

Clim. Past Discuss., referee comment RC2  
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## Comment on cp-2021-152

Anonymous Referee #2

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Referee comment on "Investigating stable oxygen and carbon isotopic variability in speleothem records over the last millennium using multiple isotope-enabled climate models" by Janica C. Bühler et al., Clim. Past Discuss.,  
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Dear editor and authors, the manuscript "Investigating oxygen and carbon isotopic relationships in speleothem records over the last millennium using multiple isotope-enabled climate models" is an interesting work. This study compared the speleothem oxygen isotopic records from SISAL v2 with four water-isotope-enabled GCMs over the last millennium, and found regional differences in the oxygen isotope signatures between models are partly attributed to modelled temperature, the lower temporal resolution makes speleothem records is unsuitable to analysis the response to volcanic and solar forcing, and all models underestimate decadal and longer variability compared to speleothem records. However, some analyses may not be sufficient enough and there are several inaccuracies in details. Thus, I recommend publishing it after a revision.

Main Comments:

- The subject of this manuscript is unclear. The current models cannot simulate the carbon isotope, how to investigate the carbon isotope using models? Thus, the title is inappropriate. This work cannot explain the relationship between the oxygen and carbon isotopes. Another option focus on the ensemble mean of the multiple GCMs. The highlights is likely derived from the differences and commonalities between the ensemble mean and each member.
- The mechanism and the reason need to be further explored. The advantage of climate model is to explore the mechanism. How does the temperature affect the oxygen isotope signature? What's the feedback? How does precipitation amount impact the water isotope at low latitudes?
- The details are needed be carefully checked and the logic and legibility should be further improved.g. It is too arbitrary to obtain the conclusion of the "major driver" from a correlation map in the climate model study. If the differences between the models is so large, how to definite that the ensemble mean is climate signal or noise.

## Specific Comments:

- The introduction is not focused. If possible, please highlight the importance of comparing simulated water isotopes with measured speleothem isotopes, illustrating the reasons for analysis from spatial, temporal and extreme events aspects.
- Page 1, Lines 13-14. How to distinguish climate drivers of variability for both modelled and measured isotopes?
- Page 2, Lines 20-21. Is it possible to show the formula of carbon isotope like oxygen isotope (line 19)?
- Page 2, Line 35. Please add the cave monitor work (Duan et al., 2016).
- Page 2, Line 38. How to understand the "speleothem carbon isotopes can be easier to interpret than oxygen isotopes"? What's the easy explanation of the speleothem carbon isotopes?
- Page 3, Lines 10-15. What's the main conclusion from the previous model-data comparison? A detailed explanation is necessary to emphasize the motivation and innovation of this work.
- Page 3, Lines 34-37. What's the main conclusion from the multi-model comparison? A detailed explanation is also necessary to emphasize the motivation and innovation of this work.
- It is recommended to illustrate the ability of each model to simulate oxygen isotope in the introduction or Data section, which would help the readers to explain the differences among the models.
- The past millennium includes different climatic backgrounds (Medieval Warm Period, Little Ice Age, and Modern Warm Period), and the spatial distributions and main driving factors of simulated water isotopes and measured speleothem isotopes may be different under warm and cold backgrounds. Comparison analyses in different climatic backgrounds are suggested.
- Page 12. Please check the description for Figure 3. It is difficult to find ECHAM5-wiso with more strongly depleted mid-latitude oceans than in the other simulations and iCESM and iHadCM3 with stronger depletion towards the poles compared to the other simulations; Modifying 48‰ to -8.48‰.
- Page 13. It is better to indicate the latitude and longitude of the cave locations mentioned in the text.
- Page 14, Figure 5. it is not enough to obtain the driver relationship from the correlation in Figure 5. There is also a high correlation between precipitation and isotopes in the high latitudes of the northern hemisphere in Figure 5. The further feedback or circulation analysis is suggested. Moreover, it is worth noting that the sign of correlations between simulated  $\delta^{18}\text{O}_{\text{sim}}$  and temperature is consistent with many correlations between measured  $\delta^{18}\text{O}_{\text{speleo}}$  and modelled temperature, but this is not same for precipitation. A possible reason is also welcome.
- Page 15, Figure 6. The caption of Figure 6 misses the description of (b) and (d).
- Significance levels should be added when discussing correlations.
- Page 20, lines 11-12. and Page 21 lines 24-25. It is too arbitrary to obtain the conclusion of the "major driver" for the climate model study.
- Page 21, line 27. What is "cave locations for 3 and more simulations"? Is it "3 or more simulated cave locations"?
- Page 22, lines 34-35. A possible reason is welcome.
- Page 24, lines 22-23. What is the evidence to support this conclusion?

## Reference

Duan, W., Ruan, J., Luo, W., Li, T., Tian, L., Zeng, G., Zhang, D., Bai, Y., Li, J., Tao, T., Zhang, P., Baker, A., Tan, M., 2016. The transfer of seasonal isotopic variability between precipitation and drip water at eight caves in the monsoon regions of China. *Geochim. Cosmochim. Acta* 183, 250-266.