

Interactive comment on “Reconstructing seasonality through stable isotope and trace element analysis of the Proserpine stalagmite, Han-sur-Lesse Cave, Belgium: indications for climate-driven changes during the last 400 years” by Stef Vansteenberge et al.

Anonymous Referee #2

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The manuscript of Vansteenberge et al presents a number of geochemical analyses across three short time intervals from the well-studied Proserpine stalagmite core from Han-sur-Lesse cave, Belgium. The analyses are very high-resolution, multi-proxy, and high quality, and yield interesting insights into the climate particular to those intervals. The manuscript is very well-written and high-quality throughout, and I recommend publication following the authors' consideration of the following points.

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In particular, I suggest that the authors investigate ways of strengthening their discussion regarding the palaeoclimate implications of their results, which I think at the moment are too limited. An enhanced discussion of how intervals of high-resolution data derived from stalagmites can help understand climate further back in time (e.g., beyond the instrumental era) would help increase the impact of the research.

More details regarding the U-Th dating should be included in the main text, including a better description of how U-Th dating and layer counting were combined (line 161). I appreciate that this was done in previous publications and is in the SOM, but a short review (two or three sentences) outlining how layer counting and the U-Th were combined would be useful in the main text. Similarly, the U-Th-derived growth rate does not really feature, but it would be useful to compare to the presumed annual cycle wavelengths; they should be broadly similar (e.g., near lines 271-272).

I think that there must be a better way of referring to the time intervals other than the 'P16, P17, and P19'. I did not see any reason stated for why the intervals are named this, and I assume there must also be other intervals (e.g., 'P18') that also exist (maybe as slabs or pencils? Although Fig S5 doesn't imply this) but are not discussed. It almost seems that the number is linked to the century of growth, but of course this doesn't quite work ('P16' is partly in the 16th Century, 'P17' is in the 17th Century, but 'P19' is in the 20th Century). Perhaps simply changing 'P19' to 'P20' and stating that the number corresponds broadly to the century C.E. might help. I suspect that the numbers represent a label of some sort, in which case the authors may not want to change these for bookkeeping reasons. In which case, I suggest that i) somewhere on lines 75-77 it would be useful to explain why the intervals are given these labels, and ii) it might also be useful to occasionally remind the reader what these labels refer to. If changing the labels isn't possible, this will help reader keep track of the time intervals represented.

The authors should consider a plot similar to the one that they refer to from Jamieson et al., 2016 (lines 451-455). The approach used in Jamieson et al.'s Figure 6 could

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really help to differentiate some of the processes particular to the three intervals discussed here. Perhaps carbon isotopes versus Mg would yield interesting insights into the different seasonal cycles inherent to the three intervals. The composite monthly geochemical proxy values shown in Figs 6 and 7 could be plotted as X and Y-axes, with the months labelled for all three intervals.

I am surprised that P does not show an annual cycle. Although the explanation suggested in lines 321-323 is certainly possible (albeit vague), it is still surprising that with a clear 'autumnal flush' of soil-derived material that P should remain unaffected. Is it possible that there are some P cycles, but that these are discontinuous so that the FFT results suggest that there are no annual cycles? Adding P to Figure 5 could help the reader can evaluate this.

Technical points: Line 15: The stalagmite does not have to be annually laminated to reconstruct monthly-scale climate. Rephrase, maybe emphasising the other benefits of annual laminations. 24: PCP will probably occur all the time, so best to say something like '...enhanced PCP occurs during...' 29: What is it in the trace element concentration profiles that reflects increased recharge? Increased specificity will help build your case early on. 36: What about other factors not discussed here? P and large organic acids in particular can depress calcite growth rates and influence partition coefficients, particularly for Sr. 42: Again, annual layering is not inherently linked to our ability to discern seasonality. Also, reconstructions can reach monthly- or even daily-scale using the right techniques, so this should be rephrased. 76: I'm sure that there is a good reason, but it would reduce confusion to explain why these intervals are called 'P16' etc. Are these the names of the stalagmite slabs or pencils? 126: I generally disagree with the requirement for stalagmites to necessarily be at isotopic equilibrium. They grow via kinetic processes so some kinetic fractionation is inevitable, and if there is more it usually enhances the primary climate signal. So I am not concerned if there are occasional intervals with more or less disequilibrium fractionation within the context of the current study. 144: 'number' instead of 'amount' 156: I seem to recall that a core

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from the same stalagmite contained petrographic evidence for a reduction in visitation to the cave during both world wars (Verheyden et al., 2006). I assume that this is the same core - is the chronology presented here still consistent with this interpretation? If so, it might be useful to state here because it would help confirm the chronology. 163: 'coupled to a Leica GZ6 microscope' 190: 'laser points'? 191: 'because' 193: elements are lowercase – here and throughout 239: 'mean' instead of 'average' here and in most other occurrences (other than when not referring to a statistical mean, e.g., 'the average cave is...' etc.) 271: How does this compare to the U-Th derived growth rate? 295: '...the Han-sur-Lesse Cave...' 457: Is deposition on the roof (i.e., on the stalactite) not enough? Is another void space really necessary? If there is a large stalactite over the Proserpine stalagmite, deposition on this might be enough to cause the observed PCP signal (I agree that it is PCP). 477: I agree with how the authors handle evapotranspiration, but I'd like them to consider the possibility that the concept isn't really relevant in highly karstified regions. If a summer month experiences an intense rain event, the rain may be channelled into a doline and into the subsurface before 'evapotranspiration' has a chance to really occur. If the Proserpine stalagmite is fed by a rapid drip with high variability, it is possible that the whole evapotranspiration concept does not apply. Hess and White (in the book "Karst Hydrology: Concepts from the Mammoth Cave area") suggest a 13% decrease in the relevance of evapotranspiration in karst regions, but I suspect it could be even more in certain situations. The authors approach is correct and is what is conventionally done, so if reducing the amount of summer evapotranspiration is useful they may want to consider this possibility – otherwise I'll leave it up to the authors whether or not they want to rephrase

Conclusions: As mentioned above, I think that it would be beneficial for the authors to conclude with a greater focus on the implications for climate science. It is impractical to perform an LA-ICPMS analysis across an entire meter long stalagmite. Does this research provide any guidance as to how short high-res intervals would be useful across very long records? I think that it does, and the authors should discuss this more than they currently do. 517: Couldn't cooler regional temp also explain the decrease in

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δ¹⁸O? Table 2 caption labelled as Table 1

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