Review Guo et al.,

Guo et al., generated a high-resolution summer monsoon proxy (Ca/Ti) from Linxia on the western CLP. The Ca/Ti ratio is interpreted as a precipitation-sensitive proxy linked to summer monsoon rainfall (Guo et al., 2021). The new precipitation proxy (Ca/Ti) and an East Asian composite speleothem $\delta^{18}O$ record ($\delta^{18}Osp$) are evaluated to elucidate the modulating drivers of these two proxy records.

The authors find that the MMV of Ca/Ti is mainly modulated by ice volume and greenhouse gases (GHG) at the eccentricity band. Both GHG and summer insolation modulate the MMV of Ca/Ti at the precession band but not that of $\delta^{18}Osp$; $\delta^{18}Osp$ MMV is modulated by winter insolation at the eccentricity and obliquity bands. The inferred mechanism of how these internal and external factors modulate the MMV calls on dynamic linkages to variability in AMOC at both eccentricity and precession bands.

Results suggest that the MMV EASM rainfall is modulated by ice volume, GHG, and insolation factors, consistent with those predicted to influence future changes in monsoonal precipitation.

This is an interesting study in which the authors address two important outstanding questions: 1) is there a reliable proxy for East Asian summer monsoon (EASM) rainfall at the millennial timescale and 2) what factors modulate the MMV thereof?

The paper is clear and well wrote, and is suitable for a journal such as Climate of the Past. However the authors must answer to major/minor comments (see below) to be sure that the main conclusions of their paper can be fully supported before considering publication.

Re: Thanks for reviewing our paper and giving us useful advice to improve our manuscript.

Major comment:

- There is no Figure with the age control points that include the error bars on these control points and more generally no errors for the age model used in this study. I suggest to add a figure that include the depth/age and errors for the age model of the loess record.

Re: Thanks for reminding us of adding a figure to show the error bars of our age model. The detail information of the age model was published in another journal (Sun et al., 2021, Earth-Science Reviews). We would mention this messages in method section. The following Figure 1 shows errors of our age model and help to explain the age model error would not affect the results of the wavelet coherence analysis. We use two different targets to establish our age model. These grain-size time series yield good correlation between loess/paleosol boundaries and glacial/interglacial transitions. The age differences between the two age models for most glacial terminations and precession cycles are around 2-4 kyr (Sun et al., 2021, Figure 1).

Sun, Y., Clemens, S., Guo, F., Liu, X., Wang, Y., Yan, Y., and Liang, L.: High-sedimentation-rate loess records: A new window into understanding orbital-and millennial-scale monsoon variability, Earth-Sci. Rev., 103731, https://doi.org/10.1016/j.earscirev.2021.103731, 2021a.

