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:

1#"Most of the plant and mammal fossil data as well as the model simulations of the authors show that the annual mean and the winter temperatures in both northern and southern China are warmer during the late Miocene than today (Table S1 and Figure 3), but why did the authors insist to claim that the winter was cooler?"

In our manuscript, we do **NOT** claim that the winter was cooler everywhere in the Asian monsoon region. Instead, we argue that the winter in **Southern China and India** might have been cooler in the Late Miocene than at present. This argument is based on plant and mammal fossil data, which indicate apparent cooler-than-present winter temperature in various localities from southern China and India (see Table S1 and Figure 3). The reviewer is right that there are also some localities in southern China and India indicating warmer annual mean and winter temperature (see Table S1 and Figure 3). This is the uncertainty in our proxy data that we clearly show to the readers. But we want to emphasize that in spite of the uncertainty, **the cooler (winter) temperature signals in our proxies from southern China and India are prominent**! They cannot be explained by systematic biases of the reconstruction methods, because using the same methods, we also get higher-than-present temperature in some localities in southern China and India (see more details in our reply to short comments from Dr. Grimm). They cannot be explained by the changes in surface elevation either, because the surface elevation in the Late Miocene is suggested to be lower or similar to present-day (see Fig. 2), which will favour warmer rather than cooler than present surface temperature. Our purpose in the manuscript is to explain these cooler temperature signals from a climatic perspective. In addition, as mentioned in our text (P73, Line26-29), we propose for more quantitative temperature reconstruction over southern China, India and their coastal region using different methods to further validate the winter cooling in the Late Miocene.

Admittedly, we did not discuss the uncertainties of our proxy data thoroughly in the submitted version. This seems to have caused some misunderstanding that we simply think the winter was cooler in the whole monsoon region in the Late Miocene. We will improve this in our revised manuscript.

2#"The lowering down of the northern Tibetan Plateau and the mountains in the north indeed causes cooling in most of China and India according to their models (Figure 4 e,f), but this cooling is not the climate response to the full boundary conditions of the late Miocene which on the contrary leads to a warming. Moreover, the model simulates stronger winter monsoon in the late Miocene experiment (Fig 4a, b), but it simulates also a warming over China at the same time. According to the conclusion of the authors, stronger winter monsoon must induce a cooling, then how to explain the coexistence of stronger winter monsoon and a warming in their model results?"

Our experiments with full Late Miocene boundary conditions show stronger winter monsoon wind but warmer surface temperature (Fig. 4a, b), because the cooling effect of the stronger winter monsoon (primarily due to the lower northern Tibetan Plateau) is counteracted by the warming effect of other Late Miocene boundary conditions (Fig. 4c, d). Except the lower northern Tibetan Plateau, the other Late Miocene boundary conditions have little effect on the winter monsoon wind, and lead to extensive surface warming (especially over northern China) (Fig. 4c, d). This makes it difficult to detect the cooling effect of stronger winter monsoon in the experiments with full Late Miocene boundary conditions (Fig. 4a, b), as well as in the proxy data (Fig. 3). Only in southern China and India where the warming effect due to other Late Miocene boundary conditions is weak, can the cooling effect of the stronger winter monsoon be manifested in the model and the proxy data. This explains why we observe more localities with cooler-than-present temperature in southern China and India than in northern China.

We will clarify this problem in the revised manuscript.

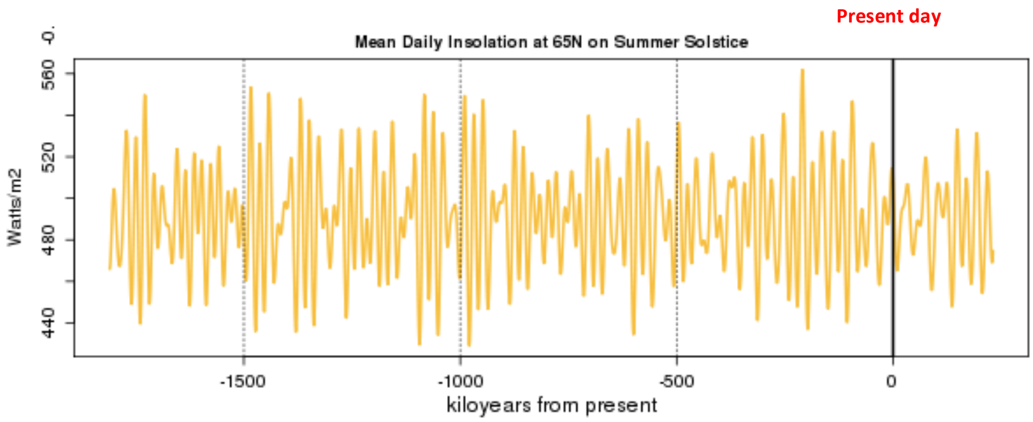
3#"I am not convinced of the use of the plant records (eg. pollen) as a proxy only for temperature. In the tropical and subtropical regions like China and India, change in precipitation might be more crucial than temperature on the variation of vegetation, but precipitation is not at all considered in the interpretation of the plant records. "

We agree with the reviewer that the hydrological conditions strongly impact plant distribution in southern China and India at present, and significantly impact the distribution of plant genera and species. Apart from important humidity gradients, the southern part of our study area today includes the transition from warm temperate to tropical vegetation and thus includes the northern distribution limits of a variety of plant genera with cold month temperature and daily extremes being one of the main delimiting factors (Fang et al., 2011). Therefore we have to assume that the plant fossil record sensitively reflects palaeo-winter temperature, at least under rainfall conditions allowing for a forest cover in the area considered.

