Replies to Editor:

Thank you very much for these constructive comments. We have revised the manuscript carefully based on these suggestions. The followings are our point-to-point replies.

1. *Model description. I think there are some aspects of this that are incorrect aside from the mention of CISM pointed out by reviewer 3. I think CAM5 has 30 levels. Perhaps you are using CAM4 physics, which has 26 levels? Also, if you used the T31_gx3v7 grid then you're not using the finite volume dynamical core. I'm not sure if that's what you mean by line 111 but this is using the Eulerian atmospheric dynamical core.*

Responses: Thank you very much for these suggestions. We rewrote model description. The statement in Line 111 is revised as follows: "The CAM4 uses the grid T31_gx3v7, with the horizontal resolution of about 3.75°×3.75° and 26 vertical levels."

2. *144-157: It wasn't totally clear to me what orography was being used in these experiments. I assume it's real world orography? But it might be best to state that explicitly.*

Response: Thank you very much for this suggestion. We use the real-world orography; and we have made the statement more clearly in the revised manuscript.

3. *Your arguments for how the Tibetan plateau is influencing the stratospheric polar vortex are a bit unclear to me (e.g., l214-216). Presumably it is affecting the upward wave propagation into the stratosphere which is then leading to changes in the stratospheric polar vortex. This could either be through the influence of the altered mean flow or the influence of wave sources from the troposphere. You might consider the arguments of Garfinkel et al 2010 https://doi.org/10.1175/2010JCLI3010.1 which relates polar vortex strength to stationary wave anomalies that occur in the North Pacific, given that you have anomalies in the North Pacific. I think it could be worth elaborating on this aspect.*

Responses: Thank you very much for this suggestion. We have carefully read the paper you suggested. The paper shows that the low over the North Pacific results in a dramatic increase in wave-1 upward propagation, convergence at the vortex, thus weakening the stratospheric vortex. We also examine the EP flux in NoTibet (Fig. R1). This figure below is the new Fig. 5 in the revised manuscript.

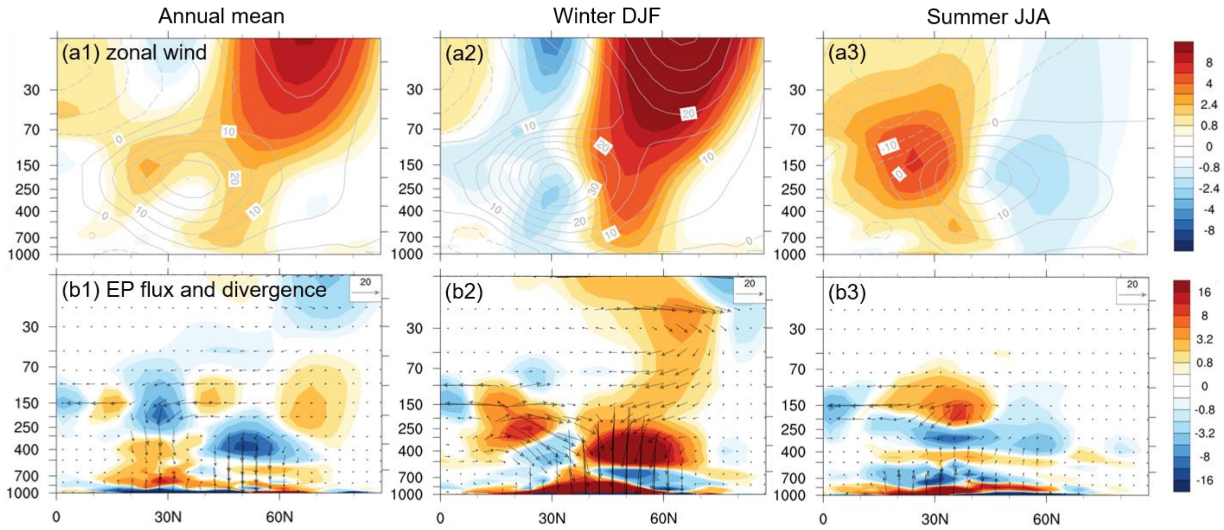

Fig. R1 Quasi-equilibrium changes in (**a**) zonal mean zonal wind (shading; m/s) and (b) EP flux (vector; m^2s^{-2}) and its divergence (shading; ms^{-1}) in NoTibet with respect to Real, averaged over years 1-100. Gray contours in (**a**) show the zonal wind in Real. (**a1**, **b1**), (**a2**, **b2**) and (**a3**, **b3**) are for annual mean, boreal winter and boreal summer, respectively. The EP flux is multiplied by the square root of 1000/pressure for easy visualization.

Removing the TP reduces the upward wave propagation in the boreal winter (Fig. R1b2). There is also divergence in the stratosphere over the Arctic, suggesting the enhancement of stratospheric westerly wind and polar vortex. Then, we use the wave activity flux to examine the change of wave propagation carefully (Fig. R2). The center of anomaly downward wave propagation is located in the North Pacific. This means the perturbation of the TP first forces waves to propagate north-northeastward in the troposphere (Fig. 6b2), triggering a high pressure in the North Pacific, which reduces the upward wave propagation from the troposphere to stratosphere, consistent with the paper you recommended.

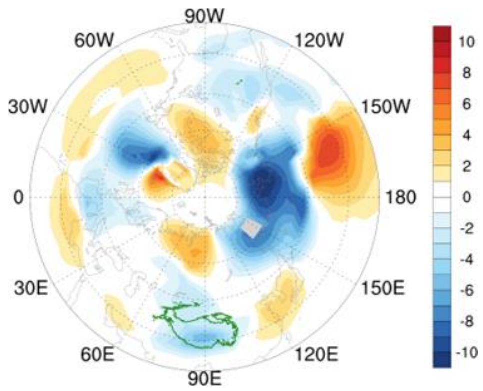

Fig. R2 Quasi-equilibrium changes in the vertical component of wave activity flux (shading; m^2s^{-2}) at 200 hPa in boreal winter, averaged over years 1-100.

We revised the text in Lines 212-218 to describe the circulation change in the stratosphere and upper troposphere in response to TP removal. Then, we discuss the mechanism of TP affecting the stratospheric polar vortex through E-P flux in Lines 248-256.

Lines 212-218: *Figure 4b shows the wintertime intensified westerlies and cooling center in the polar region. The polar low is enhanced significantly in winter. The polar vortex refers to a planetary-scale westerly flow that encircles the pole in the mid-high latitudes (Waugh et al. 2017). Removing the TP leads to intensified westerlies in mid-high latitudes in upper level, suggesting the deepening of polar vortex (a cyclonic geopotential height anomaly over the polar region in Fig. 4b), causing cooling in Arctic. While in summer, the upper-level atmospheric circulation is hardly changed over the Arctic (Fig. 4c).*

Lines 248-256: *The perturbation of the TP can affect the upward wave propagation, leading to changes in stratospheric winds and polar vortex. In boreal winter, the background westerly winds (Fig. 5a2) at stratospheric over Arctic is favorable to the upward propagation of Eliassen-Palm flux (E-P flux, Eliassen and Palm 1960; Holton and Hakim 2013). Removing the TP reduces the upward wave propagation, with divergence of E-P flux at the stratospheric vortex (Fig. 5b2), resulting in the enhancing of the westerly winds and polar vortex, and thus Arctic cooling. By contrast, the stratospheric winds are easterly in boreal summer, which inhibit the upward wave propagation (Fig. 5b3), leading to trivial changes in Arctic stratosphere after removing the TP.*

4. *227-229: The dynamical reasoning here is unclear to me. The surface warming will only propagate upward if there's diffusion or vertical advection to make it happen. I don't see why the enhanced polar jet is needed to limit the surface warming to the lower levels. Suggest clarification.*

Responses: Thank you very much for this comment. This statement in our original manuscript was not clear; so we revised this paragraph as follows: "*Responses in the upper level and surface are separated. Note that in the first 100 years after the TP removal, there is strong surface warming over the Arctic (Fig. 2),* which *does not propagate upward and cause no stratospheric warming, due to weak vertical advection.*"

5. *245-250: You invoke differences in the mechanical forcing by the orography to explain seasonality, but it should perhaps be acknowledged that during the summer the stratospheric*

winds are easterly so altered upward wave propagation is inhibited and you wouldn't expect the same kind of influence on the polar vortex.

Responses: Thank you very much for this comment. We do agree the seasonal variation of stratospheric wind is also critical to the seasonality of TP-Arctic teleconnection. This is a useful supplement to the seasonality; and we have added it in the revised manuscript (Lines 248-256).

6. *For the dynamics of the Indian Ocean teleconnections to the Southern Hemisphere, the recent paper by Gillett et al 2022 may have some insights https://doi.org/10.1175/JAS-D-21-0206.1*

Responses: Thank you very much for this suggestion. We have read the paper and cited it in our revised manuscript. In Gillett et al. (2022), they conducted CAM5 experiments with a heating anomaly over the western tropical Indian Ocean (WIO; 50°-70°E, 10°S-10°N); and their 250-hPa wave structure (Fig. 10 in Gillett et al. 2022) is similar with that in our manuscript (Fig. R3). The heating over the WIO is associated with enhanced convection, which leads to increased upper-level divergent outflow toward the south and an anticyclonic Rossby wave source in the subtropics, triggering poleward wave train in the Southern Hemisphere.

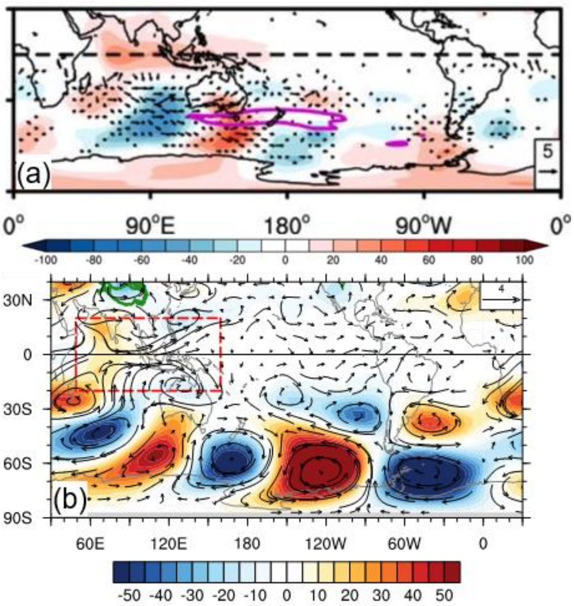

Fig. R3 (**a**) Geopotential height (m; shading) and wave activity flux (vector; m^2s^{-2}) at 250 hPa in Gillett et al. (2022) (their Fig.10e). (**b**) Changes in wind (vector; m/s) and eddy geopotential height (shading; m) at 200 hPa from tropical Indian Ocean SST-forced AGCM runs (Fig.11d).