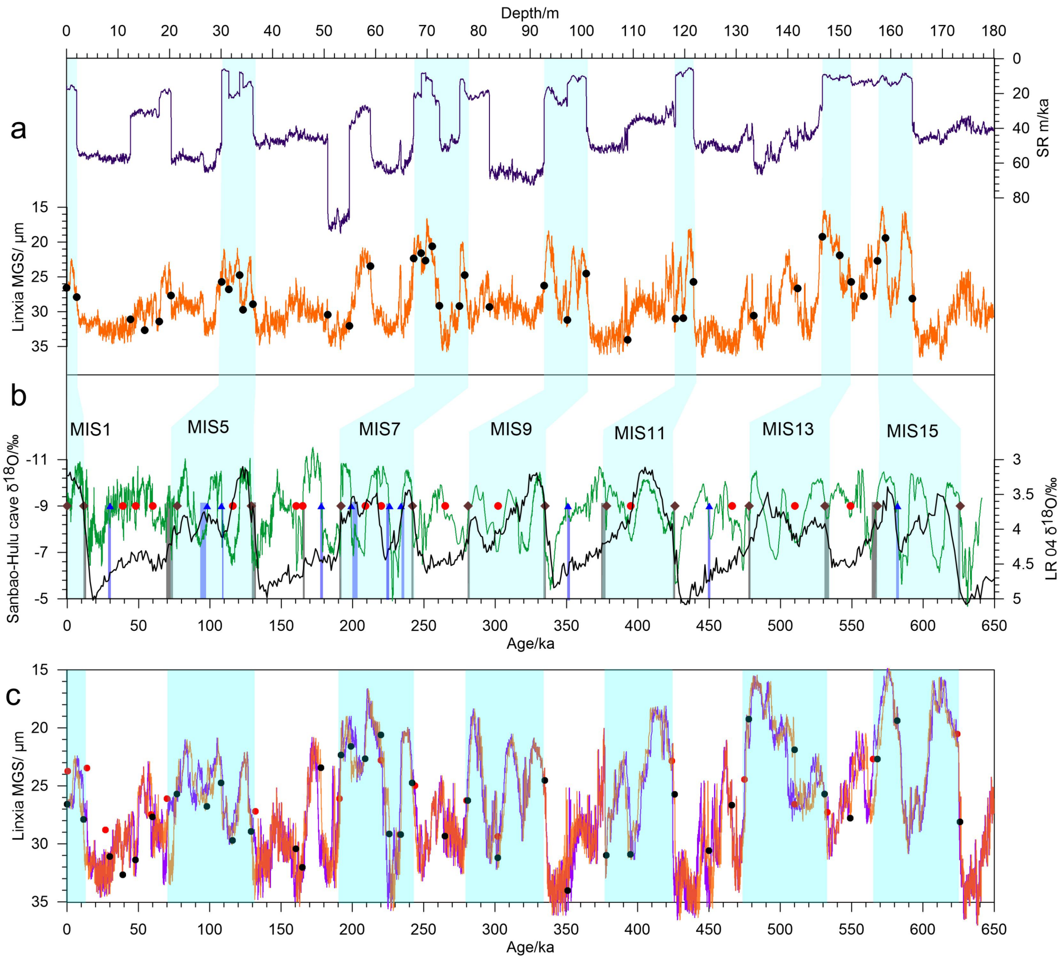

Figure 1 a) Down-core variations of mean grain size and sedimentation rate against depth, dark blue dots represent the age control points at the corresponding depth of mean grain size. b) Comparison of mean grain size in Linxia section with Sanbao-Hulu (Cheng et al., 2009, 2016) and benthic $\delta^{18}O$ records (Lisiecki and Raymo, 2005), colorful dots represent age control points at the corresponding depth of cave record. Light blue bands donate the interglacial times. c) The comparison between the grain size based age model (Purple line, control points in red) and loess-cave comparison based age model (orange line, control points in black) over last 650 ka. Light blue and gray bars indicate age difference between two comparable time series.

What is the implication of the age model errors for the wavelet coherence correlations that authors conducted (against GHG, ETP, Insolation and benthic $\delta^{18}O$ on Figure 4) and for the millennial-scale component extraction (Figure 3) ?

Re: That's really a good question. We should take the influence of age model error into consideration in method section. We assessed the this kind of influence and add the result in method parts. We isolated the millennial-scale components of loess Ca/Ti at the different age model for comparison (Figure 2). The age model difference of millennial-scale variability is 1-3 kyr. We applied Ca/Ti on grain size based age model to calculate the MMV and conduct wavelet coherence analysis, showing almost the same correlation and phase at the orbital frequency bands (Figure 3) as that of WTC results at loess-cave comparison based age model (manuscript Figure 4).

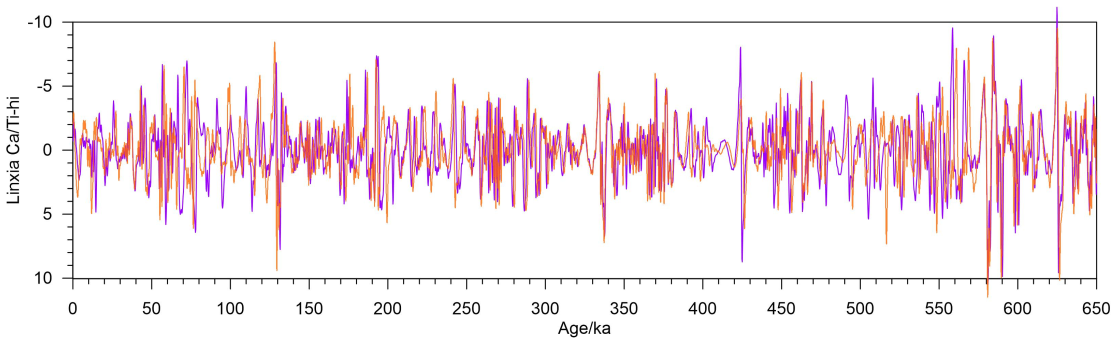

Figure 2 The comparison of millennial-scale loess Ca/Ti variations on grain size based age model (purple line) and loess-cave comparison based age model (orange line).

