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.

"Both of these papers address a very important first order question in climate science: why is there deep water formation in the Atlantic, but not in the Pacific under current conditions? This paper focusses on the effect of the Tibetan Plateau on deep water formation in the Pacific. It shows that removing the Tibetan Plateau leads to deep water formation in the North Pacific in CESM."

"In general, I am pleased with the structure of the paper, but I am concerned that some of the statements made are not supported by sufficient evidence, particularly with respect to the role of the winds over the North Pacific."

Response: Thank you very much for these encouraging comments and specific suggestions. In this revision, we added more analyses to illustrate the role of wind forcing on the Pacific circulation.

Major points:

1. *The authors emphasize the role of Ekman downwelling in pushing surface waters downward in the North Pacific, but the size of this downwelling is not shown. A quantitative argument is needed to show that the wind is having a significant impact on deep-water formation.*

Response: Thank you very much for this suggestion. The Ekman downwelling is represented by Ekman velocity in this paper. Fig. R1 shows the Ekman pumping in Real, in NoTibet, and change in NoTibet (positive for downwelling). The mean Ekman downwelling in the subtropical Pacific is about 30 m/year (Figs. R1a, b). The anomalous Ekman downwelling in NoTibet is around 10 m/year along the $26\sigma_\theta$ outcropping line, showing about 30% enhancement of the downward subduction water.

Exactly as the reviewer said, the wind has a significant impact on the deep-water formation in the North Pacific. Actually, in this paper, we emphasize at many places that both the wind-driven dynamics and thermohaline are critical to the PMOC. This is different from that in the North Atlantic, where the thermohaline dynamics prevails. In Fig. 8 of the paper, the discussion of PV dynamics is about the wind forcing.

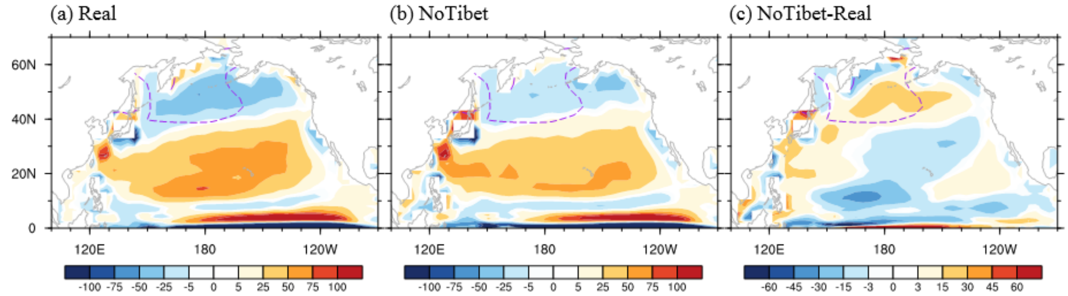

Fig. R1 Mean Ekman velocity (m/year) in **(a)** Real, **(b)** NoTibet, and **(c)** change in NoTibet (with respect to Real). Positive for downwelling.

2. *The paragraph between lines 276 and 286 is unclear: the citations that motivate the method used should be brought to the beginning of the paragraph. It is also unclear to me which of the PV contours on the plot I am supposed to be looking at, and it is impossible to tell whether they are continuous because of the contour labelling (particularly the label for 1.6 in the western boundary current). Also, why don't these PV contours extend further south, if the PMOC extends into the Southern Hemisphere? Asserting that "the subduction process in NoTibet can be well understood by the classical ventilation thermocline theory" is not enough: more explanation is needed.*

Response: Thank you very much for these suggestions. In the revision, we moved the citation to the beginning of the paragraph. Fig. 8 is re-plotted with clearer labels for the PV contours. This can be also seen in Fig. R2. The PV contours, say, the contours of 1.6-2.2, emanate from the outcropping region of $26\sigma_\theta$ from the western Pacific to the eastern Pacific, suggesting an eastward and downward subduction of denser surface water. In the eastern Pacific, the 1.6-2.2 PV contours go southward, suggesting a further southward and downward subduction.