Reference:

Gillett, Z. E., H. H. Hendon, J. M. Arblaster, H. Lin, and D. Fuchs, 2022: On the Dynamics of Indian Ocean Teleconnections into the Southern Hemisphere during Austral Winter. *J. Atmos. Sci*. https://doi.org/10.1175/JAS-D-21-0206.1

7. *Implications for global warming, l41-43, l549: I'm not really convinced by the reasoning here. Presumably the mechanical influence of the orography is an important part of the response that's seen in your experiments, not necessarily the thermal impacts and the mechanical impacts of orography are not necessarily going to change under global warming, certainly not to the degree that they differ between having the Tibetan Plateau and not having the Tibetan Plateau.*

Responses: Thank you very much for this concern. We do agree the TP's impact under global warming cannot reach the degree described in this manuscript. We would like our readers to know the perturbation over the TP, whether the mechanical effect or the thermal effect of the orography, may impact high latitudes in both hemispheres ***through this possible pathway***, which is the key point of this study. Our recent work showed the TP surface heating under global warming would trigger responses in high latitudes, namely, the warming over the North Atlantic and the strengthening of the AMOC (Wen et al. 2022).

Reference:

Wen, Q., Yang, H., Yang, K., Li, G., Liu, Z., & Liu, J. (2022). Possible Thermal Effect of Tibetan Plateau on the Atlantic Meridional Overturning Circulation, doi: 10.1029/2021GL0957. Geo. Res. Let., 49(4), e2021GL095771.

Typo's/wording:

8. *85-86: "What is the influence passage?" --> "What are the pathways of influence?" (throughout the manuscript I think it would be more appropriate to refer to pathways than passage)*

Response: Thank you very much for catching this. Revised.

9. *92: suggest being more clear what you mean by "upper level" here e.g., this could be the stratosphere or the upper troposphere.*

Response: Thank you very much for catching this. Revised.

10. *95: "Antarctic" --> "Antarctica" or "the Antarctic"* Revised.

11. *238: "remarkable" --> "higher"* Revised.
12. *276: "accompanying" --> "accompanied"* Revised.
13. *327: "should be more difficult to affect the high latitude" --> "should have more trouble affecting the high latitudes"* Revised.
14. *504: "like to" --> "likely to"* Revised.
15. *545: "resulted" --> "resulting"* Revised.
16. *561: "cause mid-latitude westerlies more zonal" --> "cause the mid-latitude westerlies to be more zonal"* Revised.

Replies to Reviewer #1:

Thank you very much for these constructive comments. We have revised the manuscript carefully based on these suggestions. The followings are our point-to-point replies.

This manuscript examines the effects of Tibetan Plateau (TP) orography on the global climate system. The authors' primary focus is on large-scale teleconnections from the TP to the Arctic and Antarctic, mediated by the atmosphere through various transient and stationary wave mechanisms. I believe that the experiments that the authors have run are sound, and their analyses are (mostly) sound. The fixed SST experiments are useful for elucidating the various wave trains that arise from Indian Ocean changes. However, there are very important omissions in the paper that I believe should be addressed before publication. In particular, the study does not look at the impacts of TP flattening on the tropical precipitation and circulation, which are undoubtedly an important part of the climate system response here. Furthermore, they completely neglect the ocean response, even though there are hints throughout the manuscript that TP flattening causes collapse of the overturning circulation in the Atlantic. I think that both of these omissions can be corrected through some further analysis by looking at the (transient and quasi-equilibrium) response in the atmospheric energy transport and the ocean heat transport. Finally, I think the study requires substantial reorganization, which I explain further below. Because of this extra analysis and reorganization required, I believe that the study requires substantial major revisions before it's suitable for publication in Journal of Climate.

Response: Thank you very much for your constructive comments and specific suggestions. Please see our detailed replies below.

Major comments:

1. ***Organization of the study**: The results section of this study is organized very oddly. For a study like this, I expect to see a figure that shows the impact of the imposed perturbation (TP flattening, in this case) on the surface climate, namely temperature and precipitation (and possibly sea level pressure), as the first figure in the results section. Since the authors emphasize differences in the transient and quasi-equilibrium response, this figure should include both of those. A figure like this lays the groundwork for understanding exactly what the climate system response is so that we can assess what requires explanation. Since the authors emphasize the long-range teleconnections to the Arctic and Antarctic, I'd also expect to see a*

figure that focuses on the impacts of these teleconnections on the Arctic and Antarctic. Are there changes in sea ice, for example? The current layout of the paper leaves us flying blindly – we literally do not even know what requires explanation as the authors begin presenting results.

Responses: Thank you very much for these suggestions. In this manuscript, we show the TP-Arctic teleconnection and TP-Antarctic teleconnection separately for two reasons. (1) The magnitude of responses in the Northern Hemisphere (NH) are much larger than those in the Southern Hemisphere (SH). As you can see from Fig. R4, the responses in the SH are not clear if we put the teleconnections over the Arctic and Antarctic in one figure. (2) These teleconnections are robust in winter in both hemispheres, so we tend to discuss the impacts of teleconnection on the Arctic in the boreal winter first, and then move to discuss the impacts on the Antarctic in the austral winter.

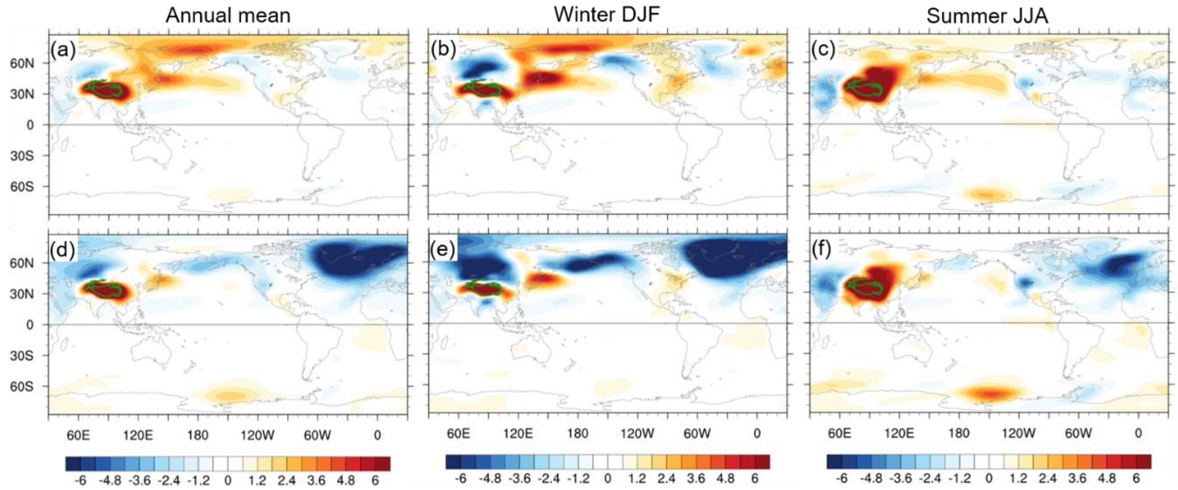

Fig. R4 Changes in surface air temperature averaged over (a)-(c) years 1-100 and (d)-(f) years 300-400. (a, d) are for annual mean; (b, e) are for boreal winter; and (c, f) are for boreal summer.

We would like to emphasize that this work is part of our series study on the role of the TP in the global climate (https://corp.fudan.edu.cn/index_research_Tibet.htm), and it focuses on the TP effect on the polar climate. We have finished the following papers regarding the TP's global climate effects:

(1) Yang, H., X. Shen, J. Yao and Q. Wen, 2020: Portraying the impact of the Tibetan Plateau on global climate. J. Climate, 33(9), 3565-3583, doi: 10.1175/JCLI-D-18-0734.1. This paper discussed the equilibrium changes of the global climate in response to the TP removal, including the global air and ocean temperatures, atmospheric moisture, radiation, ocean salinity, precipitation, Hadley cell, atmospheric and oceanic meridional heat transports, etc.

(2) Yang, H., and Q. Wen, 2020: Investigating the role of the Tibetan Plateau in the formation of Atlantic meridional overturning circulation. J. Climate, 33(9), 3585-3601, doi: 10.1175/JCLI-D-19-0205.1. This paper discussed how the TP affects the AMOC, and the mechanisms at work.

(3) Wen, Q., and H. Yang, 2020: Investigating the role of the Tibetan Plateau in the formation of Pacific meridional overturning circulation. J. Climate, 33(9), 3603-3617, doi: 10.1175/JCLI-D-19-0206.1. This paper discussed how the TP affects the PMOC, and the mechanisms involved.

(4) Wen, Q., K. Doos, Z. Lu, Z. Han, and H. Yang, 2020: Investigating the role of the Tibetan Plateau in ENSO variability. J. Climate, 33, doi: 10.1175/JCLI-D-19-0422.1. This paper discussed how the TP affects ENSO variability, and the mechanisms involved.

(5) Jiang, R., and H. Yang, 2021: Roles of the Rocky Mountains in the Atlantic and Pacific meridional overturning circulations. J. Climate, 34(16), 6691-6703, doi: 10.1175/JCLI-D-20-0819.1. This paper discussed how the Rocky Mountains affect the AMOC and PMOC, and compared the roles of the TP and RM in the global climate.

(6) Chen, Z., Q. Wen, and H. Yang, 2021: Impact of Tibetan Plateau on North African precipitation. Climate Dynamics, 57, 2767-2777, doi: 10.1007/s00382-021-05837-2. This paper investigated the TP effect on the hydrological cycle in the tropics, with a focus on its role in North African precipitation.

(7) Wen, Q., C. Zhu, Z. Han, Z. Liu, and H. Yang, 2021: Can the Tibetan Plateau affect the Antarctic Bottom Water? Geophys. Res. Lett., 48, e2021GL092448. doi: 10.1029/2021GL092448. This paper, for the first time, explored the possible role of the TP in the formation of the Antarctic Bottom Water (AABW).

(8) Wen, Q., Z. Han, H. Yang, J. Cheng, Z. Liu, and J. Liu, 2021: Influence of Tibetan Plateau on the North American summer monsoon precipitation. Climate Dynamics. doi: 10.1007/s00382-021-05857-y. This paper discussed the TP’s role in the summer monsoon precipitation of North America.

(9) Wen, Q., H. Yang, and co-authors, 2022: Possible thermal effect of Tibetan Plateau on the Atlantic meridional overturning circulation. Geophys. Res. Lett., 49, e2021GL095771. https://doi.org/10.1029/2021GL095771. This paper further discussed how the thermal perturbation induced by the TP affects the AMOC.

We didn’t show figures for precipitation in this manuscript because it’s not our focus in this study. We plot the global patterns for precipitation in Fig. R5. The annual mean responses center on

South Asia. Due to the limited paper length, we do not discuss this part in the manuscript, which is discussed in a separate paper (Shen, X., H. Yang, and Z. Liu, 2022: Effect of Tibetan Plateau on ITCZ climatology. Tellus A, submitted).