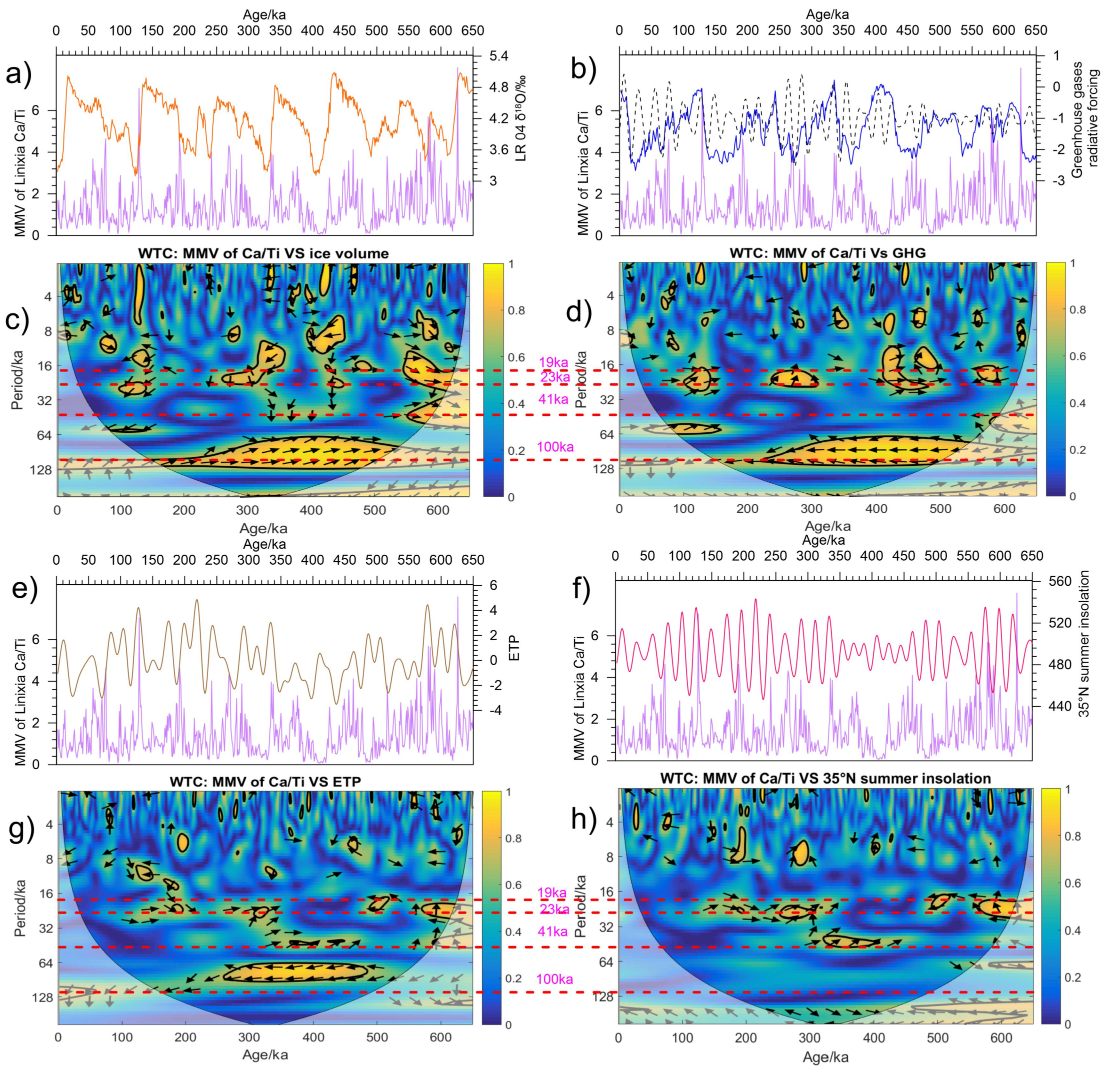

Fig. 3 Comparison of a) ice volume, b) GHG forcing, c) ETP and d) local summer insolation with MMV of loess Ca/Ti over the past 650 ka at the grain size based age model.

Minor comments:

- What is the resolution of the Ca/Ti record (in years) before resampling? I could not find it in the text.

Re: Sorry for forgetting to add the resolution of our new proxy. We revised it accordingly. The powder samples were scanned at 2 cm interval, with the resolution ranging 50~200 yr (Figure 1).

- Introduction part (lines 51-60) : “flood and drought events”. What is the definition of the authors here for flood and drought events? And at which time scale this events occur? Are they directly related to the millennial scale variability the authors reconstruct in this paper?

Re: In this paper, the definition of flood and drought events are centennial to decade (100-10 yr) timescale natural disaster.