has been previously addressed. However, the authors fail to do a more extensive comparison between their approach and other already used techniques.

Thank you for the comment. A highly relevant paper (Cosford et al., 2008) dealing with interpolation and spectral analysis of multiple E Asian stalagmites' $\delta^{18}O$ has been incorporated to lines 64-69 as: "A more complex approach combining spline smoothing and linear interpolation was presented in a multi paleoproxy study, where in addition the spectral characteristics of the data were assessed using multiple methods as well (Cosford et al., 2008). However, any transformation which adds data to or removes it from the original record unavoidably changes its spectral characteristics. This is a factor, which can easily be overlooked even in advanced studies, although, it must deserve high attention."

In the last sentence we implicitly refer to the study of Cosford et al. (2008) who only used the Nyquist frequency of the data to determine a cut-off period. On the contrary the procedure in the present paper considers the spectrum specific characteristic when determining a cut-off frequency.

Moreover, the text regarding the benefits and drawbacks of spline interpolation has been thoroughly extended as well and it is now briefly compared to linear interpolation, the Lomb-Scargle Reconstruction method and the Kondrashov and Ghil technique based on the following papers:

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.

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.

Kondrashov, D. and Ghil, M.: Spatio-temporal filling of missing points in geophysical data sets, Nonlin. Processes Geophys., 13, 151-159, doi: 10.5194/npg-13-151-2006, 2006.

The length of the manuscript used to interpret what were supposed to be only examples of the technique is, from my point of view, losing the focus of the main objective: providing a technique to deal with uneven time-series (see main aim of the paper in L71-73).

Accepted, thus Section 4 has been removed from the MS.

The authors are omitting some fundamental issues of speleothem growth by not including a proper discussion on how the water storage time in the karst may yield an auto-correlated isotopic time-series. This becomes important when interpreting the speleo record in terms of climate variables if the storage component in the aquifer is larger than

the cut-off period numerically chosen from the Lomb-Scargle Fourier Transform periodogram.
Thank you for the comment. The original signal should not be expected to be free from autocorrelation, which is amplified by water storage. It has been incorporated into Section 3.1. However, this does not question the introduction of the cut-off period to remove the artefact signals caused by interpolation techniques.

Moreover the introduction has been extended with a text referring to the infiltration dynamics of the Baradla Cave system above the samples in lines 86-92 as: "Thus, the best-match was obtained by shifting the NU2 and VK1 records by 3- and 5yrs respectively (Demény et al., 2017), supporting the synchronization of the individual isotope records. The good match of the isotopic peaks and the similar δ13C (Fig. 1a) and δ18O (Fig. 1b) amplitudes both argue for comparable water storage time in the feeding karstwater system. Based on lamina counting the chronological error at the base of VK1 is estimated to be between 3-5 yrs, however the perfect match (for δ13C see Fig. 1a and for δ18O see Fig. 1b;)) suggests the chronological difference to be much smaller. Moreover, the stable isotope records of the two stalagmites complement one-another by filling the hiatuses (Fig. 1a)."

In addition to this, interpreting paleoclimate records only in terms of spectra analysis is complex if the physical mechanisms at such periodicities is not properly reviewed. For example, how do the authors know that the anti-phase coherence shown in Figure 3 (top panel) for a specific frequency band is related to biological soil activity (L207-209) and not to another controlling factor?
Thank you for the suggestion, the sentence has been rephrased in line 239 and additional factors considered are discussed in the following sentences.

Similarly, how do the authors know that changes in the moisture source are the dominant controlling factor in that specific frequency band, as suggested in L252-253? More discussion on this would make the whole Section 3 more robust.
Thank you for the suggestion, the paragraph in question has been rephrased in lines 273-278.

The authors do not use single speleothem records but a composite record. When using composites, the temporal and proxy uncertainties increase, but these are not being dealt with in the manuscript. In addition, isotopic records from individual speleothems from the same cave may vary quite a lot depending on the groundwater history within the aquifer that eventually reaches each of the drip sites. I assume that this was mentioned in previous research but I suggest that if the authors want to use this composite record more information is provided.
Accepted and corrected. Section 2.1 has been thoroughly extended with a discussion on the similarities of the two speleothems (NU2 & VK1) the composite was derived from, regarding the most important aspects: age model construction and synchronization; see lines (80-92). This was mainly extracted and summarized from Demény et al. (2017). Moreover, new figures has been added as panels A and B to Fig. 1 showing the complementary characteristics of the stable isotope records of the two speleothems.

