We appreciate reviewer's comments, which will help us to improve the manuscript. The following are our point-by-point responses to the reviewer's comments:

"The authors used pollen, macroflora, and mostly mammal fossils to reconstruct the late Miocene temperature. Considerable uncertainties could be raised due to the in- sufficient accuracy of their chronology, the wide and insufficiently understood habitat tolerance, the unknown elevation, the representativeness of the found flora/mammals in the ecosystems, the unknown effect of CO2 for plants, and the methods used, etc.

Such kind of temperature reconstruction is only qualitatively and statistically significant. It would be an over-exploration, to my view, to make quantitatively/accurately compar- ison with the present-day temperature at individual site level. For example, we are unable to exclude the possibility that the authors correlated a late Miocene fossil from a 'cold period' with another late Miocene fossil from a 'warm period', at both long-term or/and orbital scales, given that accurate chronology or lithology/timeseries controls were not well established. This is just like to compare a glacial fossil site to an inter- glacial fossil site for the late Quaternary. The great variability of the estimated results (Table S1 & S2), and the rather large discrepancies between the nearby sites, support these uncertainties about the data quality."

We agree with the reviewer that the given accuracy of dating for localities in most cases does not allow for identifying the position within the scale of orbital climate variability. This holds also for other studies on data-model inter-comparison and is not limited to our manuscript (Lunt et al., 2008; Bradshaw et al., 2012). However, we can assume for the time-span studied here that the amplitudes of cyclic climate change were fairly minor when compared to Pleistocene climate variability (Zachos et al., 2008). Many studies have demonstrated that the proxy-based temperature data reveal regional and continental patterns and gradients (e.g., Bruch et al., 2011; Liu et al., 2011; Utescher et al., 2011; Yao et al., 2011). This would not be the case if the climate variability at a given site would be the predominant signal. Moreover, it has been indicated that the changes of surface temperature in South Asia due to orbital forcing are small (< 2 ^{o}C) compared to the changes in precipitation (Prell and Kutzbach, 1992).

Regarding the spatial representativeness of flora/mammals fossil data, it is broadly accepted that they normally provide a regional vegetation and climate signal (Fortelius et al., 2002; Jacques et al., 2011; Liu et al., 2011; Yao et al., 2011).

We agree with the reviewer that CO2 may have an effect on the climate requirements (mainly precipitation) of plants. The CO2 concentration in the Late Miocene, however, has been shown to be similar to present day (Beerling and Royer, 2011; Zhang et al., 2013). Therefore, this effect can be regarded as fairly minor.

"The reconstruction method using mammal fossils is from Liu et al (2012). This method remains preliminary and tentative. It is not yet a commonly accepted method, of which the yielded results should not be used as a basis for comparing the late Miocene and present winter temperatures in a quantitative perspective."

The method developed in Liu et al. (2012) has been well tested against modern data (see Liu et al. for details). We agree that applying methods developed using modern data to the fossil record always needs to be made with care. This means, that in this regard, it is similar to other methods used for paleo-studies (e.g. transfer functions used for Pleistocene pollen data, mollusc studies, CA method). Moreover, we did not only rely on the numerical estimate, but checked the fossil species list in the localities that suggest cooler winter temperature. The main taxonomic difference in addition to traits that were used in numerical estimates is the absence of primates in Indian localities. Primates typically rely on the fruits and other food that are available throughout the year. For example in the Late Miocene of Western Europe, the absence of primates has been suggested to be caused by increase in the temperature seasonality and winter cooling (Agustí et al., 2003), which supports our interpretation here.

"The main scientific proposition of the study that late Miocene winter temperature was cooler than for the present-day is also not justified by the used dataset. Tang et al used plant data from 48 sites and mammal fossil from 174 sites to reconstruct the late Miocene temperature. Among these, only 21 plant sites (~43%) and 59 mammal sites (~33%) showed lower-than-present MAT or CMT values (Table S1 & S2), but all the other sites (~64%), including a great number from southern China and Indian, showed higher-than-present MAT and CMT values (also Fig. 3). I am not clear why the authors optionally took the results from a small proportion of data as the target of the study. "

We agree that there are some localities in southern China and India showing higher-than-present MAT and CMT values. It is likely that the orography changes in these localities (i.e., the increase of surface elevation after the Late Miocene, and thus decrease of present-day temperature) causes such a change in these localities. This is particularly evident in the localities close to the Tibetan Plateau.