The PV contours provide information for the passage of surface water entering the interior ocean, which is mainly related to the wind-driven dynamics. In this paper, we focus on the upper branch of the PMOC, and try to portray how the surface water of the PMOC entering the interior ocean. Based on the PMOC pattern (Fig. 2b), the lower southward branch of the PMOC is located between 1000- and 2000-m depth, which is not related to the wind-driven dynamics. Since the depth of $27\ \sigma_\theta$ isopycnal level can only reach 500 m in the Pacific, the PV over $26-27\ \sigma_\theta$ in the South Pacific has nothing on the PMOC. It makes no sense to extent Fig. 8 to include the South Pacific. In addition, near the equator, the density contours are roughly parallel to the latitudes; so the PV contours of ($\frac{f}{\rho_0}\frac{\Delta\rho}{\Delta H}$) are also roughly parallel to the latitudes, as shown in Fig. 8 and in Fig. R2. The PV contours cannot cross the equator.

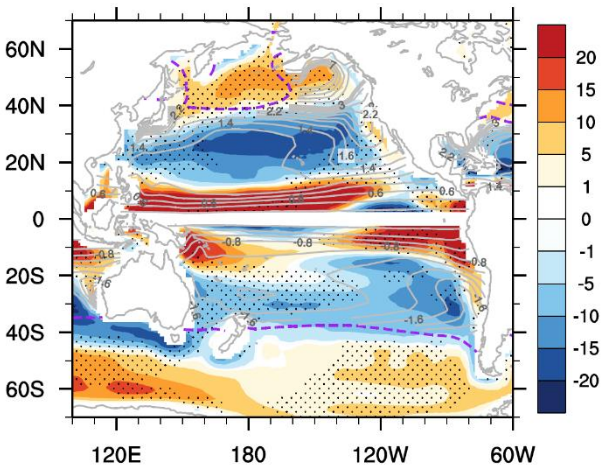

Fig. R2 Climatological mean Ekman pumping (shading; cm/day; positive for upwelling and negative for downwelling), and potential vorticity (PV; grey contour with contour interval $0.2\times10^{-10}\ m^{-1}s^{-1}$) averaged between 26 and $27\sigma_\theta$ in Real for the whole Pacific. Stippling represents the anomalous Ekman downwelling in NoTibet. The purple dashed curve represents the outcropping line of $26\sigma_\theta$ isopycnal level.

3. Line 378: "These two effects can cancel each other, leading to a trivial effect of the RM on the AMOC". I need to see more evidence for this statement. I have no way of comparing the size of these two effects as the reader/reviewer.

Response: Thank you very much for this comment. This statement is not clear; so we re-wrote this paragraph. Here, we plot the changes of surface ocean salt transport and salt advection in Fig. R3a, as well as atmospheric moisture transport and surface virtual salt flux in Fig. R3b, in response to the Rocky Mountains (RM) uplift (i.e., Real-NoRocky).

Fig. R3a shows an enhanced northward salt transport in the North Atlantic (arrow). The salt advection averaged over the NADW region (outlined by the red dashed rectangle) is 0.01 psu/month. Fig. R3b also shows an enhanced atmosphere moisture transport from the eastern Pacific to the North Atlantic (arrow). The net surface freshwater flux change leads to roughly -0.01 psu/month salt change averaged over the NADW region. Thus, these two effects on the SSS in the NADW region tend to cancel each other, leading to a trivial effect of the RM on the AMOC.