However, my suggestion would be to analyse both records separately and then compare it to the composite. This alternative approach would highlight potential discrepancies between the records and would make the study more robust.
I wonder if the composite uncertainties have an effect on the periodogram used to decide the appropriate cut-off period if they are considered with an iterative approach. Do significant peaks remain significant? How do these uncertainties affect the spectra analysis of the records when it comes to interpreting in terms of climate variables? This could be also argued for a single speleothem record, as all proxy records have dating and measurement uncertainties.

Thank you for the suggestion, due to the short time period covered by the VK1 speleothem (44 data points), the comparison of the rLSPs of the composite and the standalone records was only done using the NU2 stable isotope data (122 data points). The oxygen and carbon NU2 stable isotope records were processed the same way as the composite in the MS (spline interpolation, calculation of annual averages, spectral analysis). Moreover, the rLSPs of the original gappy NU2 stable isotope time series were estimated as well, to compare the rLSPs of both the interpolated and the raw data.
It was found that in the case of both oxygen (Fig. R3) and carbon (Fig. R4) stable isotope records in the period domain above the cut-off threshold

(i) the rLSPs of the raw and the interpolated NU2 stable isotope data show a similar pattern, i.e. the significant peaks are almost identical, especially in the period domain;
(ii) the significant periods in the composite's spectrum mirror the peaks in the original data's spectrum.

In addition, we can conclude that

(i) the composite record allowed to extend the spectral coverage to a period domain lower than the NU2 record by itself, because the two records complemented each other by filling their hiatuses (please see new Fig. 1a and the answer to your previous comment), thus ameliorating the sampling resolution.
(ii) the cut-off period determined for the composite record has proven to be accurate for the NU2 record as well, since it coherently captured the threshold below which discrepancies arose between the rLSPs of the NU2 record's interpolated and original raw data
(iii) merging replicated signals and the most definitely uncorrelated noise of multiple (in this case 2) proxies in a composite, is generally expected to improve the signal to noise ratio.

