Clim. Past Discuss.,
https://doi.org/10.5194/cp-2020-78-RC2, 2020

Climate of the Past Discussions

Interactive comment on "A data-model approach to interpreting speleothem oxygen isotope records from monsoon regions on orbital timescales" *by* Sarah E. Parker et al.

Anonymous Referee #2

Received and published: 4 August 2020

This manuscript studies the speleothem oxygen isotope (δ18O) records in monsoon regions worldwide on orbital timescales by using the SISAL database along with the isotope-enabled climate model simulations. It is indeed an important approach which may gain new insights into speleothem δ18O interpretation via data-model comparison/statistical analyses. However, the current manuscript has several issues to clarify and/or improve before it can be considered for publishing in Climate in the Past.

Major comments:

(1) The introduction does not reflect the current understanding of the speleothem δ18O, particularly in the East Asian monsoon domain. For example, it basically follows the

previous misunderstanding(s) from modeling and other research communities, especially on orbital-scale, that the speleothem δ18O was interpreted as a rainfall amount proxy by the Chinese speleothem community over the past two decades. In fact, the mainstream idea form the speleothem community has never been the 'amount affect' (e.g., Cheng et al., 2019), and therefore, one of main scientific issues addressed here is groundless.

(2) The authors mentioned that "a composite record can minimize the influence of site-specific karst and cave processes" (with real spatial variations?). However, the results and/or assumptions from the PCoA method are tentative, which lacks a underlying mechanism. The same monsoon system (e.g., the ISM and EAM boxes in the figure 1) could have different speleothem δ18O patterns on orbital-scale, as illustrated by a number of modeling results (e.g., Liu et al., 2014; Battisti et al., 2014).

(3) Lines 66-68: This is really a misleading statement. I suggest that the authors should read the original papers they cited here more carefully (as well as Cheng et al., 2016, 2019; Zhang et al., 2018; Zhang et al., 2020) and quote the original statements in these papers if necessary. For example, Cheng et al. (2009) (cited in the sentence) clearly asserted: "Thus, neither the temperature- δ18O relationship, commonly used to interpret ice-core data, nor the interpretation based on the "amount effect" is justified".

(4) Lines 229-236 and figure 4: What are the simulated precipitation δ18O values in the EAM, ISM, IAM, SW-SAM domains? Are they amount-weighted annual mean precipitation δ18O values, annual mean precipitation δ18O values or only summer (MJJAS) mean precipitation δ18O values? In addition, please give the boundary coordinate of these monsoon regions (the EAM, ISM, IAM, SW-SAM...) for the calculations. Give a detail explanation about the δ18O amplitude differences between observation and model results in the figure 4 if significant.

(5) Lines 376-379: "...there is little different in the δ18O values between the MH and the LIG in the ISM and EAM regions...", "Given that the increase in summer insolation

is much larger during the LIG than the MH, this finding is again consistent with the idea that other factors play a role in modulating the monsoon response to insolation forcing". What are the other factors and the processes? Moisture source and/or pathway? Or some kind of thresholds (e.g., Cheng et al., 2012; Cai et al., 2015)? In addition, the summer insolation is indeed higher during the LIG than during the MH, but the monsoon circulation or intensity is influenced by the temperature (thus pressure?) gradient between land and sea as well. What is the difference of the land-sea temperature (pressure) gradients for the MH and the LIG periods? Or monsoon circulation scales? A more comprehensive discussion of the issue with a help of climate models would be very welcome.

(6) The main conclusion is that "East Asian monsoon speleothem δ18O evolution through the Holocene relates to changes in atmospheric circulation (i.e. changes in moisture pathway and/or source). Changes in precipitation amount are the predominant driver of Holocene δ18Ospel evolution in the Indian, southwestern South American and Indonesian-Australian monsoons, although changes in atmospheric circulation also contribute in the Indian and Indonesian-Australian monsoon regions and changes in precipitation recycling in southwestern South America". This conclusion is not well supported and problematic as well. First, the 'amount effect' discussed here is not the same 'amount effect' as conventionally defined in the tropics (see Zhao et al., 2019 for instance). The authors implies that the local rainfall amount drive the orbital-scale variations in speleothem δ18O value. They really need to provide a mechanism/calculation for the Indian, southwestern South American and Indonesian-Australian monsoon systems to explain how the oxygen isotopic fractionation under different conditions of rainfall amounts at each cave site could result in the observed δ18Ospel changes on orbital-scale without significant monsoon circulation (including the moisture pathway and/or source) changes. On the other hand, the "East Asian monsoon speleothem δ18O evolution through the Holocene relates to changes in atmospheric circulation" is just a reinforcement of the previous view on the East Asian monsoon evolution inferred by speleothem δ18O records published in a large number of speleothem works over

the past two decades. In short, it is the monsoon circulation that to first order drives the orbital δ18Ospel changes, not only for the East Asian monsoon, but also (most likely) for other monsoon systems.

(7) Please illustrate the x- and y-axes of the figure 2a in the section 3.1 or describe them in the section 2.3. In the section 3.1, the authors illustrated that Southern Hemisphere monsoon regions are characterized by low PCoA1 scores, while Northern Hemisphere monsoon regions are characterized by higher PCoA1 scores. Please explain these terms in the context of instrumental data or modern climatology, which may be more interesting for the paleoclimate community.