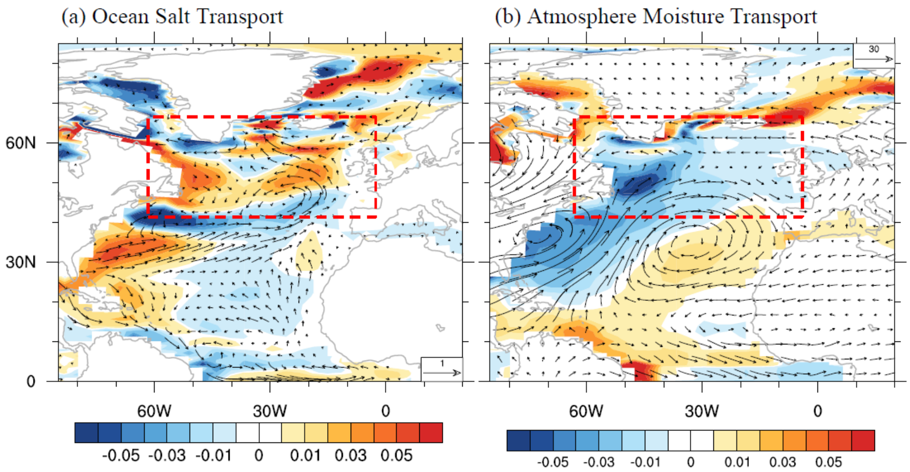

Fig. R3 Changes in **(a)** salt transport (vector; g/kg*m/s) and salt advection (shading; psu/month) in the top 40-m depth, and **(b)** vertically integrated moisture transport (vector; kg/m/s) and surface virtual salt flux induced by the net surface freshwater flux (shading; psu/month) in response to the RM uplift (i.e., Real minus NoRocky). In **(a)** and **(b)**, positive value denotes positive salinity tendency.

4. Modern oceanographers mostly agree that some fraction of the Meridional Overturning Circulation is driven by winds over the Southern Ocean (see e.g. Nikurashin and Vallis 2012, Gnanadesikan 1999). It would be good to mention this, and to show any change in Southern Ocean overturning in figure 2. The paragraph between lines 155 and 169 should be rewritten with this in mind: it is inappropriate to write as though the PMOC is entirely driven by the surface density in the North Pacific without evidence that this is *the case (I accept that the PMOC is enabled by the surface density in the North Pacific, just not that the PMOC is driven by the surface density)*

Response: Thank you very much for your suggestions. In the revision, we added Fig. 3 to address your concerns. Please also refer to Fig. R4 (Fig. 3 in the text), which shows mean global meridional overturning circulation (GMOC) in Real, NoTibet, and its change in NoTibet (with respect to Real).

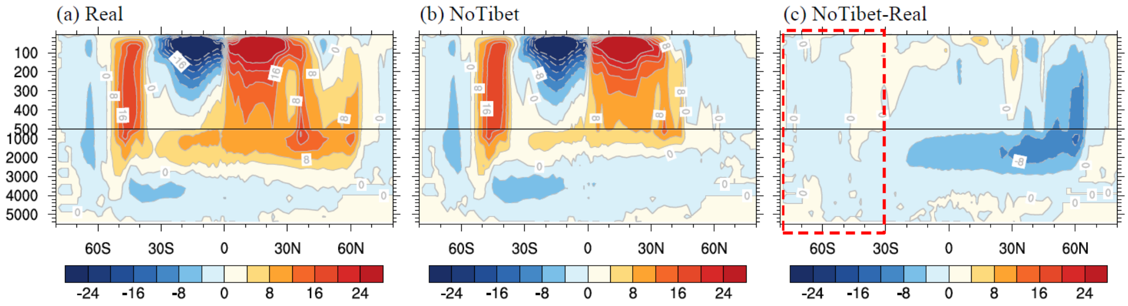

Fig. R4 Climatological GMOC in (a) Real, (b) NoTibet and (c) its change in NoTibet, with respect to Real.

We totally agree that the wind forcing over the Southern Ocean (SO) is critical to the GMOC. To see the MOC in the SO, we have to see the GMOC. Fig. R4 shows that the GMOC does not change too much in NoTibet, because the see-saw changes of the AMOC and PMOC **north of 30°S**. More interestingly, **south of 30°S** the GMOC in the SO (enclosed by dashed red rectangle, Fig. R4c) is roughly unchanged. The reason is that the wind forcing over the SO does not change too much (Fig. R5b). We thus think the contribution of wind forcing to the **initial changes** of PMOC and AMOC in NoTibet can be neglected.