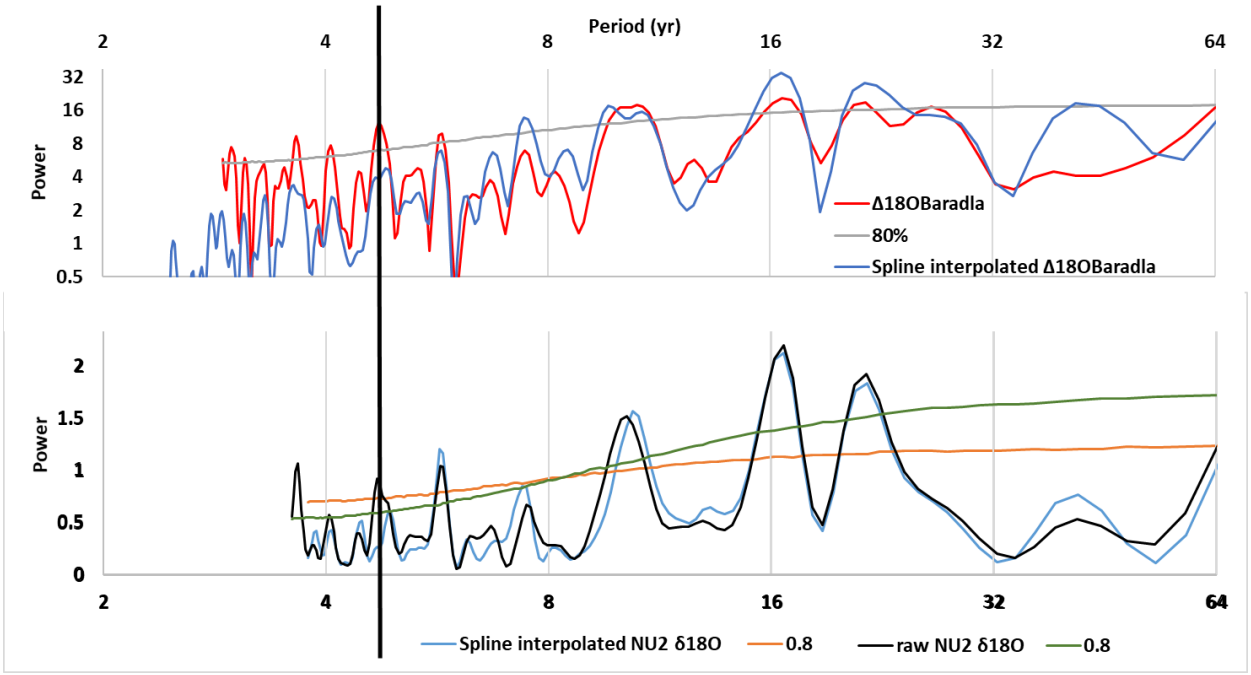

Fig. R3: rLSPs of the original, and the spline interpolated $\Delta^{18}O_{Baradla}$ record of the Baradla speleothem (upper panel), and the original raw and the spline interpolated $\delta^{18}O$ record of the NU2 speleothem (lower panel). The bias-corrected 80% chi-squared limit of a fitted AR(1) process for the rLSPs is shown in grey, orange and green for the $\Delta^{18}O_{Baradla}$, the spline interpolated and the raw $\delta^{18}O$ record of the NU2 speleothem respectively. The vertical black line indicates the determined cut-off period.

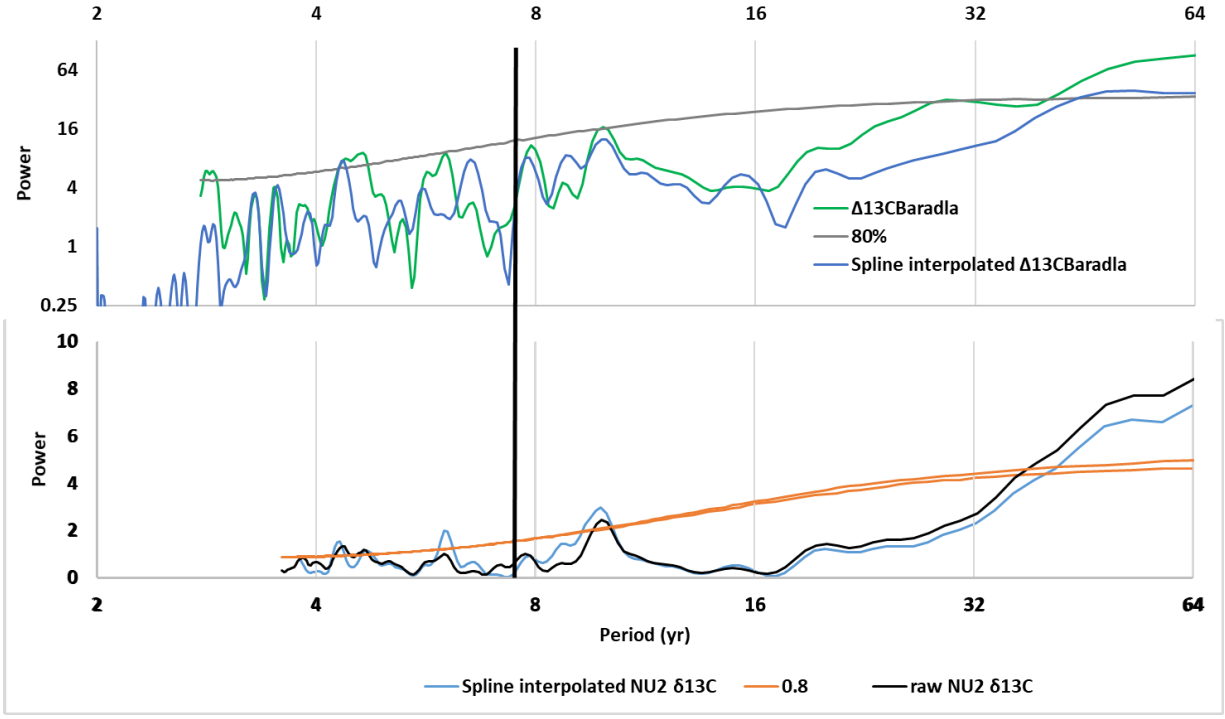

Fig. R4: rLSPs of the original, and the spline interpolated $\Delta^{13}C_{Baradla}$ record of the Baradla speleothem (upper panel), and the original raw and the spline interpolated $\delta^{13}C$

