Duan et al. provide a new high resolution 8.2ka speleothem record spanning 9.0-7.9ka BP period in north China. They reconstructed the time series over this period using a variety of indicators, including carbon and oxygen isotopes, ratios of trace elements, and growth rate. The authors identified two drought periods of 8.4 and 8.2ka and found that the behavior of carbon and oxygen isotopes and trace elements was different, which may be responsible for the nonlinear response of the local ecosystem. They suggest that there were several centennial scale climate fluctuations around the 8.2ka event, and that two droughts-one pluvial pattern between 8.5-8.0ka were a widespread event on a global scale and were closely related to the northern high latitude. The manuscript is carefully prepared, this record is relatively rare in northern China, and the age model is accurate, the resolution is super high, after a certain amount of thought and revision this paper is recommended for publication.

Re: We thank the reviewer for the positive comments.

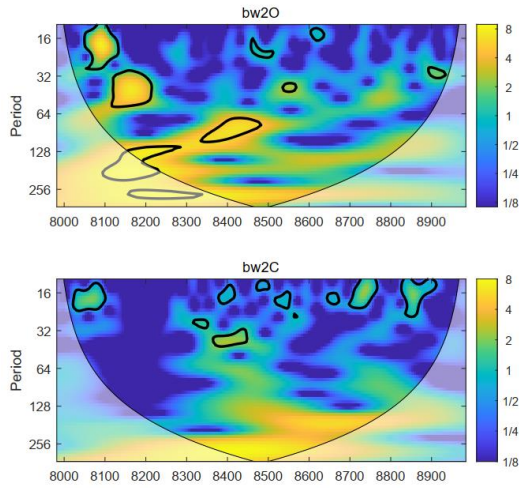
General notes

1. Cheng et al.(2009) and your last paper(Duan et al.,2023) reported that the 8.2ka event had a two-stage structure, but this manuscript and Tan et al.(2020) believe that there is a two drought-one pluvial pattern at 8.2ka and 8.4ka, does this similar expression give rise to some misunderstanding? Because in some papers 8.4ka and 8.2ka together constitute the 8.2ka cold event.

   Re: We clarify here that the two drought-one pluvial structure in this study is different from Cheng et al. (2009) and Duan et al. (2023). Specifically, papers of Cheng et al. and Duan et al. mainly focused on the 8.2 ka event that lasts from ~8.30 to 8.10 ka BP and revealed a two drought-one pluvial pattern within this event. Our study suggests that, in addition to the 8.2 ka event, another multidecadal drought event should occur at ~8.4 ka BP. As for Tan et al. (2020), we believe that the speleothem records from Northwest China support the opinion of more than one drought events during 8.5-8.0 ka BP, despite the lack of resolution and accurate age control.

2. What are the periodic changes of trace elements, oxygen isotopes and carbon isotopes? Do they have a common period and are they influenced by Solar Output, AMO, PDO or even ENSO on a short time-scale?

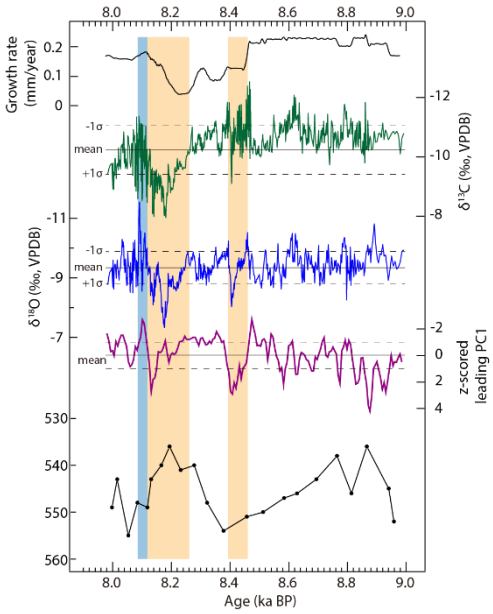
   Re: The wavelet analysis of carbon and oxygen isotope timeseries was conduct and the results are shown below. The 10% significance level against red noise is shown as a thick contour. As can be seen, two profiles don't show a common period because the $\delta^{18}O$ is dominated by interdecadal to centennial periodicity after the 8.5 ka BP while the $\delta^{13}C$ is dominated by 10~30 year periodicity almost throughout the entire study interval. To investigate the impact of the solar output, AMO, PDO and ENSO on speleothem proxies, the signals of AMOC variability should be removed, which is beyond the scope of this study. Even so, we will try to figure out this issue in next step as the reviewer suggests.



3. Can the $\delta^{234}U_{initial}$ attached to the dating results be used as an indicator to reflect these climatic events? Can the carbon isotope at 8.4ka be considered a wet event?