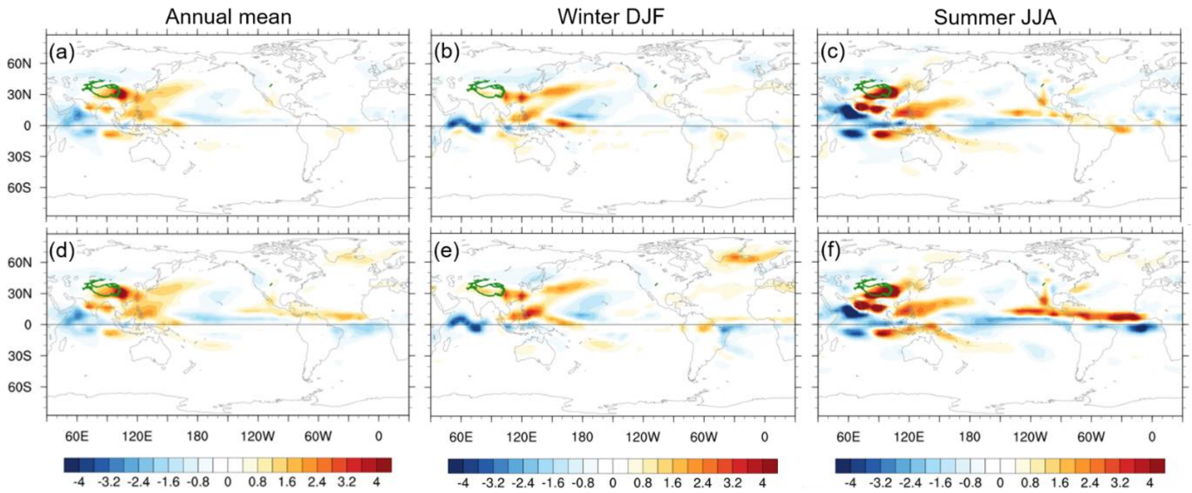

Fig. R5 Same as Fig. R4, but for changes in precipitation.

As for your concern of showing the transient and quasi-equilibrium responses, we want to emphasize our focus is on the atmospheric process (transient response: years 1-100) in this paper. We are sorry that the beginning of section 3.1 was not clear; and we have carefully revised the manuscript this time. We emphasize that we only focus on atmospheric process; and the atmosphere reaches quasi-equilibrium quickly. We add changes in year 20, which is similar to year 90 to support this argument. The surface climate is different in years 300-400 due to the ocean adjustment, which was carefully studied in our previous work (Yang et al. 2020). We showed in our previous papers that the equilibrium atmosphere response in years 300-400 is very similar to that in years 1-100. In other words, the equilibrium changes in the surface climate and the ocean circulation have only very small feedbacks to the atmosphere. Therefore, in this manuscript we only discuss the atmosphere response in years 1-100.

2. ***Description of the time scales of the response****: The authors suggest at many points in the manuscript that the climate system response to TP flattening varies significantly across time scales. However, the authors never present a wholistic picture regarding what the responses are across these different time scales. Moreover, the authors show very little of the quasi-equilibrium response, particularly over the Antarctic. However, they have clearly run long experiments that include this response. Why is the quasi-equilibrium response only hinted at and never adequately*

described or explored? This is linked to the point above, which is that the organization of the study is very problematic.

Responses: Thank you very much for these comments. We rewrote the first and second paragraphs in section 3.1. We describe the climate system response across time scales (years 1-400), and emphasize that the fast atmospheric process (years 1-100) is our focus in this manuscript.

Figure R6 shows a wholistic picture of the response. The surface climate and ocean responses do vary significantly across time scales, but the atmosphere reaches a quasi-equilibrium state quickly after the TP removal. During the first few years, the ocean has little time to adjust; and the TP perturbation impacts climate system mainly through fast atmospheric process, which is our focus.

For your concern about "show very little of the quasi-equilibrium response," the atmospheric responses in the first few years are similar to those in the quasi-equilibrium stage (years 300-400). Figures R7 and R8 compare the wave train and atmosphere circulation in the NH over years 1-100 and years 370-400. Figure R9 compares the wave train in the SH over years 1-30 and years 370-400. Bear in mind that this paper discusses the mechanism, pathways and seasonality of atmospheric process over the Arctic and Antarctic caused by the TP. The atmospheric process adjusts very quickly to reach its quasi-equilibrium. What's more, investigating the fast climate response to a particular forcing factor is of more practical significance. Therefore, we choose to discuss the first few years in this manuscript.

For the quasi-equilibrium response, we carefully discussed it in our previous paper (Yang et al. 2020). So, in this work we focus on the transient response only.

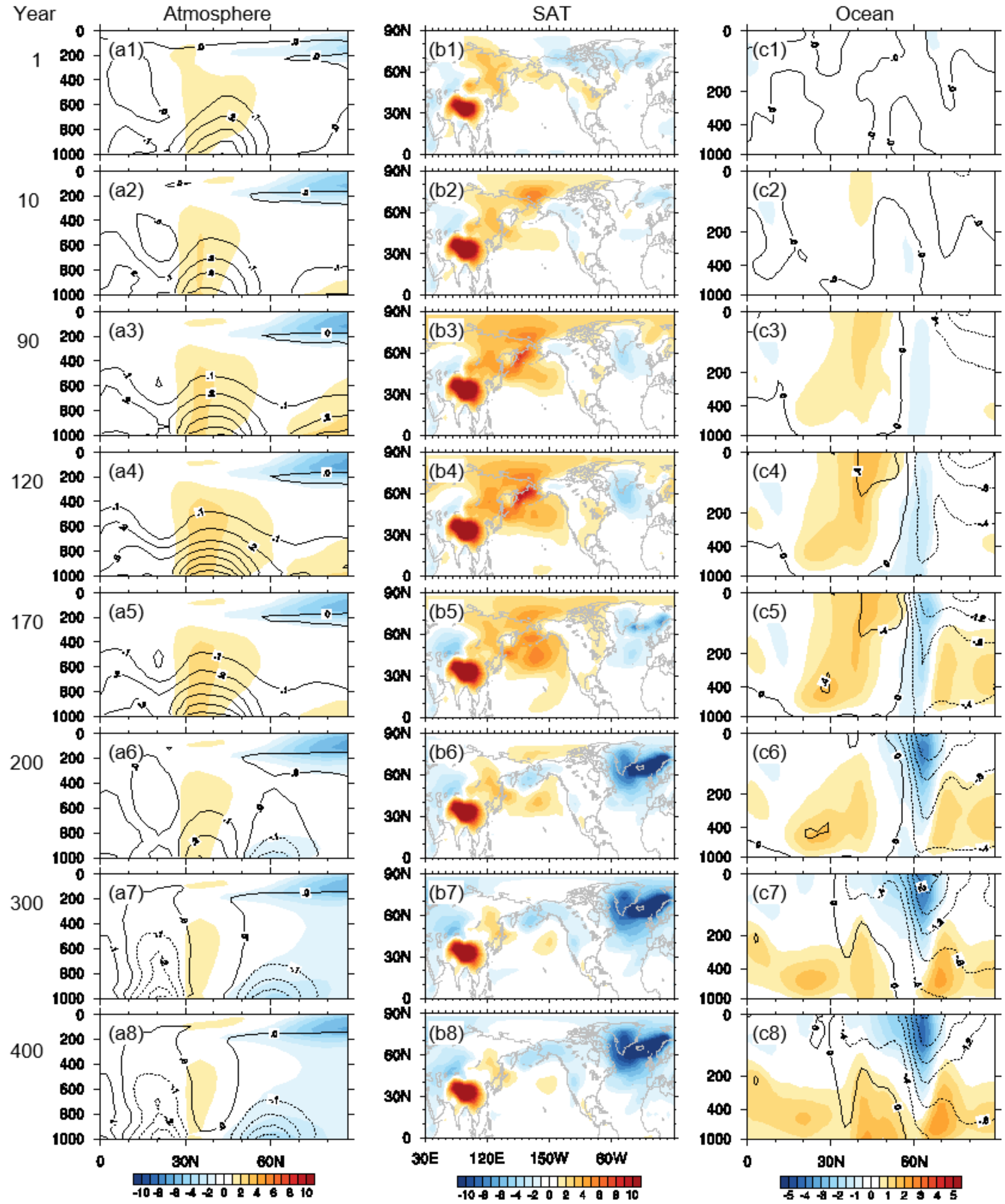

Fig. R6 (Left) Zonal mean air temperature (shading; °C) and specific humidity (contour; g/kg) in pressure-latitude section, (middle) surface air temperature (SAT; °C), and (right) zonal mean ocean temperature (shading; °C) and salinity (contour; psu) in depth-latitude section. From top to bottom: These variables are averaged over the given years given along the left panels, showing their temporal evolutions.

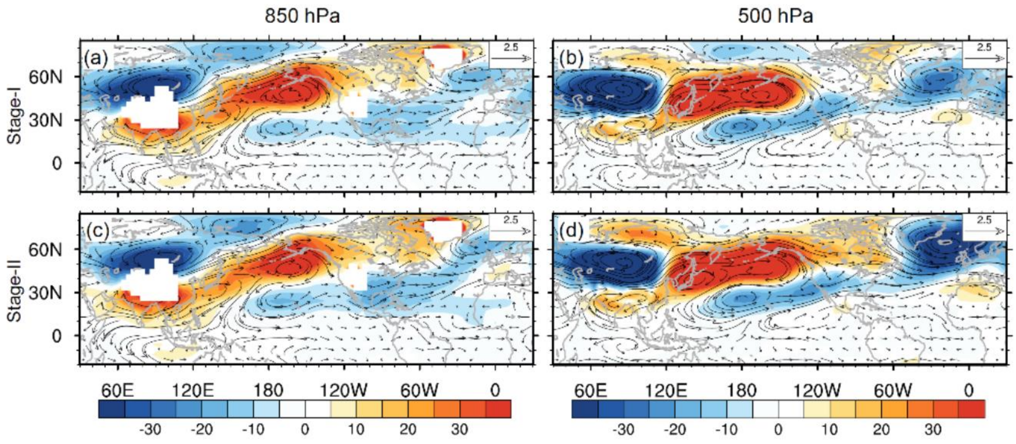

Fig. R7 Changes in geopotential height (shading; m) and wind (vector; m/s) at (a, c) 850 hPa and (b, d) 500 hPa in NoTibet with respect to Real. Top panels are for Stage-I, and bottom panels are for Stage-II. To clearly illustrate the wave structure, the zonal mean value of the geopotential height has been removed. Stage-I is from model years 10-50, and Stage-II is from model years 300-400. From Yang and Wen (2020).

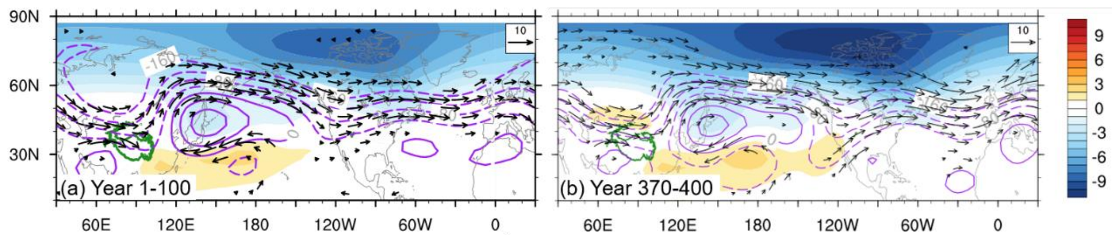

Fig. R8 Changes in surface wind (vector; m/s), temperature (shading; hPa) and geopotential height change (contour; m) in NoTibet with respect to Real, averaged over (a) years 1-100 and (b) years 370-400.