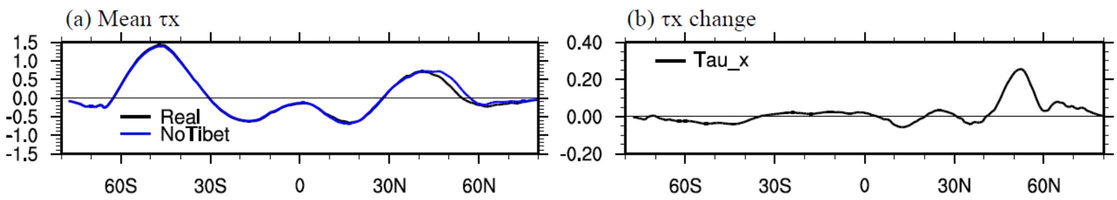

Fig. R5 **(a)** Zonal wind stress (dyne/cm^2) in Real (black) and NoTibet (blue). **(b)** Changes in zonal wind stress in NoTibet, with respect to Real.

We fully recognize the importance of the wind forcing over the SO, because to a great extent the GMOC is maintained by the persistent Ekman pumping in the SO (Toggweiler and Samuels, 1995; Gnanadesikan 1999; Wunsch and Ferrari, 2004; Nikurashin and Vallis, 2012). In NoTibet, the persistent and stable Ekman pumping in the SO provides a necessary background condition that makes the full establishment of the PMOC possible. However, to start the PMOC, the local buoyance change in the North Pacific is crucial.

In the revision, we focused on the North Pacific and toned down the statement: the PMOC is started by the surface buoyance change in the North Pacific, but the full establishment of the PMOC still has to rely on the persistent Ekman pumping in the SO.

Toggweiler, J. R., B. Samuels, 1995: Effect of Drake Passage on the global thermohaline circulation. Deep Sea Research Part I: Oceanographic Research Papers, 42, 477-500.

Gnanadesikan, A., 1999: A simple predictive model for the structure of the oceanic pycnocline. Science, 283, 2077-2079.

Wunsch, C., R. Ferrari, 2004: Vertical mixing, energy, and the general circulation of the oceans. Annu. Rev. Fluid Mech., 36, 281-314.

Nikurashin, M., G. Vallis, 2012: A theory of the interhemispheric meridional overturning circulation and associated stratification. Journal of Physical Oceanography, 42, 1652-1667.

5. The first paragraph of the introduction mentions the weakening of the PMOC. Before this sentence, I think it is important to present evidence that the PMOC once existed.

Response: Thank you very much for this comment. We found some evidence from the review paper of Ferreria et al. (2018) (Fig. R6). There is some evidence showing a possible strong North Pacific Deep-Water (NPDW) formation between 70 and 30 Ma (million years ago), and diminishing NPDW since 30 Ma. The NPDW nearly disappeared since 10 Ma. Please refer to Ferreria et al. (2018) and references therein. We have revised this paragraph carefully.

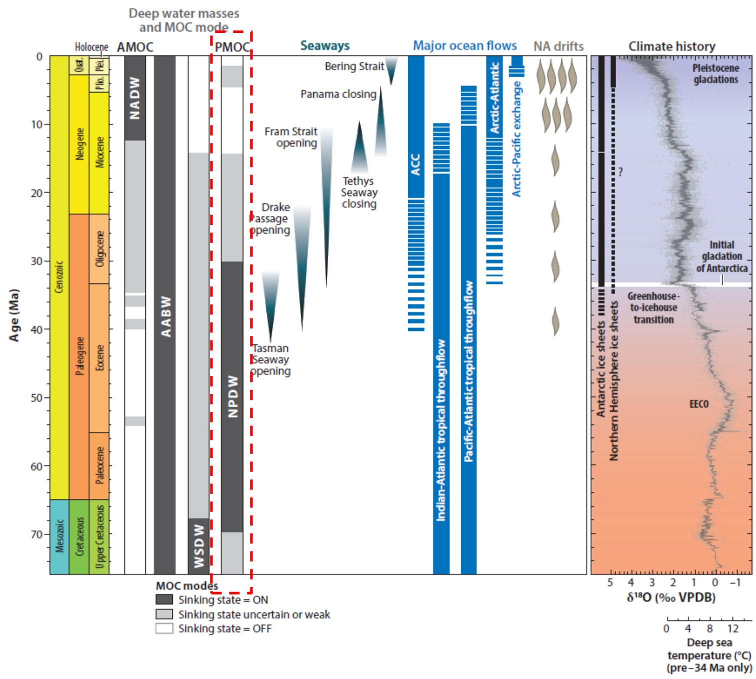

Fig. R6 A history of global MOC since the Upper Cretaceous based on geological data and models. Please focus on the MOC. The evolutions of the PMOC and North Pacific Deep-Water (NPDW) are enclosed by the red dashed rectangle. NA: North Atlantic; NADW: North Atlantic Deep Water; Ma: million years ago. Adapted from Ferreira et al. (2018).

