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Interactive comment on "A Stalagmite Test of North Atlantic SST and Iberian Hydroclimate Linkages over the Last Two Glacial Cycles" *by* Rhawn F. Denniston et al.

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As is described below, we are currently in the process of obtaining additional information from the caves and the stalagmites described in this study. We are requesting from the editor additional time in order to fully address the comments made by each of the reviewers. Thus, our responses should be considered preliminary and incomplete versions of the detailed and developed discussion that will accompany a later revised draft of this manuscript.

1.- Chronology. The six speleothems used for this study are complicated samples in terms of growth axis (very variable along the samples), evidences of dissolution, minor

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and major hiatus, etc.). In fact, the growth of the six speleothems is very discontinuous and thus making difficult the detection of all the hiatus by U-Th dates. I see two possible ways of improving the chronologies that should be carried out by the authors. First, more dates are necessary in some stalagmites and, this time, analysing a higher amount of calcite would be desirable (I already pointed out this in my previous review. . . 50-150 mg for U-Th dating is insufficient with samples where U concentration is low as it happens here). Sampling a higher amount is possible and necessary to get more accurate dates. Errors of above 2000 years are common in Table 1 and I think they can be improved.

We are acquiring additional dates for select intervals using the larger sample sizes suggested here. These dates will be available in the next few weeks, at which time we will recalculate age models wherever appropriate.

Second, I suggest including some petrographic analyses (thin slides) to help on the identification of hiatus. I am not sure if the authors have done that study since it is not shown but comments on the textures and fabrics are made on 146-157 lines. A figure on this issue in the Supplementary material would be desirable.

We have relied primarily on the U-Th dates to construct the age model. Identifying hiatuses using thin section petrography would not necessarily allow a more accurate age model as the duration of the hiatus cannot be determined independently from the U-Th dates. We therefore feel that the in-depth petrographic analysis of these stalagmites is beyond the scope of this study.

Additionally, I would like to see a figure with all the age models together (an example is provided in Fohlmeister et al., 2012) to show the intervals that are really replicated.

We included age models for individual stalagmites, however this figure will be added to the Supplemental Material in the revised version.

The authors emphasized along the manuscript the good replication of this dataset and

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I cannot agree with that. They refer to Fig S2 many times to show replication in d13C records. . .. And in that figure it is evident that replication is really minimal (very short periods and not well reproduced patterns). The authors have to focus their interpretations where chronology was better assessed and replicated and be very cautious where the presence of hiatus was not so well replicated. In fact, sentences like "deposition of multiple stalagmites was punctuated by hiatuses of similar time spans. . ." (lines 181-184) should be avoided (they are not true) and need to be more concrete: I just see one interval where two stalagmites stop growing at the same time, at ca. 100 ka BP.

We did not intend to suggest that the starting and stopping points of each cessation in growth in one stalagmite coincided exactly with hiatuses identified in other stalagmites. Cave hydrology is sufficiently complex so as to make such an event unlikely. Instead, our intention was to note a broad overlap, often during periods of cold and/or dry climates. In the revised version, we will flesh out in detail the intervals of the hiatuses and their relationships to each other and to those in other regional stalagmite records.

Other example: "The reproducibility of carbon isotope ratios between coeval BG stalagmites argues that their d13C values may be viewed as an integrated time series not substantially impacted by inter-sample isotopic offsets" (lines 223-225).

We agree that the amount of overlap is not substantial, but were it occurs, similar d13C values are observed. We will more clearly show this with new figures in the manuscript.

There is also highlighted the coincidence with hiatus in S France and N Spain stalagmites (lines 291-296) and this is not always true (Figure 6).

As mentioned above, we will expand our discussion of the timing of hiatuses in the Portuguese and other regional records. We will note both the intervals when hiatuses do not agree, and also emphasize what we consider to be substantial similarities in the overall timing of hiatuses, particularly given the individual hydrologic characteristics and altitudes? of each cave, differences in regional climate, and the distance between

the cave sites.

2.- Present-day cave environment. To my knowledge, this is the first time paleoclimate records from these two caves are presented. Then, it should be mandatory to understand present-day processes that would help to interpret past records. For example, distinguishing if the correlation of hiatus is with cold or with dry events (or both) is important and must be supported by more present-day data.

As mentioned in our response to a comment by Reviewer 1, we are adding to the Supplemental Material maps of both caves. BG has never been mapped but we are currently working with an experienced team of cavers to create a map suitable for publication. A previously constructed map of GCL will be adapted for publication. More detail on the ages and isotopic compositions of the bedrock hosting each cave will be added, as will isotopic compositions of vegetation and soil organic carbon. In addition, we have recently (January 2018) visited both caves and collected additional environmental monitoring data (temperature, barometric pressure, humidity, and drip rates) acquired via data loggers over the past 1-3 years, and dripwater obtained over the recent months. These new cave monitoring data will be included in the revised manuscript. There have been two years of below average rainfall and drip rates have decreased accordingly during this interval. However, we have no means of examining dramatic reductions in ocean and atmospheric temperature, such as marked Heinrich stadials, would have impacted rainfall or infiltration at these cave sites. We further argue that – while necessary and helpful – modern conditions might not be of great help when investigating glacial-interglacial dynamics, because the last 100-150 years have been dramatically affected by anthropogenic factors (CO2 increase, aerosol emissions preferably in the NH, etc., e.g. Ridley et al. 2015, Nat Geosc.) so as to render extrapolations of modern correlations of above-cave and in-cave changes hardly comparable on such long perspectives.