Re: Speleothem $\delta^{234}U_{initial}$ is a complex indicator to investigate the local hydroclimate change. The comparison results between $\delta^{234}U_{initial}$ (the lowest curve) and other proxies are shown in below figure. As can be seen, the $\delta^{234}U_{initial}$ values reach the highest at ~ 8.4 ka BP and the lowest at ~8.2 ka BP, in contrast to the consistently positive shifts in the other proxies. This indicating that complicated mechanisms exert influence on the speleothem $\delta^{234}U_{initial}$ signal. Moreover, resolution of the $\delta^{234}U_{initial}$ record is low, possibly limiting the detailed comparison with other proxies.

We don't think the 8.4 ka event can be considered a wet event. The succession of vegetation system is quite resilient to the climate change, and thus $\delta^{13}C$ values of speleothem not always follow the patterns of $\delta^{18}O$ and trace element ratios. In this study, pluvial conditions at ~8.46 ka BP can be inferred from both anomalously negative $\delta^{18}O$ and trace element ratios, which could be responsible for the simultaneous negative $\delta^{13}C$ values. However, the $\delta^{13}C$ don't follow the dramatic positive excursion of the other two proxies during 8.46-8.39 ka BP, which could be attributed to the nonlinear relationship between the change of vegetation and hydrological conditions, in particular during short climate excursions. On the other hand, a relatively stable plant community and well-developed soil could be formed above the karst zone at that time, which increase the resilience of vegetation to environmental variations during and just after pluvial period, in turn suppressing the large and rapid variation of $\delta^{13}C$ in the karst system. But still, an inconspicuous positive trend can be noticed in the carbon isotope timeseries in this interval, especially the highest value up to ~-9.1 ‰ at 8.40 ka BP.



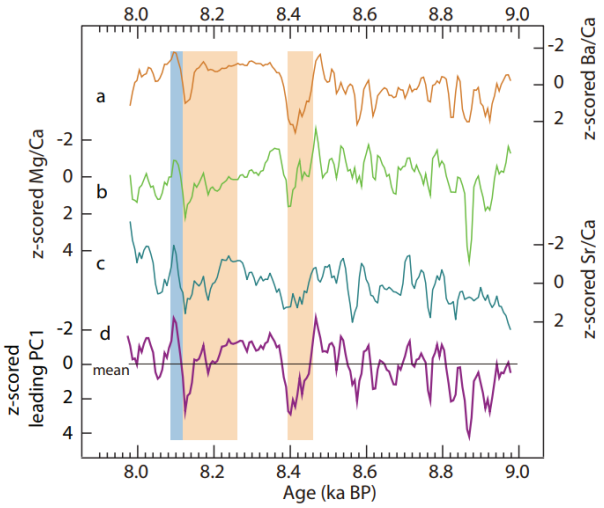
4. Carbon isotopes vary much more than oxygen isotopes, as is the case in Hulu cave. It is generally assumed that carbon isotopes are more sensitive to climate change. Why is there a nonlinear response now?

   Re: As our response to Comment 3, local vegetation system are somehow resilient to climate variation when the tolerance threshold of vegetation system is not broken. Therefore, delay and/or smoothed signals are observed in $\delta^{13}C$ relative to the $\delta^{18}O$ records, especially in short time scales and/or limited range of climate change. In longer time scale, however, speleothem $\delta^{13}C$, as a rainfall amount proxy, in response to climate change could be more sensitive than $\delta^{18}O$ as demonstrated by Li Yunxia et al. (2020, EPSL). Therefore, there is no conflicts between this study and previous studies on the explanation of the carbon isotope considering the local environment of each cave location and time scale.

Specific notes

1. Figure2a, this paper is based on Duan et al., 2023 (GRL) to add new data for research. Please distinguish the ages used in the previous paper and the new ages added in this paper in this figure. Figure2f, from 9.0-8.5ka, there is a clear decreasing trend in the PC1 index of trace elements in this period, indicating that the climate is becoming wetter, which is not reflected in oxygen and carbon isotopes.

   Re: We change the published age results to red color in Figure 2b. It seems that the decreasing trend in the PC1 arises from the anomalously positive Mg/Ca excursion at ~8.87 ka BP, without which this trend is much flat as can be seen in separated trace element ratio records (Figure S2).



2. Figure3, in addition to the dating error of LAO you have marked, the marking of the dating error bar of other stalagmites records is conducive to the understanding of this paper.

   Re: Done.

3. Figure s2, what are the correlation between the three trace elements, if there are calculations of the correlation, you can show their consistency.

   Re: The correlation coefficients for Mg/Ca and Sr/Ca, Mg/Ca and Ba/Ca, and Sr/Ca and Ba/Ca, are 0.24 (p<0.01), 0.49 (p<0.01), and 0.47 (p<0.01), respectively.