(8) The authors used the anomaly for comparison from different model results. However, readers might also want to see a detailed comparison between model results, particularly between the model results from this study and those from previous studies.

(9) Lines 397-400 and the figure 3: "The LGM is characterised by a similar orbital configuration to today, however global ice volume was at a maximum and GHG concentrations were lower than present. The δ18Ospel anomalies are more positive during the LGM than the MH or LIG, suggesting drier conditions in the ISM, EAM and IAM, supported by simulated changes in δ18Ospel and precipitation (Fig. 3)." This sentence is again misleading. While the authors highlighted a similar orbital configuration between the LGM and today, they actually discussed the issue related to a comparison of the LGM with the MH or LIG, presumably implying that they have similar orbital configurations. The LGM (21$\pm$1ka) is near a Northern Hemisphere insolation minimum whereas the MH/LIG are near the insolation maxima. As such the related discussions should be rephrased, and so does the related conclusion, since the insolation difference should be taken into account together with GHG and the global ice volume, because one could also argue that the δ18Ospel just follows the insolation with effect to a lesser extent from GHG and the global ice volume.

Minor comments:

Lines 97, 112 and 160, ‘the Principal Coordinate Analysis (PCoA)’, the abbreviation occurred three times, keep the first one.

Line 121, please give the full name of the climate models: ECHAM5 and GISS E-R

Line 163, ‘. . .missing data that . . .’ , ‘that’ should be ‘than’?

Line 189, what is the ‘OIPC’?

Lines 268-277, the abbreviations (EAM, SW-SAM, SAfM, CAM, IAM) occurred too late in the section 3.1, it’s better put them in the introduction.

Line 358 ‘southern China Sea’ should be ‘South China Sea’.

Figure 5, the time series for Dongge Cave can be replaced by a high-resolution time-series, please double check with the database.

References:

Cheng, H., Zhang, H., Zhao, J., Li, H., Ning, Y., & Kathayat, G., 2019. Chinese stalagmite paleoclimate researches: A review and perspective. Science China Earth Sciences, 62(10), 1489-1513. doi: 10.1007/s11430-019-9478-3.

Zhao, J.Y., Cheng, H., Yang, Y., Tan, L.C., Spötl, C., Ning, Y.F., Zhang, H.W., Cheng, X., Sun, Z., Li, X.L., Li, H.Y., Liu, W., Edwards, R.L., 2019. Reconstructing the western boundary variability of the Western Pacific Subtropical High over the past 200 years via Chinese cave oxygen isotope records. Clim. Dyn 52, 3741–3757.

Cheng, H., Edwards, R.L., Wang, Y., Kong, X., Ming, Y., Kelly, M.J., Wang, X., Gallup, C.D., 2006. A penultimate glacial monsoon record from Hulu Cave and two-phase glacial terminations. Geology 3 (34), 217–220.

Cheng, H., Edwards, R.L., Sinha, A., Spötl, C., Yi, L., Chen, S., Kelly, M., Kathayat, G., Wang, X., Li, X., Kong, X., Wang, Y., Ning, Y., Zhang, H., 2016a. The Asian monsoon over the past 640,000 years and ice age terminations. Nature 534 (7609), 640–646.

Cheng, H., Sinha, A., Wang, X., Cruz, F.W., Edwards, R.L., 2012. The global paleomonsoon as seen through speleothem records from Asia and the Americas. Clim. Dynamis 39 (5), 1045–1062.

Cai, Y., Fung, I. Y., Edwards, R. L., An, Z., Cheng, H., Lee, J. E., Tan, L., Shen, C. C., Wang, X., Day, J. A., Zhou, W., Kelly, M. J. and Chiang, J. C. H., 2015. Variability of stalagmite-inferred Indian monsoon precipitation over the past 252,000 y, Proc. Natl. Acad. Sci. U. S. A., 112(10), 2954–2959.

Battisti, D. S., Ding, Q. and Roe, G. H., 2014. Coherent pan-Asian climatic and isotopic response to orbital forcing of tropical insolation, J. Geophys. Res. Atmos., 119(21), 11997-12020, https://doi.org/ 10.1002/2014JD021960.

Liu, Z., Wen, X., Brady, E.C., Otto-Bliesner, B., Yu, G., Lu, H., Cheng, H., Wang, Y., Zhang, W., Ding, Y., Edwards, R.L., Cheng, J., Liu, W., Yang, H., 2014. Chinese cave records and the east asia summer monsoon. Quat. Sci. Rev. 83, 115–128.

Cheng, H., Edwards, R.L., Broecker, W.S., Denton, G.H., Kong, X., Wang, Y., Zhang, R., Wang, X., 2009. Ice age terminations. Science 326 (5950), 248–252.

Zhang, H., Griffiths, M.L., Chiang, J., Kong, W., Wu, S., Atwood, A., Huang, J., Cheng, H., 2018. East Asian hydroclimate modulated by the position of the westerlies during Termination I. Science 362, 580–583.

Zhang, H., Cheng, H., Baker, J., & Kathayat, G., 2020. Response to Comments by Daniel Gebregiorgis et al. “A Brief Commentary on the Interpretation of Chinese Speleothem δ18O Records as Summer Monsoon Intensity Tracers”. Quaternary 2020, 3, 7. Quaternary, 3(1), 8.

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2020-78, 2020.