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Interactive comment on "Late Miocene-Pliocene climate evolution recorded by the red clay covered on the Xiaoshuizi planation surface, NE Tibetan Plateau" *by* Xiaomiao Li et al.

Anonymous Referee #3

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Ms. Cp-2018-73: Late Miocene-Pliocene climate evolution recorded by the red clay covered on the Xiaoshuizi planation surface, NE Tibetan Plateau âĂÍ By Li Xiaomiao et al.

Overview:

This study provides multiple environmental proxies, including carbonate content, element concentration, magnetic susceptibility and grain size, from the red clay deposits of the Xiaoshuizi section to study the late Miocene-Pliocene climate evolution of the western Chinese Loess Plateau. The authors identify two time intervals with different climate patterns: 1) 6.7-4.8 Ma minimal weathering and pedogenesis representing arid

condition, which is a result of weakened paleo-Asian summer monsoon, and intensified Westerly circulation; and 2) 4.8-3.6 Ma enhanced weathering and pedogenesis indicating humid climate. This transition from arid to humid climate is considered to indicate enhancement of the paleo-Asian summer monsoon, which is inferred as the combined effects of: increasing Arctic temperatures, expansion of the tropical warm pool into the subtropical region, and water freshening in the subtropical Pacific.

This study presents many proxy data and provides detailed discussion, which are likely of interests to researchers studying Neogene climate changes of East Asia, especially evolution of the East Asia summer monsoon. Thus, this paper should be published. However, I have some concerns and questions that need to be solved before the manuscript can be accepted. A moderate to major revision is recommended.

Major concerns:

1) The introduction part is not well written as there are many ambiguity and in-accuracy (see detailed comments below). This section needs significant reworking.

2) The authors seem to preferentially pick 4.8 Ma as the boundary between the two climate intervals. However, most of the proxies exhibited in Fig. 3 seem has a distinct change at 4.6 Ma, but not 4.8 Ma, e.g., $Al2O3$, $K2O$, as well as the three magnetic susceptibility plots. In addition, for the grain size and carbonate content plots, there is no apparent difference below and above 4.8 Ma.

3) This manuscript is generally good written in English, but additional efforts are required to polish the language.

Line-to-line comments:

L1-2: I found the title is kind of misleading. The authors emphasize the Tibetan Plateau as the location of their section. However, throughout the manuscript, the Xiaoshuizi section is compared with other sections on the Chinese Loess Plateau, and reflects nothing of the Tibetan Plateau evolution. So it would be more appropriate to emphasize the location as the "western Chinese Loess Plateau".

L49: one of the most intensively studied intervals of what? Climate I assume?

L51: in line 41, the authors state closure of the Panamanian Seaway at 4.8 Ma, and it seems that the seaway closure has significant climate effects. Thus, it would be inappropriate to state here that the Zanclean is similar as present due to similar land-sea distribution.

L52-53: references for "comparable temperatures in the tropical region" need to be added.

L54: Zanclean is a period from cold to warm?

L66-67: wired transition from the previous sentence. Not consistent.

L68: This is at least not accurate, if not wrong. Numerous studies have demonstrated that surface uplift of the Tibetan Plateau is stepwise and spatially diachronous. See reviews of Tapponnier et al., 2001, Wang et al., 2014 and many others. The south-central parts of the Tibetan Plateau were uplifted much earlier than the Zanclean, e.g., Paleogene. In the northern Tibetan Plateau, although there might be tectonic deformation in the margins of the Plateau (Li et al., 2015), the major part of the northern Plateau is probably uplifted during the Miocene, as evidenced by numerous other evidence, see review of Yuan et al., 2012. While it's OK to stick on the authors' own preference, it's necessary to discuss/reflect other research progress.

L72: 3 Ma or 2.6 Ma? Be accurate.

L 75: first appearance of ASM in the main text, need to define first. In addition, for summer monsoons in Asia, there is the East Asia Summer Monsoon and the South Asia (India) Summer Monsoon. Which one do you mean? I assume East Asia Summer Monsoon?

L76-77: In the abstract, the authors consider the ASM as moisture carrying, but the

Westerlies as moisture lacking. So it's not appropriate to list them together. In addition, moisture transport is short-time climate condition, how could it cause long-tern glaciation?

L82: "warm and wet" climate yield "wet" climate? Definitely!

L84: a weakened summer monsoon of where? Globally or East Asia only?

L89-91: onset of interior Asian aridification since the late Miocene? This is totally unjustified. Numerous studies indicate much earlier onset of Asian interior aridification, e.g., since 22 Ma (Guo et al., 2002), or much earlier at Eocene-Oligocene transition (Dupont-Nivet et al., 2007), or late Eocene (Bosboom et al., 2014).

L103-105: is this phenomenon also observed in other studies?

L107-108: what inconsistent? Need to clarify. For the evidence listed above, it's necessary to point out which region is dominated by westerlies, which is dominated by ASM.