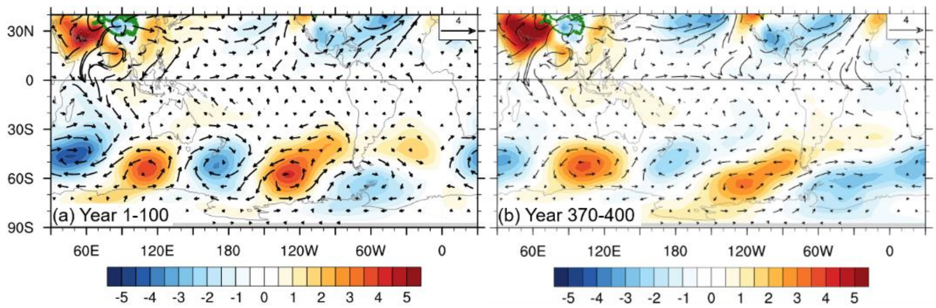

Fig. R9 Changes in surface wind (vector; m/s) and sea-level pressure (shading; hPa) in NoTibet with respect to Real, averaged over (a) years 1-30 and (b) years 370-400.

3. ***Consideration of large-scale energetics**: If there is a fast response to TP flattening that warms the Arctic, it seems reasonable that this should be evident in the atmospheric energy transport. Is it? What happens to the ocean heat transport over these time scales? What about the*

response over the Antarctic – are there responses in the atmospheric energy transport that may explain some of the surface climate response over this region? All these factors should be considered for understanding the different time scales of the climate response to TP flattening.

Responses: Thank you very much for the comments. We examined the meridional atmospheric heat transport (AHT) in Yang et al. (2020) (their Fig. R10). The AHT is consistent with the temperature averaged over the whole layer of the atmosphere. Although there is a fast response to TP flatting, which warms the Arctic surface, the upper troposphere and stratosphere show strong cooling; so after removing the TP, the northward AHT in the mid-to-high latitudes is reduced. Therefore, the AHT cannot explain the Arctic surface warming in our experiments, and the AHT change is the result of the changes in atmosphere temperature and circulations. The AHT responses can nearly be neglected in the Antarctic due to the wave-like changes in the region, because the zonal mean temperature changes there are very small.

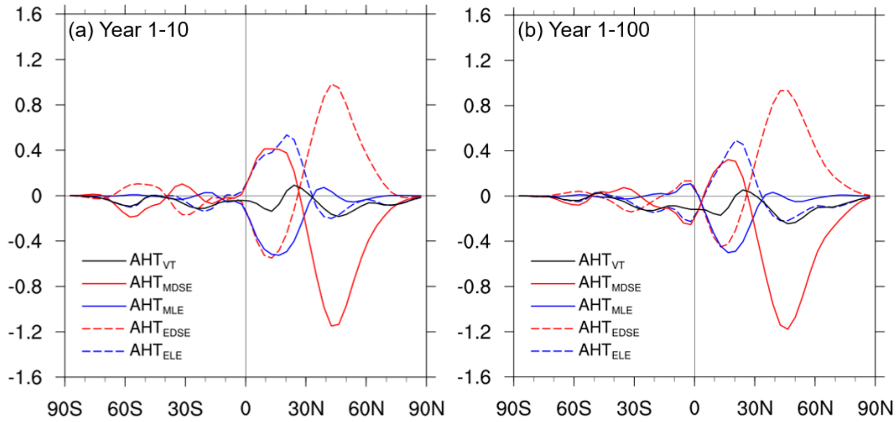

Fig. R10 Changes in meridional atmospheric energy transport (PW) due to TP removal: (a) averaged over years 1-10; (b) averaged over years 1-100.

During the first few years, the ocean has little time to adjust; so the ocean heat transport (OHT) has trivial change (Fig. R11). In the quasi-equilibrium stage, the northward OHT is weakened by as much as 0.4 PW, about 20% of the peak OHT at 30°N, as a result of AMOC shutdown (Yang et al., 2020; Yang and Wen, 2020)

We need to point that the change in heat transport is a result of TP's perturbation, not a driving factor, of the surface climate change. Therefore, the AHT and OHT are not suitable for analyzing the surface climate responses in this study.

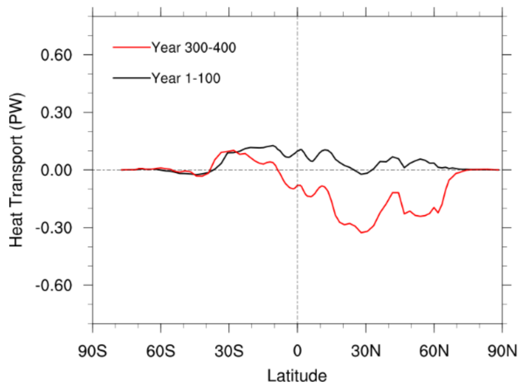

Fig. R11 Changes in ocean heat transport (PW) due to the TP removal. Black curve is averaged over years 1-100, and red curve is averaged over years 300-400

4. ***Tropical precipitation and Circulation Impacts****: Flattening the orography of the TP almost certainly impacts the Hadley cells and ITCZ (consider, for example, Kang et al 2008, Kang et al 2009, Frierson et al 2013). It is likely that this response is important for understanding how TP flattening impacts the Antarctic. The authors should include an assessment of the tropical precipitation, atmospheric mass overturning streamfunction, and cross-equatorial energy transport in their analysis.*

Responses: Thank you very much for the comments. Responses in tropical circulation and energy transport are important; so they are included in our first step to understanding the TP's role in climate system. Please see Figs. 8a and 12c in Yang et al. 2020 (also shown as Figs. R12a, c). Removing the TP can result in more than 10% intensification of the northern branch of the Hadley cell, since the convective center shifts toward the NH, causing the enhancement of AHT toward the north (red curve in Fig. R8c). Detailed discussion on the TP's effect on the ITCZ is examined in Shen et al. (2022) (Shen, X., H. Yang, and Z. Liu, 2022: Effect of Tibetan Plateau on ITCZ climatology. Tellus A, submitted). In this manuscript, we emphasize the TP' s role in polar regions; and tropical precipitation is not our focus. Due to the limited paper length, we prefer not to include it in this manuscript.

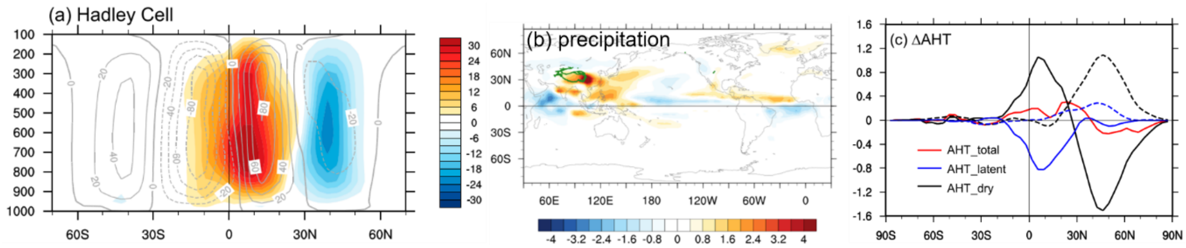

Fig. R12 Quasi-equilibrium annual mean changes in (a) Hadley cell (Fig. 8a in Yang et al. 2020), (b) precipitation (same as Fig. R4a), and (c) atmosphere heat transport (Fig. 12c in Yang et al. 2020).

5. ***The ocean response**: The AMOC response that the authors hint at is the unaddressed elephant in the room here. Clearly, there is a substantial ocean response to TP flattening. However, the authors do not address this ocean response in their study, even while talking about climate responses over regions where such ocean circulation changes may be responsible for a sizeable portion of the response. Over both the Arctic and the Antarctic, we expect that changes in the AMOC would substantially impact the surface climate. Over the Arctic, many studies have shown that AMOC changes (and accompanying ocean heat transport changes) impact surface climate (see, for example, Holland & Bitz 2003, Rugenstein et al 2013, and many others). Even over the Antarctic, changes in the Atlantic overturning circulation may be expected to impact the surface climate, either through thermodynamics (see, for example, Lin et al 2019, Fig 2c) or through changes in the deep overturning cell (see Marzocchi & Jansen 2017). Furthermore, we expect that changes in the AMOC can trigger compensating changes in the Indian Ocean (see Trenberth & Fasullo 2017, Forget & Ferreira 2019). While the authors have (thoughtfully) run multi-centennial fully-coupled experiments, they have not used these experiments to understand the full scope of the climate response. The study requires further analysis to understand the ocean response to TP flattening, and how this ocean response impacts the surface climate.*

Responses: Thank you very much for the suggestions. It is precisely because the AMOC response is so important, our first step of understanding TP's role in global climate is to investigate the impact of the TP on the AMOC (Yang and Wen, 2020); thus, this is not our focus here. Please see Fig. 2 in Yang and Wen (2020) (also shown in Fig. R9), which illustrates the AMOC index and its spatial pattern in the quasi-equilibrium stage. Removing the TP leads to AMOC shutdown.

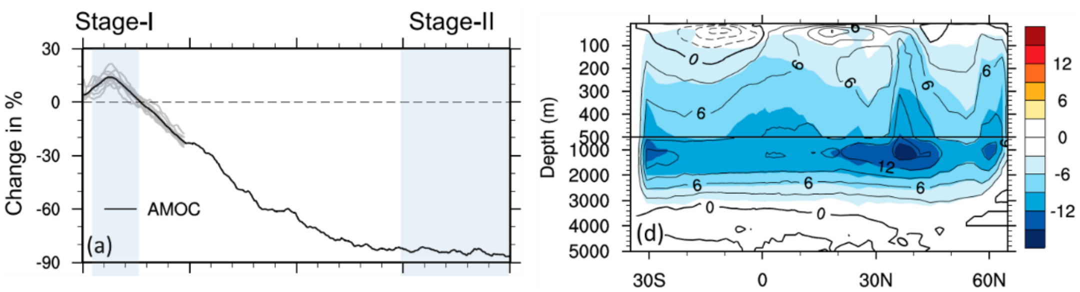

Fig. R13 (a) Temporal evolution of percentage change in the Atlantic meridional overturning circulation (AMOC), with gray curves representing results from 10 ensemble runs. The AMOC index is defined as the maximum streamfunction in the range of 0°-10°C over 20°-70°N in the Atlantic. (b) AMOC pattern (Sv) in Real (black contour), and its changes (shading) in stage II.

We do agree that the ocean responses, such as the AMOC, can impact the surface temperature in the Arctic and Antarctic. This was discussed in Yang et al. (2020) and Wen et al. (2021). We have quantified the TP's role on global climate, especially regarding to ocean responses. In this manuscript, we discuss the mechanism, pathways and seasonality of atmospheric process due to TP perturbation. Thank you very much for the recommended papers.