Ferreira, D., P. Cessi, H. K. Coxall, et al., 2018: Atlantic-Pacific Asymmetry in Deep-Water Formation. Annual Review of Earth and Planetary Sciences, 46, 327-352.

6. I am not sure that 400 years is long enough to determine the ultimate fate of the AMOC/PMOC. Jansen et al. 2018 show that a similar overturning system can reach a quasi-equilibrium in the first 400yrs that is very different from the final overturning after 10,000 yrs.

Response: Thanks for this concern. In this study, 400 years of integration seem to be fine to determine the quasi-equilibrium fate of the AMOC/PMOC, since we emphasize the starting processes that enable the PMOC. Recently, we integrated NoTibet to year 1400. Fig. R7a shows the AMOC (PMOC) is on an "off" state ("on" state) for 1000 years. It is interesting to see that the AMOC is always stable, while the PMOC in the later stage experiences strong multi-decadal variability. We will work on this issue in our future work.

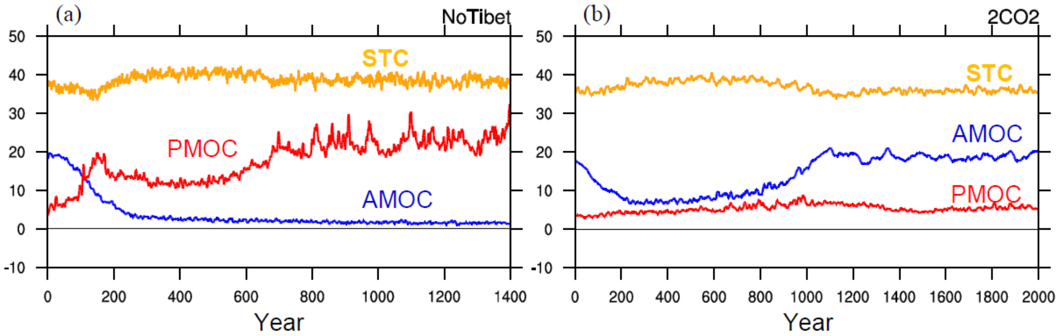

Fig. R7 Time evolutions of Indo-Pacific subtropical cell (STC; orange), AMOC (blue), and PMOC (red) in **(a)** NoTibet, and **(b)** a 2000-year 2CO2 run. The STC is defined as the maximum streamfunction in the range of 20-30°C isothermal over 0-30°N. Units: Sv.

As a comparison, the AMOC in a 2000-year 2CO2 run does show a more complex evolution (Fig. R7b). We carried out the 2000-year 2CO2 run using the same CESM and same model configuration as Real, except that the CO2 concentration was increased by 1% for 70 years and then fixed at the doubling level.

Fig. R7b does show a different state of the AMOC in 200 years from that in 2000 years, similar to the situation occurred in Jansen et al. (2018) as the reviewer mentioned. In the 2CO2 run, the AMOC becomes weaker at 200 years and then recovers after 1000 years. It takes about 800 years for the AMOC to recover in the CO2 run. We are working on this case right now, and hope to report the mechanism of the AMOC recovery in our next paper.

Fortunately, so far in the topography experiments the changes of the AMOC and PMOC did not show multi-equilibrium states.

7. I am interested that the PMOC only has 10Sv of overturning. This seems small: can you show the Residual Overturning stream function for the final state?

Response: Thank you very much for this comment. Please refer to Fig. R7a, after 1400-year integration, the strength of the PMOC can reach 25 Sv, stronger than the AMOC in Real. Figs. R8a and b show the PMOC pattern averaged over years 300-400 and over years 1000-1400, respectively. From year 300 to year 1400, the pattern of the PMOC does not change much. As a comparison, the mean AMOC in Real is plotted in Fig. R8c. The PMOC is stronger than the AMOC, because of the larger width of the Pacific basin than the Atlantic. Since this work focuses on the mechanisms that enable the PMOC, the 400-year results should be adequate.