Nonetheless, we emphasize that the localities with cooler temperature are widely spread in southern China and India (Fig. 3). This can hardly be explained by the changes in orography (cooler-than-present temperature would imply widely spread subsidence of these regions since the Late Miocene), therefore is more likely to be driven by climate changes. Note that a very recent study using bioclimatic analysis also indicates cooler than present winter and annual mean temperature in the Late Miocene in a locality from southwestern China (Li et al., 2015). This further supports a cooler-than-present winter in southern China and India in the Late Miocene.

'The proposition that late Miocene winter temperature was cooler than for the present- day also contradicts most of the previously published geo-biological evidence while the authors failed to provide any valid explanation or discussion."

We were not aware of any of these geo-biological evidences that suggest warmer-than-present temperature over southern China (continent) and India (continent) in the Late Miocene. We would appreciate very much if the referee could point out the references for us to check. But we note that even if the geo-biological evidence suggests warmer conditions in the Late Miocene, it does not exclude the possibility that winter temperature might have been lower-than-present. This can be seen in Fig. 6a (Xiaolongtan, and Luhe localities) that although the plant fossils suggest warmer-than-present annual and summer temperature, they indicate cooler-than-present winter temperature. Such seasonal difference can be easily overlooked in most of the qualitative geo-biological studies. Therefore, we stress in our study that quantitative temperature reconstructions over continental Asia, particularly in southern China and India are essential to further evaluate our results and arguments.

"It is hard to believe that the other boundary conditions, such as the ice and CO2 con-ditions had not obvious impacts on the Asian winter temperatures, as stated in the ms. A lower Tibetan Plateau and lower northern mountains in the late Miocene are also not commonly admitted. Many scientists suggested that Tibetan Plateau would have reached to its maximum elevation by ~8 Ma."

We do not deny the contribution of other boundary conditions on the Asian winter temperature. We have shown in our Figure 4c,d that except a lower northern Tibetan Plateau and Tianshan Mountains, other Late Miocene boundary conditions can lead to a generally warmer winter temperature. Also, we do not think CO2 plays an important role in the Late Miocene temperature, because its concentration in the Late Miocene has been shown to be similar to present day (200-400 ppm) (Beerling and Royer, 2011; Zhang et al., 2013).

The surface height of the Tibetan Plateau in the Late Miocene is still a controversial issue. While some studies suggest the whole Tibetan Plateau may have been at present-day height (Wang et al., 2014), there is abundant evidence suggesting lower elevation of the northern Tibetan Plateau (Zheng et al., 2000; Wang et al., 2008), Tianshan Mountains (Charreau et al., 2009) and the Alai Mountains (Jolivet et al., 2007). This is also supported by more recent studies

(Yuan et al., 2013; Caves et al., 2014; Liu et al., 2014). One point that we can state with more certainty in this context is that the southern Tibetan Plateau may have reached present-day elevation before the Late Miocene. Therefore, we kept the southern Tibetan Plateau at present-day height in our Late Miocene runs (see Figure 2). Our study implies that a better knowledge on the temperature and winter monsoon strength may be useful to infer the Tibetan Plateau growth.

"Although both proxy data and model outputs do not really support the view of cooler- than-present winter temperature in southern China and Indian, the authors continue to consider this a true scenario for the late Miocene, and attributed it to 'stronger-than- present' winter monsoon winds."

As explained in detail in the answer to reviewer 2 (first answer), we observe cooler temperature in many fossil localities from southern China and India, and we observe cooler winter temperature in our regional model experiment (see also Fig. 3d). We admit that there are uncertainties in our proxy data and modelling data in depicting the cooler-than-present winter temperature. But the model and proxy data together do suggest that the winter temperature is likely to have been cooler-than-present in southern China and India in the Late Miocene.