We focus on the fast atmospheric process, during which the ocean response can be neglected (Fig. R6). Therefore, the SST change (years 1-30) in the tropical Indian Ocean is mainly caused by fast atmospheric process. To confirm this, we conducted a slab ocean experiment, in which the ocean dynamic processes are inactive. The SST changes in the slab ocean experiment are consistent with those in the fully-coupled experiment (Fig. R14). *In the revised manuscript, we do not include the results from the slab-ocean run*.

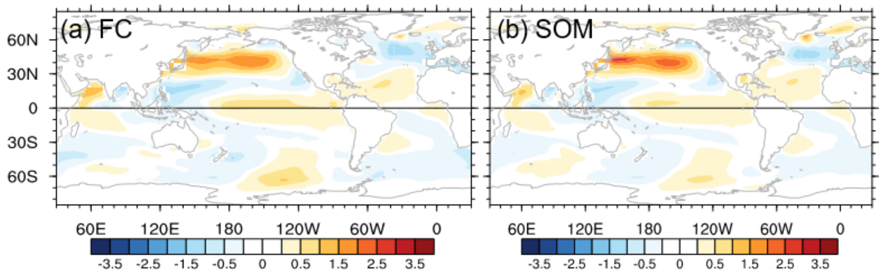

Fig. R14 Changes in sea-surface temperature (SST; °C) (a) during the first 30 years in Fully coupled run and (b) in the slab ocean run.

Minor comments:

6. *109: There is no active ice sheet in this model. CISM is a stub component.*

Responses: Thank you very much for this suggestion. We revised this sentence as follows: "*CESM is composed of an atmosphere model (Community Atmosphere Model; CAM4) (Park et al. 2014), land surface model (Community Land Model; CLM4) (Lawrence et al. 2012), ocean model (Parallel Ocean Program; POP2) (Smith et al. 2010), sea ice model (Community Ice Code: CICE4) (Hunke et al. 2010), and one coupler (CPL7).*"

7. *Choice of model resolution, length of runs, etc: Since the authors are mostly considering the short-timescale transient response (see major comments above), why did they choose to run such long experiments at such a coarse resolution? I'm not quite sure that the choice of model and analysis is consistent with the actual scope of the study.*

Responses: Thank you very much for your concern. We would like to say the low resolution does not affect the results. In one of our previous papers (Yang et al. 2015), we used the same CESM model with high resolution (1.9x2.5_gx1v6, i.e., the atmosphere model has the finite volume nominal 1.9°×2.5° in the horizontal). We compared the mean climate states of high-resolution model and low-resolution model, and found no significant differences between them, including the mean global SST and SAT, the mean meridional heat transport, and so on. Considering the computing resources we have, we chose the low resolution in this study.

We ran the model for 400 years because the ocean responses do not reach equilibrium in a short time. Our previous studies had a detailed analysis of slow responses to TP perturbation. The present manuscript emphasizes the fast atmospheric process during the first few years.

8. *Flat and OnlyTibet experiments: I don't believe that these are ever mentioned in the Results section. Why were these run if they weren't analyzed and their results reported upon?*

Responses: Thank you very much for this comment. We ran this group of experiments to study the changes due to the presence of the TP. This can give us more confidence to estimate the TP's role in global climate. We have carefully examined the results from Flat and OnlyTibet. The climate changes in NoTibet (with respect to Real) are opposite to those in OnlyTibet (with respect to Flat), and they have roughly the same magnitude. Therefore, we have confidence to show the TP's role. The consequences caused by TP perturbation are robust. We only show results from NoTibet and Real experiments for the sake of simplicity.

9. *320: This is the temperature convergence, not the advection. Also, what model variables were used for this calculation? Instantaneous covariances (such as VT) should be used to capture the eddy terms if using monthly output.*

Responses: Thank you very much for this suggestion. We use the monthly mean temperature, U-wind and V-wind for this calculation. In Fig. 7a3, we plot $\vec{V} \cdot \nabla T$. This is the temperature advection term. The convergence term should be $T\nabla \cdot \vec{V}$. VT is the heat transport, and $\nabla \cdot (\vec{V}T) = \vec{V} \cdot \nabla T + T\nabla \cdot \vec{V}$. For your reference, we also plotted model output VT in Fig. R15. You can see that the patterns in Fig. R15 are similar to those in Figs. F7a3, b3; however, they are different variables.

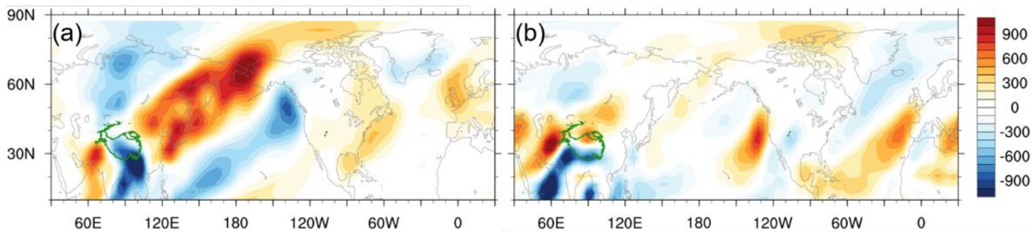

Fig. R15 (a) Changes in surface meridional heat transport (VT; Kms^{-1}) during the first 100 years in (a) boreal winter and (b) boreal summer.

10. 370-371: This isn't necessarily true if there are also large-scale changes in the ocean occurring simultaneously. It's almost certain that there are changes in the oceanic subtropical cells that are driving these SST anomalies over the Indian Ocean. There are several studies that look at Indian Ocean responses to AMOC collapse, driven by energetics, that change the cross-equatorial energy transport (see above). This requires further analysis.

Responses: Thank you very much for this suggestion. We have revised the statement in Lines 374-380 because it needs further investigation.

11. Figure labelling: All figures should have color bars labelled with units, and should have titles that include the time scales over which the response is being assessed.

Response: Thank you very much for this suggestion. They are all included in the figure captions. The first sentence in each figure caption tells clearly the variable and its units, as well as the time scale we choose. For the clearness of the figure, we decided not to add titles and units in the figures.

12. 538-540: Once again, the authors have literally not shown anything substantive about the ocean overturning circulation response. This is incorrect.

Responses: Thank you very much for this comment. We show the colder climate in the NH in Fig. 2 after 200 years due to the AMOC shutdown, which was carefully discussed in our previous papers (Yang and Wen 2020; Yang et al. 2020). Most previous studies investigated the TP's role in global climate using atmosphere circulation models. Our model results emphasize the critical role of ocean feedback on climate change caused by TP flatting. This manuscript focuses on fast atmospheric processes and teleconnection; and we also find that the oceanic processes do not feedback to the teleconnection much. Since the teleconnection pattern does not change much, as shown in Figs. R4, R6, the ocean responses are not shown.

13. 572-574: Since this is not a paleoclimate study, it is clear that the response assessed here will not be analogous to that which occurred when the TP was forming.

Responses: Thank you very much for this comment. We are aware that the results here may not be comparable to observed features because the model uses modern climate parameters (higher CO_2 concentration). Tectonic changes, like the TP uplift, only occurred on the geological time scale. Quantifying the impact of TP uplift on polar climate is difficult in a realistic world. This study can help us understand possible responses over the polar regions related to dramatic TP changes in the Cenozoic.

14. Grammatical issues: The paper is generally well written. However, there are a lot of small grammatical errors scattered throughout the manuscript that require editing. I will leave this to the authors

Response: Thank you very much for this suggestion. The gramma in the revised manuscript is improved greatly with the help of a professional English editor.

15. 426: Incorrect spelling of Bellingshausen Sea.

Response: Sorry. Revised

References:

Yang, H., Q. Li, K. Wang, Y. Sun and D. Sun, 2015: Decomposing the meridional heat transport in the climate system. Clim. Dyn., doi: 10.1007/s00382-014-2380-5, **44**: 2751-2768

Yang, H., & Wen, Q. (2020). Investigating the role of the Tibetan Plateau in the formation of Atlantic meridional overturning circulation. J. Clim, 33(9), 3585–3601. https://doi.org/10.1175/jcli-d-19-0205

Wen, Q., Zhu, C., Han, Z., Liu, Z., & Yang, H. (2021). Can the topography of Tibetan Plateau affect the Antarctic bottom water? Geo. Res. Let., 48(6), e2021GL092448. https://doi.org/10.1029/2021gl0924.

Yang H, Shen X, Yao J et al (2020) Portraying the impact of the Tibetan Plateau on global climate, doi: 10.1175/JCLI-D-18-0734.1, J Clim 33(9):3565–3583

Replies to Reviewer #2:

This paper examines the far-reaching impacts of the Tibetan plateau (TP) on the polar region and identifies the seasonality and passage through which the TP influences the polar regions. Both coupled and atmospheric configuration of CESM has been used to determine the possible teleconnections. The stationary waves propagation pathways causing the teleconnection were identified, and their seasonal dependence was highlighted. The premise of the study is interesting and it could add a valuable contribution to understanding the influence of the role of TP orography in the climate system, so I think it could be appropriate for publication in the Journal of Climate. However, I have a number of concerns/required improvements to the paper that I think should be addressed before publication.

Responses: Thank you very much for your constructive comments. We have revised the manuscript carefully based on these suggestions. The following are our point-to-point replies.

Major comments:

1. *Although the coupled modeling simulations were carried out for an extended period, i.e., 2400 and 1400 years still, the paper only analyzed the first few years specifically for examining the Antarctic teleconnections. The ocean circulation changes take many years to adjust fully to a perturbation caused by such large orographic suppression, and hence it is possible that the equilibrium response to TP lowering may differ significantly. Therefore, this particular analysis would probably be closer to a quasi-equilibrium state if the authors analyze the last 30 years of the 400-year model runs. They should also check the top of the atmosphere (TOA) flux imbalance in the simulations for the last few years of the model runs.*

Responses: Thank you very much for the comments. Reviewer #1 also raises the same question on why we only analyzed the first few years (years 1-100) but not the quasi-equilibrium stage (years 300-400).

There are two reasons. First, the equilibrium responses of the atmospheric process are similar to those during the first few years. In other words, the oceanic processes do not feedback to the teleconnection much, because the teleconnection pattern does not change much with time. Please refer to Figs. R7-R9, in our replies to Reviewer #1. We compared the responses during years 1-100 and years 370-400. Changes in atmospheric circulation and the wave train (pathways of influence) in both hemispheres remain the same. Only changes in surface climate differ significantly, which is related to the ocean response (Fig. R16), as reported in Yang et al. (2020).

Second, the equilibrium response, including the ocean response and surface cooling in the Northern Hemisphere (NH), was carefully discussed in our previous studies (Yang and Wen, 2020; Yang et al., 2020), so we won't describe it again. In this work, we discuss the fast atmospheric process related to TP's perturbation impact on the polar regions. The fast response is of more practical significance to future climate change.