The authors need to understand what is happening today regarding calcite precipitation in the cave. Does it happens the whole year or focused in the rainy season? Is it more

abundant during warmer years? In lines 238-239 it is said that “any seasonal biases in calcite crystallization remain poorly constrained”. Then, how can they link the data to NAO that is a winter process? I think that some interpretations will be better supported by more monitoring data.

Despite continued monitoring, many questions regarding seasonality of calcite deposition remain poorly constrained. We have just obtained plate-grown calcite from BG and are currently measuring its isotopic composition; these data will be included in the revision. We also agree with this reviewer (and Reviewer 4) that linking the Portuguese stalagmite record to the NAO is unnecessary given the scope of this study and we are minimizing this portion of the discussion in the manuscript. We note however, that the NAO influence can be of importance even in summertime (Ogi et al. 2003, GRL; Linderholm et al. 2009, J. Quat. Sci.) and that the question about NAO impact at BG needs careful assessment.

Besides, the switch of 2 per mil in the d13C record from sample CGL6 “for ease of comparison to SST” needs a justification in the text, not a simple note in the figure caption. I do not think such shift in measured values is justified at all without a deeper understanding of the cave environment (soil, host rock, etc).

It is conceivable that the one stalagmite from GCL was impacted by different vegetation over the cave or from secondary effects impacting dripwater. Carbon isotopic values can alter dramatically (several permil) if kinetics are involved (Mühlinghaus et al. 2007) and it is conceivable that drying could lead to a more open system, increased PCP and lower drip rates – all forcing higher d13C values. It is impossible to know what the soil or vegetation over either cave was like at 200 ka. However, the bedrock d13C values of both caves have been measured and this alone cannot account for the full offset with BG. We present the original (unshifted) values of this stalagmite on the same plot and only shift the d13C values in order to better match the SST trend. We therefore feel this is an appropriate means of presenting these data, but will include a more thorough discussion and justification in the revision.

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3. Representation of data. Finally, I also have some concerns on the representation of data versus age. In general, I find too “optimistic” sentences or interpretations in the text that are not always easy to seen in the figures. A good example is Figure 6 that is used to emphasize the excellent correspondence of d13C from the stalagmites with other records but the scale does not permit to see it!! Examples: how can we see the positive change during the YD (lines 299-300)? How can we see the hiatus at 80-78 ka (lines 292-293)? What about the “effective moisture from 170-160 ka and 145-135 ka? (lines 303-304). Figure 6 needs more ticks in the x-axis to follow the text and some dashed lines or bars to help the reader to find in the figure the events indicated in the text.

This is good point and Figure 6 will be modified as suggested. In addition, a new figure will be added to the manuscript that zooms in on these intervals to show the overlap.

Regarding representation of data, I also missed some other records that are cited and compared in the text several times, such as Villars cave or many other marine records. Fig. 8 where a zoom is shown for two different intervals would be the place to include those other records. If not, the reader has to go to previous references to compare visually other figures with this new dataset. For the YD, for example, there are many other records available.

We will modify this figure as suggested, and will also expand the scope of Figure 1 to include Villars Cave.

Additionally, I have not found in the text any explanation about the representation of pollen data. Is that a combination of records? A stack? How is it made? And regarding the representation of ice cores, why do not use the “real” ice core for the beginning of the record? The older part can be compared to the synthetic curve, but for the 0-125 ka I suggest to include NGRIP record.

The pollen data are indeed from multiple cores (as listed in Figure 6), but this point will be made more clear in the revision. Per the reviewer’s suggestion, original NGRIP data

will be used from 0-125 ka, while the synthetic Greenland record will be used for the remainder.

Minor remarks: - line 285 and line 293. Why Fig. 2?? This is certainly a mistake, I am afraid.

This change will be made.

- line 119-120: explain the correction you did using cave drip water

Approximately 2L of dripwater was collected over several months at BG from the drip that fed the stalagmites analyzed in this study. This water was analyzed for its 230Th/232Th ratio at the University of New Mexico Radiogenic Isotope Laboratory. A more detailed description of these methods will be included in the revision.

- Table S1.There are many reversals not explained in the text.

Including the error windows, there are two dates are stratigraphically reversed and these did not impact the age model. Nonetheless, additional dates are currently being obtained and a more detailed discussion of the U-Th dates will be included in the revised version of the text.

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