record of the NU2 speleothem (lower panel). The bias-corrected 80% chi-squared limit of a fitted AR(1) process for the rLSPs is shown in grey and orange for the $\Delta^{13}C_{Baradla}$, and the $\delta^{13}C$ record of the NU2 speleothem respectively. The vertical black line indicates the determined cut-off period.

I do not see any benefit in including the speleothems from Belgium in this study. They are just another example and they're only mentioned in the 25 lines of the discussion section, just before the conclusions. I suggest the authors either omit these records or discuss them more extensively.
Accepted, thus Section 4 has been removed from the MS.

Minor comments
L34: The temporal resolution of the speleothem proxy record will depend on the karst processes at play at that particular drip site. This can hugely vary from sub-annual to centennial resolution and therefore, it is not always possible to obtain a highly resolved temporal record. Regarding the "high spatial resolution"? I'd suggest that "they are well distributed worldwide" instead.
We only said, that they can be sampled at high spatial and temporal resolution, but the sentence in question has been rephrased and extended as "…(iii) can be sampled at high spatial and temporal resolution depending on the growth rate of the speleothem, (iv) are well distributed worldwide, and (v) …" in lines 30-33

Would it be possible to know what are the benefits of using a cubic spline in contrast to other interpolation methods?
The Reviewer is referred to our answer given to her first general comment.

L52: I don't understand the concept of "reference records". Why are these records considered to be a reference for their regions? This manuscript does not compare several series from the same region, so I think the usage of this term can become misleading. L52-53: An additional criteria to select "reference records" according to the authors, should be the overlap with meteo data (you could find accurately dated records close to annual that do not overlap with meteorological instrumental data).
The paragraph in question has been rephrased and the problematic sentence removed.

L86: There is no need to include the definition of delta here.
Accepted and corrected, the definition has been removed and a short reference has been inserted into line 96 about how the isotope compositions are expressed.

L92: "see section 2.1". That sentence is already part of section 2.1!
The typo has been corrected.

L106-109: It doesn't really matter for the purpose of this manuscript but you can obtain a longer PC-based NAO index from the 20CRv2c dataset, which goes back to 1851 (https://www.esrl.noaa.gov/psd/data/20thC_Rean/)
Thank you for the comment.

L117-118: I would like to see the periodogram of the original record along with the one from the reconstructed signal early in the text. In contrast, Figure 1 does not provide much information (it is difficult to visually compare both panels). This is related to my comment below for L134.
The text has been rephrased in the corresponding line, because this was intended to be a general description. In addition the Figure, the Reviewer is specifically missing is Fig. 2 in the MS.

L244-245: Which period corresponds to a "strong negative NAO mode" and for which frequency-band is this evident?
The text has been extended in line 278 as "…(~1955 - ~1970; Fig. 5)…" and so signal can be detected in this time interval at any frequency.

L134: I would like to see a figure showing the significant powers of both series (original and reconstructed)
The Reviewer is referred to our answer given to her 6th General comment "However, my suggestion would be to analyse both records separately…", specifically to Figs. R3 & R4.

The use of "composition" when referring to a composite series is confusing (for example "precipitation-composition" relationship in L212. Also, in L37, the usage of "composition" seems to mean "proxy records". Please clarify.
Accepted and corrected in every necessary place

L226: ". . .with the primary climate parameters", these being?
Accepted and corrected, precipitation and temperature has been added to the sentence.

Fig 5 (and others): could you please mark the cut-off periods below which the spectral analyses are not significant?
The signal in those periods is not simply insignificant, but not present. These are now marked with dots on the relevant figures.