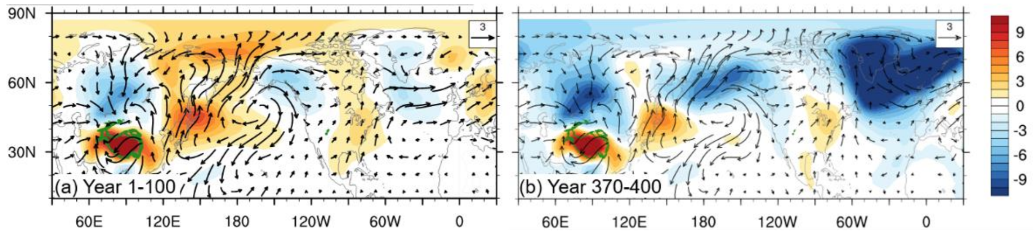

Fig. R16 Changes in surface wind (vector; m/s) and temperature (shading; hPa) in NoTibet with respect to Real, averaged over (a) years1-100 and (b) years 370-400.

We checked the TOA flux imbalance during years 300-400 (Yang et al. 2020). The TP change causes a slight net energy imbalance in the Earth system, of about 0.1 PW (Fig. R17, solid black curve; or see Fig. 2 in Yang et al. 2020). The TOA energy imbalance is mainly due to the reduced outgoing LW, which in turn results from the global surface cooling due to ocean dynamics. Figure R18 (Fig. 3 in Yang et al. 2020) shows the horizontal patterns of TOA fluxes.

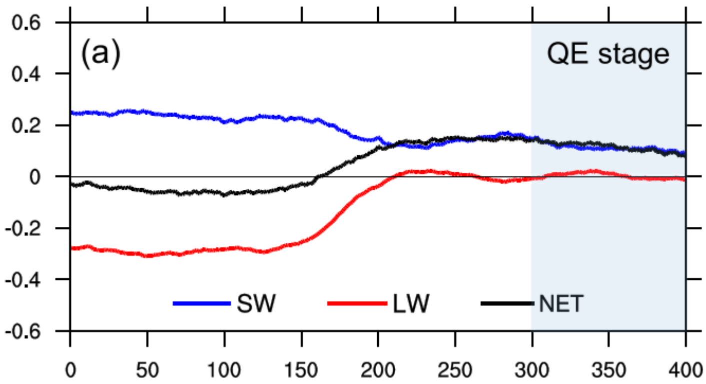

Fig. R17 Temporal evolutions of globally integrated net radiation flux (black), net downward shortwave (SW; blue), and net outgoing longwave (LW; red) at the TOA (PW, $1PW=10^{15}W$; positive for downward anomaly) due to TP removal. From Fig. 2 of Yang et al. (2020).

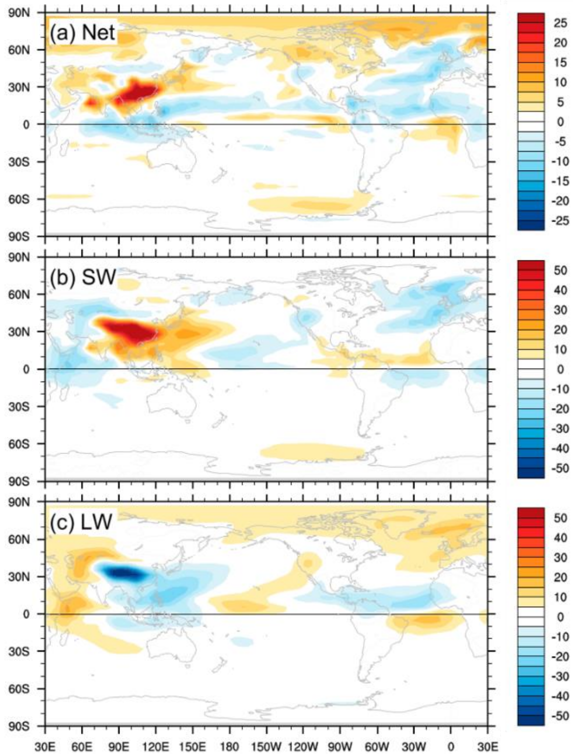

Fig. R18 Quasi-equlibrium changes in radiation flux and clouds due to TP removal: (a) net radiative flux, (b) SW, and (c) LW at the TOA. Units: Wm^{-2}. Positive (negative) value represents downward (upward) flux. From Fig. 3 of Yang et al. (2020).

2. *For the Arctic region, the tropospheric temperatures have not reached quasi-equilibrium in the first 100 years, which is also evident from Figure2; hence the results for this set of simulations should also be examined for the later period to identify the remote impact of TP suppression and its passage. The authors should also make an attempt to discuss the role of changes in the oceanic circulation and AMOC in causing Arctic cooling in the lower troposphere to highlight the importance of both oceanic and atmospheric passages through which TP influences the Arctic using these coupled simulations.*

Responses: Thank you very much for the comments. We add changes in year 20 in both Fig. 2 and Fig. 3 in the revised manuscript. The pattern is similar to that in year 90, suggesting the tropospheric temperatures have reached quasi-equilibrium in the first 100 years. Figure R19 shows changes in surface temperature over the Arctic with time. The tropospheric temperature warms up during the first 100 years and then cools down in ~200 years due to the shutdown of the AMOC. The warming is mainly caused by atmospheric processes, which reach the quasi-equilibrium state very quickly; so the response in the Arctic troposphere remains stable during the first few years.

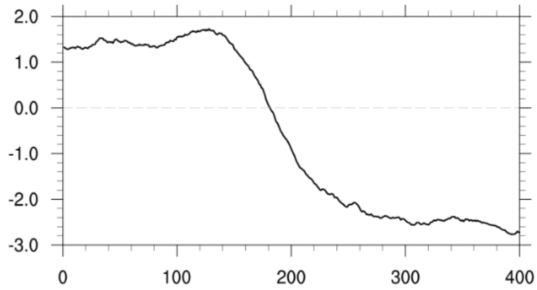

Fig. R19 Temporal evolution of SAT change (°C) averaged over the Arctic (60°N-87.5°N).

Our previous paper examined the oceanic passages during the later period: the shutdown of the AMOC promotes the cooling in the North Atlantic (Yang and Wen 2020; Yang et al. 2020). Therefore, we do not include the ocean process here.

Note that the atmospheric process is our focus in this manuscript. We choose the first few years because responses are mainly due to atmospheric processes, as the ocean hasn't changed much (Fig. R6). In addition, the atmosphere pathways of influence are alike through the whole model years (Figs. R7, R8); so examining the first 100 years is adequate.

3. *Without the depiction of significant testing, it is really difficult to comment on the robustness of the response, especially in the response over the Antarctic, which lies in the opposite hemisphere. The authors should either show the significance testing by applying stippling on the figures or should only show the differences that are statistically significant for all the figures.*

Responses: Thank you very much for the suggestions. The changes of variables in this study are significant in both hemispheres, except for the response in the Southern Hemisphere in the austral summer. Responses over the Antarctic in the austral summer are not robust, as shown in Fig. 9. We carried out the student *t*-test for all results shown in figures related to changes. For visual simplicity, we tend not to show the significance test. Figure R20 shows the SAT, temperature averaged over 100-200 hPa and wave train with significance levels. Changes of all these variables exceed the 95% significance level in most regions according to the student *t*-test. In the revised manuscript, we add the statement of student *t*-test in sections 2 and 4.

Lines 165-168: *Most changes are significant at the 95% confidence level, which is expected because altering TP topography induces very strong mechanical forcing and strong responses around the globe. For visual clarity, we do not show significance test in any figures.*

Lines 381-382: *Changes in the austral winter are significant at the 95% level, based on the student t-test, while they are not significant in the austral summer.*

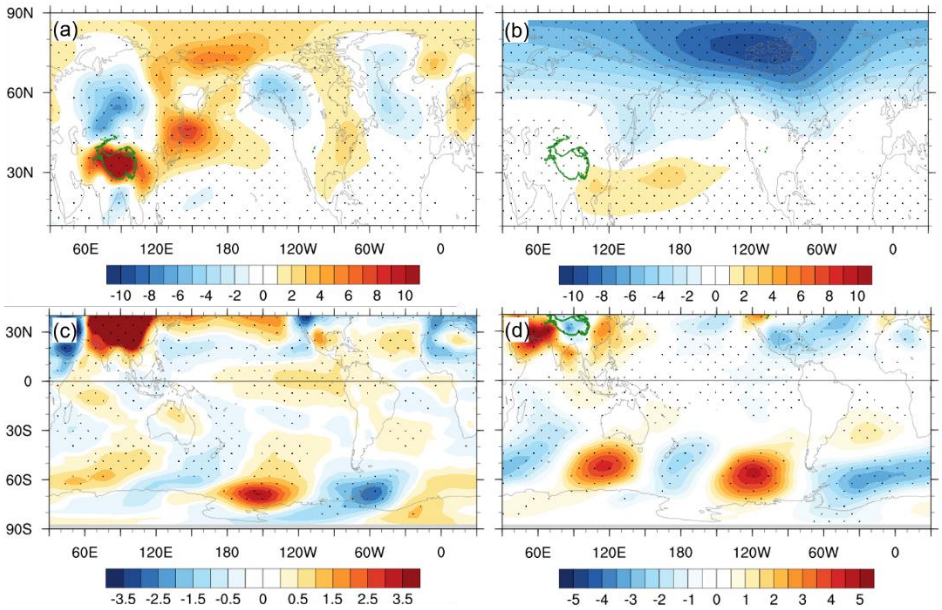

Fig. R20 Changes in (a, c) surface air temperature (SAT; °C), (b) temperature (°C) averaged over 100-200 hPa and (d) sea-level pressure (SLP; hPa). All values are for winter season in both hemispheres. SLP are obtained by subtracting the zonal mean values. Stippling indicates changes exceeding the 95% significance level according to student *t*-test.

4. *Since the coarser resolution of the CAM5 model is used in the present work and a major part of the discussion is focused on the stratospheric and upper tropospheric circulation in identifying the pathways, the authors should demonstrate that the stratospheric circulation is captured properly in the model, despite the model being a low-top coarser resolution model compared to the WACCM. This is important as the model bias and coarse resolution of the model can influence the results.*

Responses: Thank you very much for your suggestion. Figure R21 shows the temperature at 100 hPa from CESM simulations and ERA5 reanalysis data. We can see that they are mostly consistent, including the maximum center and value. Although the CESM model has a low-top resolution, it can well simulate mean climate of the upper troposphere and stratosphere.

Figure R22 shows the geopotential height in the boreal winter at 100 hPa from CESM simulations and ERA5 data, with the global mean values subtracted. Although the CESM simulates the vortex a bit stronger (mean state) than the ERA5's, the structure of stratospheric circulation is captured properly, as the pattern from CESM control run is generally in good agreement with that from the ERA5 reanalysis.

We think the influence of the model bias can be neglected. The results we present are differences between the control run and topography perturbation experiment, and the model biases in these runs are comparable; so most of the model biases should not be in the difference field.