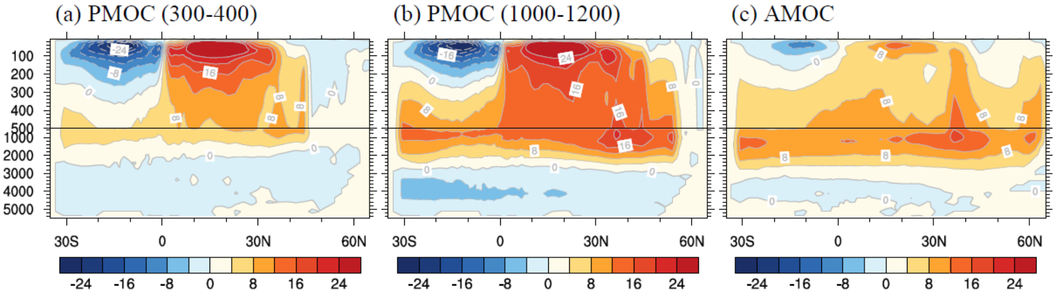

Fig. R8 Mean PMOC in NoTibet averaged over (a) years 300-400 and (b) years 1000-1400. (c) Mean AMOC in Real.

Minor points:

8. Line 80: "...the Pacific is featured by the wind-driven circulation". I think you mean that "the Pacific is characterized by the wind-driven circulation". Even if that is the case, given that many oceanographers think that the AMOC/PMOC are wind-driven, it'd be good to say that "the Pacific is characterized by a shallow wind-driven circulation".

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

9. The legend in figure 2a could be improved: it should give lines for "PMOC NoTibet", "PMOC NoRocky", "AMOC NoTibet" and "AMOC NoRocky"

Response: Thank you very much for this suggestion. It is re-plotted (Fig. R9).

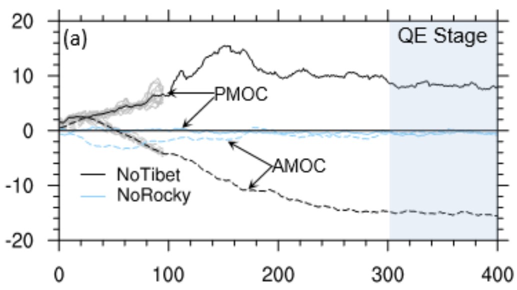

Fig. R9 Temporal evolutions of the PMOC (solid) and AMOC (dashed) in NoTibet (black) and NoRocky (blue).

10. In figure 2, it is not clear whether the overturning includes the Gent McWilliams velocity. Please make sure that it is included and say that in the caption.

Response: Thank you very much for this suggestion. The MOC in Fig. 2 is the residual MOC, which is the sum of the Euler mean, the GM effect, and sub-mesoscale effect. We have made it clearer in the figure caption.

11. *Line 78-92: It'd be good to use the phrase "salt-advection feedback", since this is the accepted term for the feedback between a stronger overturning and higher salinities/densities in the north of the basin.*

Response: Thank you very much for this suggestion. We have revised this paragraph carefully.

12. *You may also want to refer to Jansen et al. 2018 on line 147.*

Response: Thank you for this suggestion. We cited Jansen et al. (2018) in discussion section.

13. *The colorbar of figure 6 should be labelled all the way to the ends. Otherwise I cannot tell what the extreme values are.*

Response: Thank you for this suggestion. We re-plotted the original Fig. 6. It is Fig. 7 now.

14. *Line 276: Can you clarify why you choose the 26 \sigma_{\theta} isopycnal?*

Response: Thank you for this suggestion. We chose $26\sigma_\theta$ based on Fig. 6, which shows the mean surface density pattern by contours. Fig. 6 also shows the anomalous high-saline surface water being advected by the Kuroshio extension and North Pacific Current eastward along roughly south of the $26\sigma_\theta$ line. Based also on Fig. 9, choosing $26\sigma_\theta$ as the outcropping line is proper. In this revision, we clarified the reason why we choose $26\sigma_\theta$.

