Reply to reviewer comments 1 (RC1):

Witkowski et al. reported multiple biomarker records from a late Paleogene section from the Luhe Basin on the southeastern Tibetan Plateau. The biomarker indicators include TOC, n-alkanes, hopanes, terpenoids, and brGDGTs. The section may or may not include the Eocene-Oligocene Transition (EOT) around 33.9 Ma. Based on these biomarker records, authors infer that regional vegetation did not change significantly over the study period (likely the Rupelian), while the depositional environment changed dramatically from a lower energy flood basin, wetland/peatland and/or shallow lake to a higher energy flood plain and/or channel. The brGDGT-based MBT'5me temperature record shows high variability but does not show particular long-term trending. The authors conclude that the regional temperature has not changed much since the late Paleogene (with the support of model simulations), despite the dynamic changes in depositional environment.

The tectonic evolution in the Tibetan region has affected the Asian monsoon system and global climate, as well as biodiversity. However, the links among them is far from being understood. This study, reporting climatic and environmental changes during the Rupelian period from the southeastern Tibetan Plateau, would definitely contribute to our knowledge on this topic, and should be of broad interest to scientific community. This manuscript is worth to be considered by the journal. I provide a few comments below for authors' consideration.

We thank the reviewer for their positive comments and their constructive feedback. We respond to each comment below in bold text. Line numbers refer to the "track changes" version of the manuscript.

Authors stated that the regional temperature during the Rupelian period was close to present-day value, which is also reflected in the title. Although authors cited paleobotany- and model-based results to support their claim, it is quite difficult to accept this claim As in authors' simulations, regional temperature cooled by ~6C from 4x to 2x preindustrial pCO2 (with topographic effect contributing little), it is hard to imagine the regional temperature would have remained the same when pCO2 dropped from 2X to the preindustrial value. I would suggest that authors might check their 2x simulation to find out why temperature did not change significantly from the preindustrial value and provide such an explanation in their text. If such an explanation is not available, then authors might consider weakening this statement a bit.

This is an excellent point. In our description, we were referring to the Rupelian and Chattian, which this section definitely contains; in the Rupelian and Chattian, the palaeobotany, models, and biomarkers all closely agree (e.g., Fig. 6). The 6°C cooling in the models is across the Eocene-Oligocene transition, which we were more tentative in claiming in this section, given the uncertainties on the Ar/Ar dating. We have added a paragraph describing why the model and biomarker data disagree across this boundary (if this section contains the EOT), and that "this difference is likely due to spatial resolution of the model (large homogenous grids) versus the biomarker data (specific details on a basin scale); the model cannot capture the complex topography that may influence the climate at this site." Developing higher spatial resolution models are currently being pursued (but are not available at this time).

Authors provided two possibilities that the EOT may or may not be present in their studied section. However, I note that at the bottom of their stratigraphic column, Chron C15n, which is around 35 Ma, appears to be well defined. Authors do not have much confidence in this chron?

Based on the reviewer's comments, we now include the ages in all relevant figures and have added ~Line 98, "The uncertainties in the age are important to note, as it means that the Lühe Basin may or may not cover the Eocene-Oligocene transition (EOT) that occurred at 33.9 Ma, though the palaeomagnetism suggests that this section likely includes the EOT."

Also, the study period covers the most of Rupelian period, not Chattian period authors claimed (although simulation results for the Chattian period should be OK for comparison with authors' results).

We agree. We note that there are minimal differences between the Rupelian instead of Chattian, especially in terms of the relative uncertainties between intra-stage reconstructions. The main point here was to differentiate between the non-ice period hothouse of the end Eocene vs. the icehouse conditions of the Oligocene. We more explicitly refer to the Rupelian results throughout the manuscript.

Authors attributed the large variability in MBT'5me, ~0.3 unit which is equivalent to 10-15 C temperature changes to the mixture of in situ vs. allochthonous brGDGTs. Could authors compare the MBT'5me with one of the environmental indicators (for instance, Paq?) to see if a possible relationship could be found? This is quite important as authors stated that depositional environmental changed from earlier to later time. That is, such depositional environment changes could have contributed to/resulted in the no overall trending.

This is an excellent suggestion to further test whether the temperature is impacted by changes to the mixture of in situ versus allochthonous brGDGTs. We plotted MBT'5me against Paq (as well as MBT'5me against lithology), but there are no apparent trends.

Similarly, authors in one place (around Line 360) mentioned the increase in 6-methyl brGDGTs, which could also be verified by authors' CBT/pH record. Authors might be aware that the increase in 6-methyl brGDGTs, i.e., the change of IR6me value, could significantly affect MBT'5me value, as reported in recent studies, for instance, Wu et al., 2021, CG, https://doi.org/10.1016/j.chemgeo.2021.120348 and Wang et al., 2021, GCA, https://doi.org/10.1016/j.gca.2021.05.004. Authors are strongly suggested to evaluate this effect. My sense is that MBT'5me value could be lowered a bit if this effect is corrected, based on the information authors provided. If correct, authors may not need to present two possibilities whether EOT is present or not (my Point #2), and authors might see relatively high temperature at the lower part, whihc could represent the late Eocene interval. Authors might also want to look at the MBT' index.

We agree. We have reworded this section to more accurately reflect the record ~Line 359-363, "This variability in CBTpeat (but not in MBT'5me) is due to four samples in the upper section (depths 273.5, 301.9, 311, and 331.5 m) that contain 6-methyl brGDGTs; these are the only samples that contain 6-methyl brGDGTs in this whole section. Our tests show no correlation of the 6-methyl brGDGTs with overall changes in depositional environment (e.g., against Paq values) but do show expected changes with pH (Wu et al., 2021; Wang et al., 2021). Indeed, the four 6-methyl brGDGT-containing samples have high pH values (respectively, 7.6, 6.3, 7.7, and 6.6 pH), as compared with …"

The MBT'5me temperatures with/without 6-methyl samples are similar throughout (the four samples with 6-methyl brGDGTs are respectively 20.4, 14.1, 15.5, and 16.5C). These four samples are the youngest/upper part of the section (latest Rupelian, earliest Chattian) and do not impact the EOT at the bottom/lower part of the section.

A recent study He et al., 2022, Science Bulletin https://doi.org/10.1016/j.scib.2022.10.006 might be added to support the view that this region might have reached present elevation since the late Eocene.

Added (Line 460).

Some explanation should be provided for the lithologic column in Fig. 2.

Added.

pH reconstruction is not plotted in Fig 6 but stated so in figure caption.

Removed from figure caption.