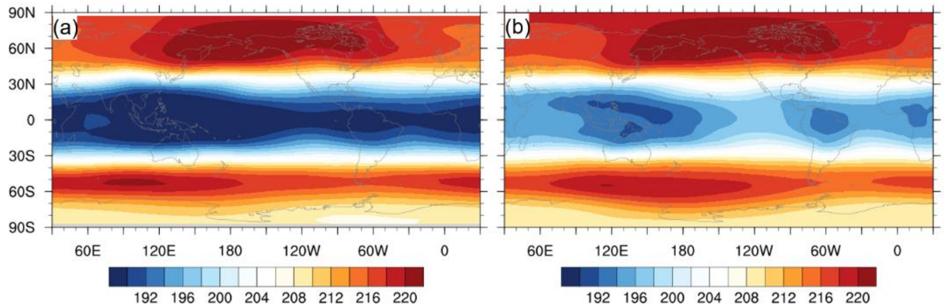

Fig. R21 Temperature (K) at 100 hPa from (a) the CESM control run and (b) ERA5 reanalysis, averaged between 2000 and 2022.

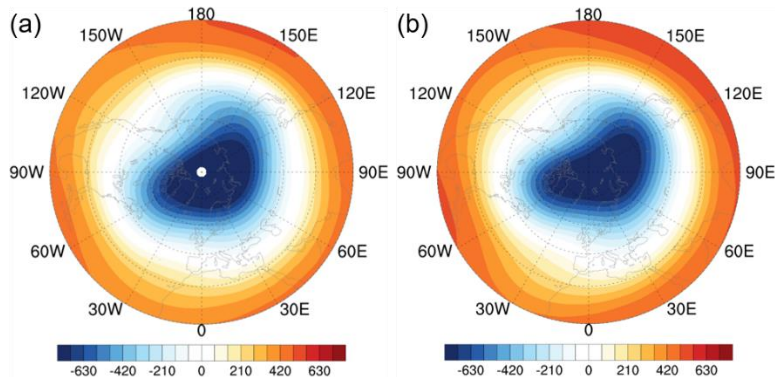

Fig. R22 Geopotential height (m) at 100 hPa in boreal winter from (a) the CESM control run and (b) ERA5 reanalysis, averaged between 2000 and 2022. Values are obtained by subtracting the global mean values.

Minor comments:

5. *50: back to approximately.* Revised.

6. *Figure 2: As the scales of the label bars in the panels are the same so the label bars can be moved at the bottom like those in Figure 3.* Revised.

7. *L190-193: Did you compare the AGCM runs with coupled runs to make this claim?*

Responses: Thank you for asking. We compared the AGCM and coupled runs. In addition, we conducted slab-ocean experiments, and have compared the slab-ocean runs with the coupled runs. The slab-ocean simulations contain a control run (300 year) and a NoTibet run (removing topography of the TP at year 200 of the control run and then integrating it for 200 years), with the ocean dynamic process frozen. Figure R23 shows the patterns of SAT and zonal mean temperature in the slab-ocean simulations. We can see that there is weak cooling in the North Atlantic, much weaker than the cooling in Fig. 2b5. This suggests the strong surface cooling over the Arctic is mostly attributed to the ocean dynamics, that is, due to the weakening of the AMOC. The upper-level cooling over the Arctic in Fig. R23a is mostly consistent with that in Fig. 2a5. What's more, the cooling center occurs quickly after TP removal, and remains stable over the rest of the model years, suggesting the atmospheric dynamics plays a leading role. *In the revised manuscript, we did not include the results from the slab-ocean runs*.

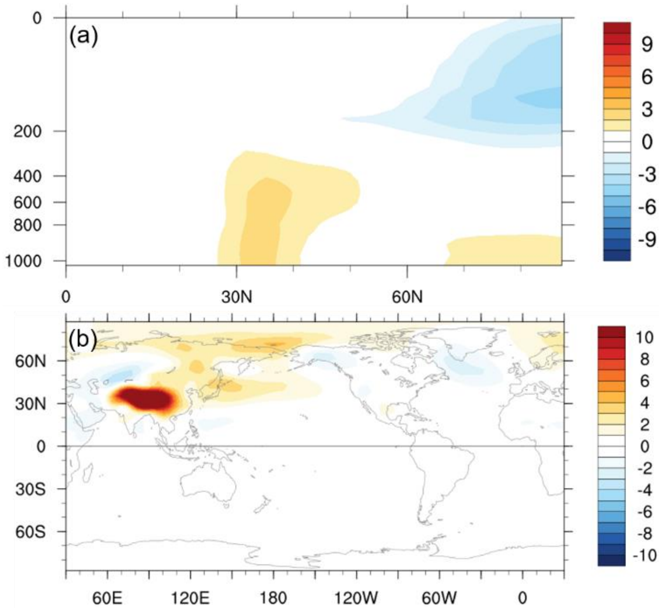

Fig. R23 Changes in (a) SAT (°C) and (b) zonal mean air temperature (°C) averaged over years 150-200 in slab-ocean simulations.

8. Figure5: The mean zonal winds in Real cases can be overlaid as contour lines in these figures.

Responses: Thank you very much for this suggestion. We re-plotted the original Fig. 5, adding the mean zonal wind in Real.

9. Figure7: The surface winds anomalies are shown at which level? I think the values were computed in CAM's hybrid coordinate and need to be converted to pressure coordinates at 1000 hPa before plotting. Further, the surface temperature and winds are averaged over the period of 1-100 years which is not at a quasi-equilibrium state as it lies in the lower troposphere.

Responses: Thank you very much for the comments. For the first question, we computed the values in CAM's hybrid coordinate. If the values are converted to pressure coordinate at 1000 hPa, the changes over TP perturbation and land do not show (Fig. R24). Also, the warming over the Arctic surface remains. Therefore, we use the lowest level of model's hybrid coordinate.

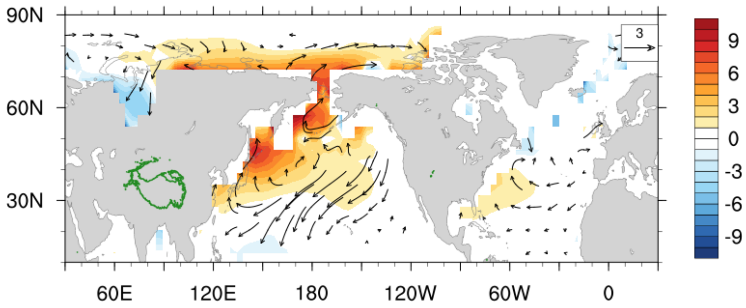

Fig. R24 Changes in SAT (contour; °C) and wind (vector; m/s) in NoTibet with respect to Real, converted to 1000 hPa.

For your second concern, the NH is warming up in the first 100 years and then cools after 150 years due to the ocean response (Fig. R19). The fast warming is due to the atmospheric process and remains stable during the first 100 years, because atmosphere adjusts in a short time and reaches the quasi-equilibrium state quickly. As you can see in Fig. R25, the surface circulation is similar in years 10, 20, 50, and 90; so we can use the SAT and wind averaged over the period of years 1-100 to study the fast response of the Arctic surface warming.

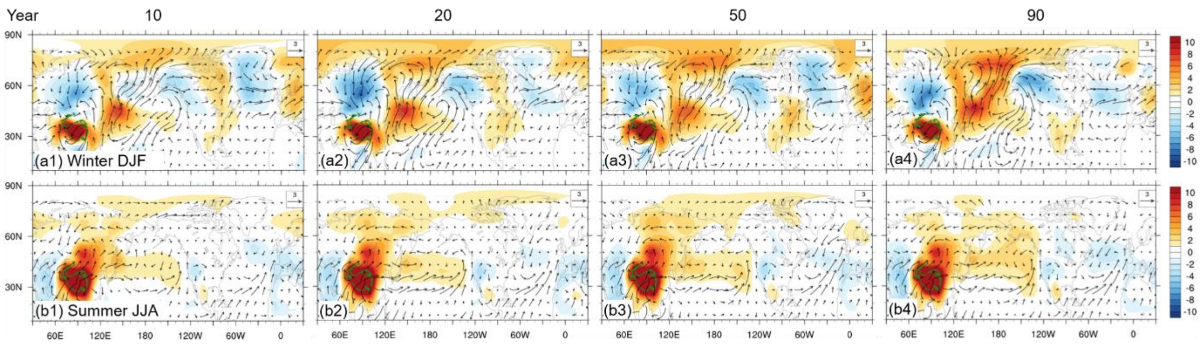

Fig. R25 Changes in SAT (contour; °C) and wind (vector; m/s) in NoTibet with respect to Real. From left to right: These values are averaged over years 5-15, 15-25, 45-55, and 85-95. Upper (lower) level is for the boreal winter (summer).

10. 371: In the coupled model, the perturbations caused by such large orographic suppression cannot reach to quasi-equilibrium state in such a short period as the response time for ocean circulation to reach a quasi-equilibrium state is comparatively large.

Response: Thank you very much for this concern. We have removed the text in Lines 370-375 because it needs further investigation.

11. L408-409: This observation is consistent with the findings of the idealized orographic forcing experiments performed to study the behavior of stationary waves, which suggests that the stationary waves generated due to orographic forcing in one hemisphere do not directly influence the opposite hemisphere due to the absorption of waves at the equator. The recent work by Wills and Schneider 2016, 2018 (https://doi.org/10.1175/JCLI-D-15-0781.1; https://doi.org/10.1175/JCLI-D-17-0700.1) and Tewari et al., 2021 (https://doi.org/10.1175/JAS-D-19-0335.1) performed using idealized mid latitudinal orography can be mentioned here to support this reasoning.

Responses: Thank you very much for the suggestion. The papers you mentioned are very useful. They all show that the orography-forced stationary waves cannot propagate across the equator, which agrees with our conclusion: The TP cannot impact the Antarctic directly. We cited in Line 449:"*This agrees well with previous studies (Wills and Schneider 2016, 2018; Tewari et al. 2021), which suggested the orography-forced waves cannot directly influence the other hemisphere due to the absorption of waves at the equator.*"

12. 381, 444: wind ->vectors. Revised.

13. 70: in ->the Asia pacific. Revised.

14. 453: ->These three Revised.

15. 524: AABW??

Responses: Sorry. AABW refers to the Antarctic bottom water. We have revised the text in Line 531.

References:

Yang, H., & Wen, Q. (2020). Investigating the role of the Tibetan Plateau in the formation of Atlantic meridional overturning circulation. J. Clim, 33(9), 3585–3601. https://doi.org/10.1175/jcli-d-19-0205

Yang H, Shen X, Yao J et al (2020) Portraying the impact of the Tibetan Plateau on global climate, doi: 10.1175/JCLI-D-18-0734.1, J Clim, 33(9):3565–3583

Replies to Reviewer #3:

The authors performed a set of coupled model experiments with and without the TP to show that the TP can affect the Arctic directly via orography-induced stationary waves and indirectly via stationary waves caused by sea-surface temperature (SST) in the Indian Ocean.

They also have noticed that the fast atmospheric processes play an important role in providing a favorable condition for the eastward and poleward energy propagation of the forced waves.

The most important result they presented in the manuscript is the seasonality and passage of the TP affecting the polar regions, and implies that the change around the TP under current global warming would have a fast and profound effect on polar climate.