L110: why the western CLP is especially important? Need to give reasons here.

L126-127: rejuvenated at what time?

L175-182: what are the criteria to divide the carbonate content plot into 6.7-4.8 Ma and 4.8-3.6 Ma. I do not see apparent difference between these two subdivisions. For the 6.7-4.8 Ma interval, the carbonate content is 3.8-39.2The 6.0-5.5 interval, with much smaller amplitude of fluctuation, seems to be more different from the other time intervals.

L185-187: looking at Fig. 3, it's pretty hard to determine whether two plots are of similar trend, or opposite trend. I would suggest to provide statistical evaluation to help readers understand the similarity between plots.

L188: provide the ranges of Al_2O_3 and K_2O for the two time intervals.

L189: why choose 4.8 Ma as the boundary? The values between 4.8-4.6 seem be more similar as the 6.7-4.8 Ma interval.

L193: similar question, why group values between 6.9-4.8 together, but not include values between 4.8-4.6, which exhibit more similarities as the 6.9-4.8 Ma interval, which are of lower values and smaller amplitude of variation.

L204: there is no difference between these two intervals.

L206: in Fig. 3, it shows >40 ïĄ■m.

L251: I have a question here, maybe very basic in your discipline. If one wants to use K2O/Na2O values to determine the intensity of chemical weathering, a pre-assumption is that before weathering, all the samples have similar K2O/Na2O values. Right? How about if the original K2O/Na2O values are different? This question might also exist for other chemical proxies used here.

L287-288: Could you please explain this in more detail? Which feature in Fig. 5d denotes orbital signal increase since 4.8 Ma? As far as I can infer from Fig. 5d, in the carbonate content plot, the orbital parameters increase since 4.9-5.0 Ma. While, in the Xpedo plot, it seems the increasing timings are diachronous for different orbital parameters.

L292-295: Here the authors propose that the carbonate content and Xpedo signals reflect incomplete preservation of paleoclimate signals. Then the question is if the original paleoclimate signals are incomplete, how would you use these records to predict paleoclimate changes?

L308-312: According to the authors' statement, the rapid change from 6.7-4.8 Ma low amplitude to 4.8-4.1 Ma large amplitude is observed in all the three orbital parameters. But for the benthic foraminiferal d18O record, similar change is only observed in the 41-kyr component. Why? This does not read like strong evidence to infer that the wet-dry oscillations were driven by changes in ice volume or global temperature. An

associated question would be if the authors do not consider solar radiation intensity is the cause of the wet-dry cycles, but ice volume or global temperature, then what's the cause of ice volume and global temperature changes? Isn't solar radiation intensity a driving factor?

L317-318: I find this conclusion hard to believe. For the carbonate content signal, the authors state that they record incomplete paleoclimate signal (see comments for L292-295). For the K2O/Na2O and Rb/Sr record, a more apparent change seems to be at 4.6 Ma.

If higher carbonate content represents dry climate, and lower carbonate content represents humid climate, compared with 6.7-4.8 Ma, the 4.8-3.6 Ma would have more humid period, but also much drier period, because the 4.8-3.6 Ma has larger variability. While, I did not see a clear wetting trend.

L363-364: This is a false statement. Even at present, the Tibetan Plateau cannot block the Westerlies completely. The Westerlies can travel to the northeastern Tibet through valleys in the Tianshan.

L368: which plots are pedogenesis proxies? Cite the specific plots here. "roughly"? how rough? Better to give a quantitative value.

L391-392: is there evidence to suggest reduced amount of atmospheric water vapor? Weakening of the paleo-ASM and dominance of Westerlies can explain the aridity. This does not necessarily need reduced amount of atmospheric water vapor.

L469: "extremely wet"? wetter than any other period?

L528-530: I probably missed it, but how could your records reflect seasonality of precipitation? Which proxy records seasonal signals?

L532: why the strongest summer monsoon is between 4.6-4.25 Ma? What are the possible reasons for the decreasing strength after 4.25 Ma?

Figures:

Fig. 1: a, the present outline is too large, the wind vectors are too small to see. It's better to show a smaller region with more details; e.g., regions between 10N-50N, 70E-130E. c. highlights the Xiaoshuizi section. Hard to find now.

Fig. 2: These photos exhibit very few useful information.

Fig. 3: Between 4.8-4.6 Ma, most plots show a weird shape. Is this because there are limited samples compared with other time intervals?

Fig. 5: apparently the authors need to provide more information in the caption about their plots. For example, Fig. 5d, what does the color mean? What does the black curve represent? Also, the horizontal age scale is better to use Ma, but not ka, as Ma is used throughout the manuscript. In Fig. 5a-b, there are other strong periodicities denoted. How about these periodicities in Fig. 6d?

Fig. 6. It will be better to arrange all the proxies with the same logic, e.g., left-wet, right-dry.

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