"In terms of geological evidence, no data support 'stronger-than-present' winter mon- soon. Tang et al cited Li FJ et al (2008, 2014) to support their view but Li et al has never stated stronger-than-present winter monsoon in their studies. They just recog- nized that winter monsoon was relatively strong during some late Miocene intervals (compared to the other late Miocene/Pliocene intervals). Stronger-than-present winter monsoon are also in contradiction with most of the geological data acquired up-to-date"

We are aware of that Li FJ's work only covers 7-3.5 Ma. We only cite Li FJ et al's work as: "**A winter monsoon dominated** climate over the western Loess Plateau before 6 Ma is also reported by Li et al. (2008, 2014), who use cold-philous species of fossil snails as an indicator for the winter monsoon strength." (Page 74, Line19-21). We do not state that a "**stronger-than-present**" winter monsoon results from their study. For more discussion on the winter monsoon proxy, please see our reply to the following comments.

"Note that the authors also miss-understood these studies (cited on P74, lines 8-10). These colleagues used grain-size to document the winter monsoon history, rather than dust accumulation rate as the Tang et al noted in the ms (P74, lines 10-15). Dust grain- size in China and in North Pacific is a widely accepted proxy for determining past wind strength. These data clearly defined much weaker winter monsoon winds for the late Miocene despite of the sub-order fluctuations. The conclusion for the stronger-than- present winter monsoon is indeed a speculation according to the 'cooler-than-present' winter temperatures. It is also very unlikely that winter monsoon could 'jump over' northern China, leaving it much warmer (as shown in Fig. 3), but only cool southern China and India. "

We do not agree with the reviewer that we misrepresent or misunderstand the references we cite. Indeed, grain-size has been widely known as a proxy for winter monsoon, but dust accumulation rate is also frequently used (or mis-used) to indicate winter monsoon strength. To demonstrate this, we copy the following excerpts from the references we cite:

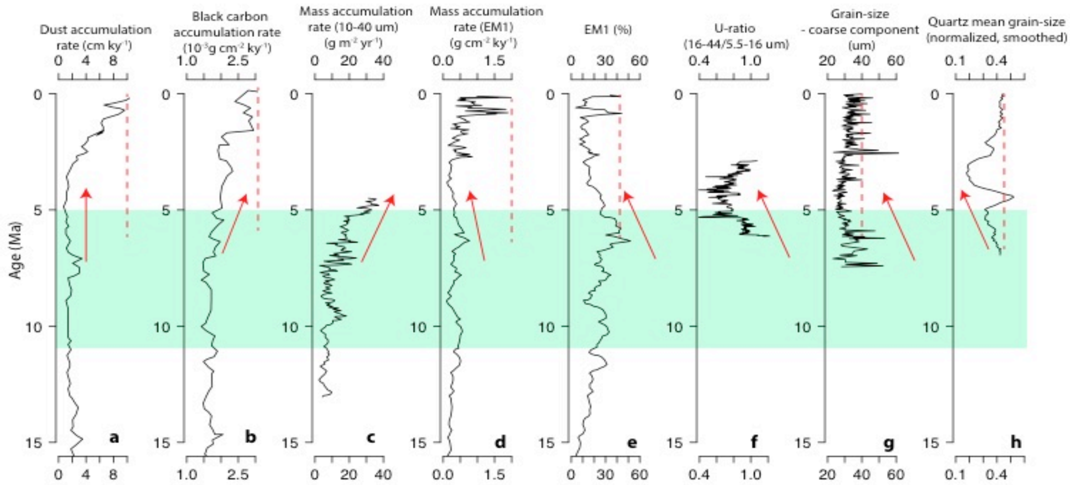
Guo et al. (2002): *"The Miocene sequences of Qinan do not show any obvious longterm intensification of loess deposition between 22 and 6.2Myr. The major increases occur after about 3.5Myr, in the Pliocene and Pleistocene epochs (Fig. 3). This suggests that the level of aridity and the strength of the winter monsoon winds in central Asia remained at moderate levels through the Miocene."*

Jia et al. (2003): *"The East Asian winter monsoon, an important agent for black carbon transportation, might have been weak before ca. 7 Ma, because black carbon concentration and accumulation rate were low and constant (Figs. 2A, 2C)."*

Fan et al. (2006): *"The MAR* (i.e., Mass accumulation rate) *of this fraction is directly linked to the intensity of Asian winter monsoon"*