In this study, six atmospheric model experiments using CAM5 of the CESM1.0 (AGCM) were performed to further investigate the influence of the TP on the Antarctic via atmosphere passage.

I would suggest the authors to make the following changes:

Responses: Thank you very much for these constructive comments. We have revised the manuscript carefully based on these suggestions. The following are our point-to-point replies.

Major/Minor comments:

1. *The geographical boundary line thickness should be increased in all figures, and the significance test should be added.*

Responses: Thank you very much for the comments. The geographical boundary line thickness is increased in all figures. For the significance test, please see our replies to Q#3 of Reviewer #2.

2. *It will be better to show a single-color bar, instead of showing individual color bar for each figure because the range is same for both the panel in Figure 2.*

Response: Thank you very much for the comments. Revised.

3. *Lines 160-163 of this Mann Kendall trend test are utilized in trend computation; however, no such trends are shown in this article.*

Responses: Thank you very much for the comments. We changed to use student *t*-test to examine the statistical significance of our results; and most changes are significant at the 95% confidence level.

4. *The conclusions made in lines 557 to 559 shows the compatibility of results obtained with previous findings but no such results are shown in this study. I would like to see the results of the precipitation simulations across the South Asian monsoon domain.*

Responses: Thank you very much for the comments. Figure 9a2 shows wind anomaly due to the TP removal. The cross-equatorial southerly winds over the Indian Ocean are reduced, leading to SST warming there. This is due to the weakening of the South Asian summer monsoon resulted from the TP removal, consistent with previous studies. Out previous study showed changes in precipitation after removing the TP (Fig. 6 in Chen et al. 2021). This is also shown in Fig. R26. Precipitation is reduced over most South Asian monsoon regions.

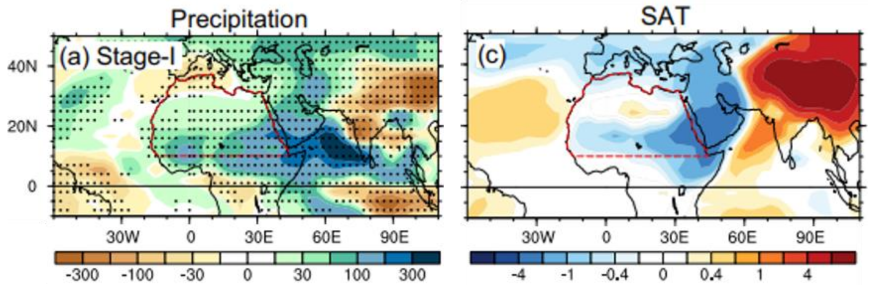

Fig. R26 Spatial patterns of precipitation change, and SAT change during the rainy season in NoTibet with respect to Real, averaged over years 1-60. From Fig. 6 of Chen et al. (2021).

5. *In addition, I'd like to see the plot of the surface air temperature in each simulation, as shown in Figures 11 and 12. Also if possible show the transient eddy, total eddies and mean meridional circulation.*

Responses: Thank you very much for the suggestions. Figures R27 and R28 show the SAT in each simulation. We use the monthly mean outputs; so the transient eddies and total eddies cannot be calculated properly.

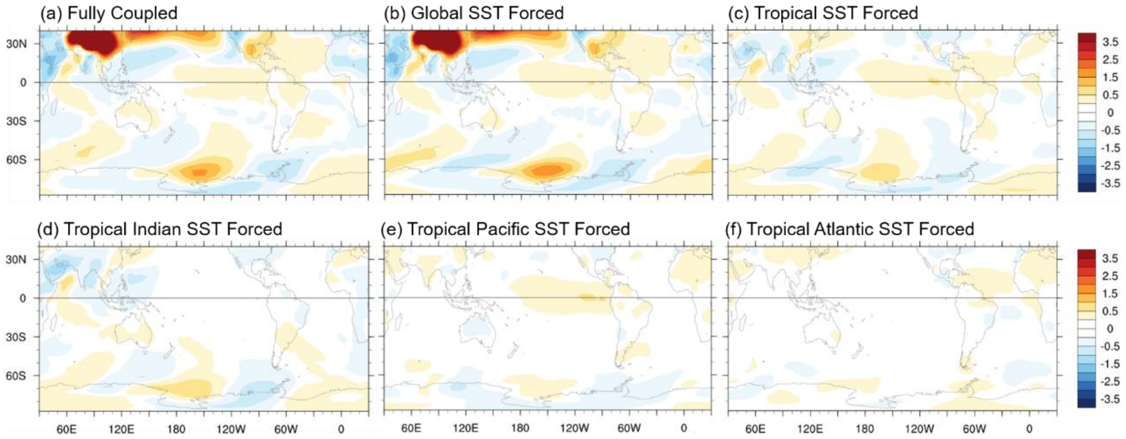

Fig. R27 (a) Changes in SAT (°C) from fully coupled runs averaged over years 1-30. (b)-(f) are the same as (a), but for the results from AGCM runs.

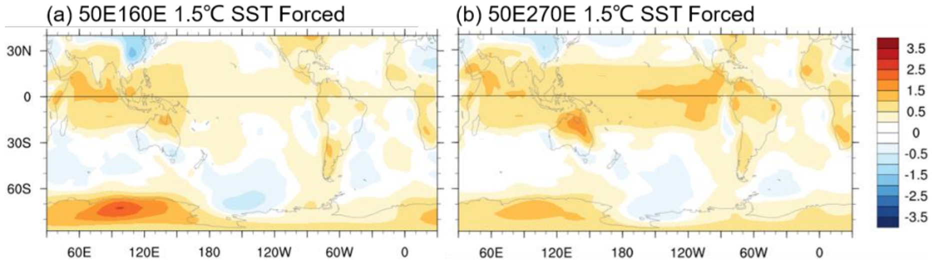

Fig. R28 Changes in SAT (°C) averaged over years 1-30 in experiments with tropical Indian Ocean forcing: (a) from NoTibet_TroIO_1.5, and (b) from NoTibet_TroIOPac_1.5.

6. *In section 1, refences from paleoclimate studies are irrelevant and more refences relevant to teleconnections of Arctic and Antarctic to TP should be included.*

Responses: Thank you very much for the comment. There are few papers studying the teleconnection of the Antarctica in response to the TP. A few papers studies the TP-Arctic teleconnection (White et al. 2018; Ren et al. 2019), but did not clearly show the pathway and seasonality. We use paleoclimate evidence and studies to demonstrate that the perturbation of the TP can really impact the polar regions. The impact of the TP on the polar regions deserves an in-depth investigation, but the research of TP-polar teleconnection is lacking. What's more, quantifying the impact of TP uplift on global climate is difficult in a realistic world. This study can help us understand detailed responses in the climate system related to dramatic TP changes in the Cenozoic.

7. In section 2, descriptions of SST experiments are not much clear, and need more explanations.

Response: Thank you very much for the suggestion. We have rewritten this paragraph.

8. Can you make a plot similar of Figure 2 by taking the average over the year near 400 (e. g, 380-400), because in each 100 year gap the patterns are diminishing for air temperature over TP and strengthening for specific humidity over north Atlantic?

Responses: Thank you for the suggestion. Please refer to Fig. R29. After 300 years, the climate system reaches a quasi-equilibrium state; so the response near year 300 and that near year 400 are almost identical.

Specific humidity is related to air temperature. During the first few years, the perturbation of the TP warms up the Arctic surface, so the specific humidity there increases. Then, the cooling center occurs in the North Atlantic about years 170-200 due to the weakening of the AMOC; so the specific humidity over the North Atlantic is reduced.

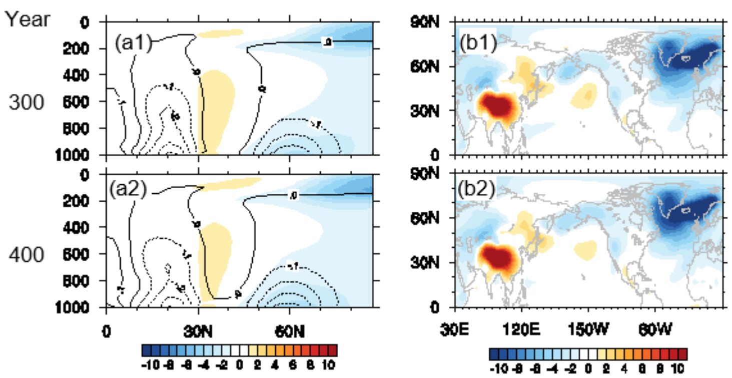

Fig. R29 Changes in zonal mean air temperature (color; °C) in winter averaged over (a) years 190-210 and (b) years 290-310.

9. Kindly confirm, is the strengthening of signal over Tibetan plateau and arctic region further increase with time during DJF in Figure 3? For this, do a plot by taking an average period near 200 or 300 years.

Responses: Thank you for the suggestion. In the revised manuscript, we add the response in year 20 in Fig. 3 to show the signals over the TP and upper level of the Arctic do not increase with time. They remain stable as the atmospheric process reaches its quasi-equilibrium state very quickly, as you can see in Fig. R30; changes in years 20, 90, 200, and 300 are almost identical.

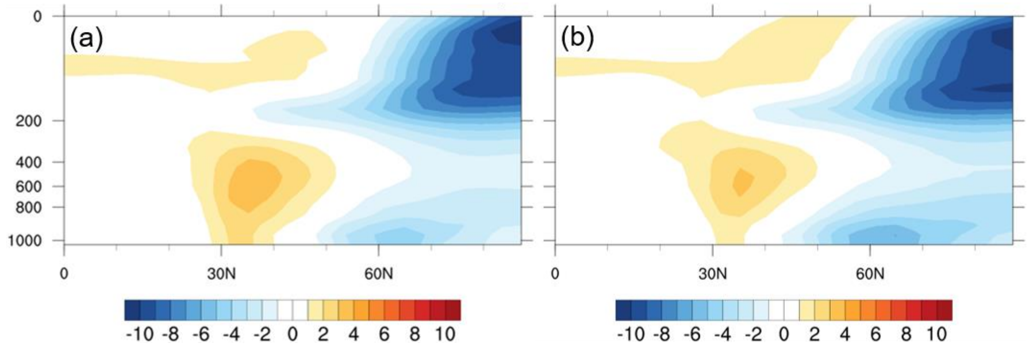

Fig. R30 Changes in zonal mean air temperature (shading; °C) in winter averaged over (a) years 190-210 and (b) years 290-310.

10. You have forced the SST by adding 1.5°C for the Figure 12, is there any specific reason why you choose 1.5°C? Explain in detail.

Responses: Thank you for asking. There is no specific reason. We do these experiments to explain the wavenumber of the Rossby wave train in the Southern Hemisphere. The wave length is comparable to the size of SST warming we impose. We can also choose 1°C or 2°C, which only alters the wave amplitude.

11. At line 453, it should be these (written thess). Revised.

References:

Chen, Z., Q. Wen and H. Yang 2021: Impact of Tibetan Plateau on North African precipitation. Clim. Dyn., 57: 2767-2777, doi: 10.1007/s00382-021-05837-2.