4#"The authors referred to several earlier publications for model and experiment design. I suggest giving more information in this paper. The CO2 concentration and orbital parameters used in the late Miocene experiment are the same as present-day. As the focus of this paper is on very regional and seasonal features, I do not think it is appro- priate to keep the orbital parameters same as today because changes in insolation are extremely important for the monsoon climate as has been showed by many studies. It was also said in the Tang et al (2013) paper that this late Miocene period covers several million years with many orbital cycles. Different orbital configuration should be considered to see if the conclusions still hold "

We will add more information about our model and experiment design in the main text. We agree with the review that orbital parameters are important for the monsoon climate. But such influence is more prominent in precipitation than in surface temperature in South Asia (Prell and Kutzbach, 1992). Normally, the orbital parameters favouring more insolation in Northern Hemisphere, can result in stronger summer monsoon but weaker winter monsoon. The variation of orbital parameters in the Late Miocene may explain some of the discrepancies in our proxy data that may represent periods with different orbital parameters. But it is unlikely to have biased the entire dataset toward cooler-than-present winter temperature in southern China and India in the Late Miocene.

In our model experiments, we use the present-day orbital parameters for the Late Miocene experiments. The insolation at 65N with this configuration is in the middle (or slightly upper middle) of its potential range due to the variation of orbital parameters (http://biocycle.atmos.colostate.edu/shiny/Milankovitch/, see following figure). Therefore, our model results could fairly represent the average conditions in the Late Miocene. We would expect that using orbital parameters favouring lower-than-present insolation at 65N, the winter monsoon in the Late Miocene can get even stronger than present. If we use orbital parameters favouring higher insolation at 65N, the winter monsoon in the Late Miocene should get weaker. But it may still be stronger-than-present. In general, we think our model results are sufficient to suggest that the Late Miocene winter monsoon wind, on average, was stronger than present.



5#"Based on the coexistence of stronger winter monsoon wind and a cooling over China in both present-day observation and in model simulations, the authors claimed that the stronger wind is the cause of the cooling. More explanation should be given to demonstrate the robustness of this cause-effect relationship. Figure 1 and 5 show that for the present-day, stronger winter monsoon is associated with a cooling in both northern and southern China, but in the late Miocene experiment, the similar strong monsoon is associated only with a cooling over the western Pacific and the coastal regions of China. If we agree that strong winter wind causes cooling in China, it would be more logical if the northern China also gets cooler because the wind blows from the north to the south. Is it possible that the cooling over the western Pacific in the late Miocene experiment is due to other reason? "

The strong winter monsoon causes surface cooling by advecting cold air from north to south. The cooling effect depends on the temperature of the moving air mass advected from the north and the local temperature. We do expect that both northern China and southern China become cooler with stronger winter monsoon. But northern China should not necessarily exhibit more prominent cooling than southern China, because the local temperature in northern China is already low. Since the local temperature in southern China can be much higher than the advected cold air mass, the cooling effect in southern China due to strong winter monsoon might be more prominent in southern China than in northern China (as seen in Fig. 5c,d). Moreover, since the Late Miocene is much warmer in the high-latitude region, the cold air advection to northern China may not be as strong as that at present. This can also reduce the effect of winter monsoon strength on surface temperature in northern China (as seen in Fig. 5c,d).

We note that the cooling effect of winter monsoon can be even stronger over the near-shore ocean because of the interaction of winter monsoon with ocean water mixing. We do not see any evidence suggesting other mechanisms might induce the cooling over the western Pacific on interannual-scale in our Late Miocene experiments (as seen in Fig. 5c,d). On inter-annual scale, the strong winter monsoon is normally related to La Niña conditions (Sakai and Kawamura, 2009), which would favour higher (rather than lower) sea surface temperature in the western Pacific.

6#"For claiming that "the modern-like interannual variation of the 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", the authors need to explain what causes the interannial variability in monsoon winds and in temperature for both present-day and the late Miocene. "

The interannual variation of the winter monsoon is strongly associated with El Niño- Southern Ocean oscillation (ENSO) (Chen et al., 2004; Sakai and Kawamura, 2009), North Atlantic Oscillation (NAO) and Arctic oscillation (AO) (Gong et al., 2001; Jhun and Lee, 2004). We will include an explanation on the causes of the inter-annual variability of the winter monsoon wind in the revised manuscript.

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