Wan et al. (2007)*: "Through end-member modeling, variation in MAR of the coarsest endmember EM1 can be used to reconstruct the changing East Asian winter monsoon intensity."* In this paper, they use also grain-size feature as a winter monsoon proxy with a slightly different meaning: *"The variation in the proportion of EM1 in the terrigenous materials can be used to reconstruct the change of intensity of eolian supply relative to fluvial input, and thus potentially the change of intensity of the winter monsoon relative to the summer monsoon."*

To further show how the "dust accumulation" winter proxy differs from the "grain-size" proxy in depicting the winter monsoon strength in the Late Miocene, we provide the following composite figure. The first 4 panels (**a**: Guo et al. (2002), **b**: Jia et al. (2003), **c**: Fan et al. (2006), **d**: Wan et al. (2007)) are "accumulation" based records, the last 4 panels (**e**: Wan et al. (2007), **f**: Vandenberghe et al. (2004), **g**: D. H. Sun et al. (2008), **h**: Y. B. Sun et al. (2010)) are "grain-size" based winter monsoon proxy. All the "accumulation" based proxies clearly suggest weaker-than-present winter monsoon strength, while the "grain-size" based proxies suggest a Late Miocene winter monsoon strength similar to or even stronger than present-day, which support our results.



Note that while the ”accumulation” based proxy suggest little change or enhanced winter monsoon intensity during the Mio-Pliocene transition, the ”grain-size” based proxies all suggest a decreasing trend in winter monsoon intensity. As discussed in our manuscript, we consider the ”grain-size” proxies more robust in inferring the winter monsoon strength.

As noted by the reviewer, we suggest strong winter monsoon in the Late Miocene, but we do not observe a cooling effect over northern China (Fig. 3). This can be explained by our model results shown in Fig 4. The cooling effect of the stronger winter monsoon (primarily due to the lower northern Tibetan Plateau) (Fig. 4e, f) is counteracted by the warming effect of other Late Miocene boundary conditions (Fig. 4c, d), such as more thermophilous aspect of vegetation and lower surface elevation in the monsoon region (Fig. 2). This warming effect (Fig 4c, d) is particularly strong in northern China, outweighing the cooling effect of the strong winter monsoon in this region in our Late Miocene experiment (Fig. 4a, b). In contrast, the warming effect due to other Late Miocene boundary conditions is relative weak in southern China and India (Fig. 4c, d), thus permitting the cooling effect of the strong winter monsoon to be manifested in these regions (see Fig. 3 and Fig. 4a, b).

“Another main conclusion of the manuscript is that the late Miocene climate/circulation patterns would be different from today and that ‘the modern-like interannual variation of winter monsoon with a strong association with the Siberian High and the surface temperature changes in the monsoon region may not have been fully established in the Late Miocene’ (P77-78). This is also speculative, lacking necessary demonstra- tions. Similar-to-present environmental patterns have been well documented by paleo- botanic and geological data (e.g. Sun and Wang, 2005, Palaeo-3, 222:181-222; Guo et al, 2008, Climate of the Past, 4:153–174; Wang et al., 2014, Climate of the Past, 10, 2007-2052). The authors should consider these available results. ”

We emphasize that "**the modern-like interannual variation of winter monsoon"** may not have been fully established in the Late Miocene based our model results (see Figure 5). This does not exclude the possibility that the modern-like summer monsoon pattern may have established in the Late Miocene, which has been suggested by the studies pointed out by the referee (e.g. Sun and Wang, 2005, Palaeo-3, 222:181-222; Guo et al, 2008, Climate of the Past, 4:153–174; Wang et al., 2014, Climate of the Past, 10, 2007-2052). In fact, we have also shown that the modern-like interannual variation of summer monsoon may have already been established in the Late Miocene (Tang et al., 2013). Here, we focus on the winter monsoon pattern, not the summer monsoon pattern. But we will add a short discussion on this problem in the revised manuscript to avoid confusion of the summer monsoon and winter monsoon spatial patterns.

In summary, the reviewer challenges most on our proxy data and its uncertainties in indicating cooler-than-present winter climate in the Late Miocene. We have discussed this issue in Section 4.1 of our manuscript. But apparently, it is not convincing enough to the readers. We will elaborate this part according to the reviewer's comments in our revised manuscript.

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