15. *Line 314-315: "In addition, the PMOC can be fully established in 150 years, much more quickly than the AMOC". Can you give a citation to support this statement?*

Response: Thank you for this suggestion. This statement is improper. We revised it as follows: "Since the thermocline dynamics has a shorter timescale, the PMOC develops much quickly than the AMOC slows down (Fig. 2a). The PMOC reaches its peak strength in about 150 years, when the AMOC is only weakened by 50%."

16. *It would be nice to know what causes the temperature change in the North Atlantic for the NoRocky case*

Response: Thank you for this suggestion. We carried out the term analyses on the SST equation to disclose the mechanism for the SST change in NoRocky.

The SST warming in the North Atlantic in NoRocky (Fig. 11a1) is caused by anomalous net surface heat flux (red curve, Fig. R10a), in which the main contribution comes from the enhanced shortwave (SW) radiation (red curve, Fig. R10b). All curves in Fig. R10 are averaged over the North Atlantic (60°W-0°, 40°-60°N).

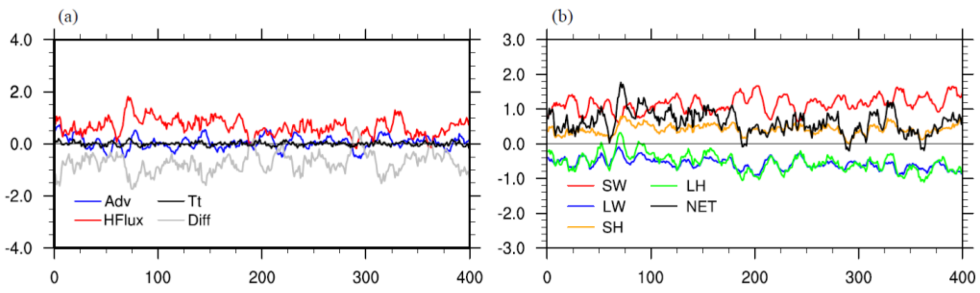

Fig. R10 Temporal evolutions of terms in **(a)** SST equation (°C/year) and **(b)** surface heat flux (W/m^2, positive for downward anomaly) averaged over the North Atlantic (60°W-0°, 40°-60°N). In **(a)**, red curve is for net downward surface heat flux, blue is for three-dimensional advection, grey is for vertical diffusion, and black is for temperature tendency. In **(b)**, black curve is for net surface heat flux (NET); red is for SW; blue is for LW; orange and green are for SH and LH, respectively.

Removing the Rocky Mountains causes moisture reduction over the North Atlantic (Fig. 10b), which prohibits low-cloud formation, leading to more incoming SW absorbed by the surface ocean (Fig. R11). Thus, it results in SST warming.

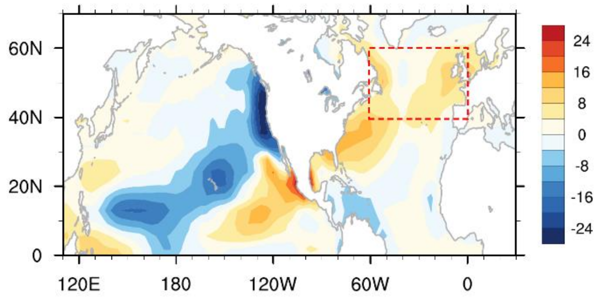

Fig. R11 Changes in downward SW (W/m^2) in NoRocky. Positive is for downward flux.

17. *Title: I propose the title: "Investigating the Role of the Tibetan Plateau in the Formation of the Pacific Meridional Overturning Circulation"* Revised.
18. *Line 54 "Sensitive experiments" should be "Sensitivity experiments"* Revised.
19. *Line 119: "starts from the rest" should be "starts from rest"* Revised.
20. *Line 138: "Removing the TP can lead to" should be "Removing the TP leads to"* Revised.
21. *Line 195: "consists of" should be "comprise"* Revised.
22. *Line 201: Mention that it is panel a of figure 5.* Revised.
23. *Line 391: Replace "would not be" with "are not"* Revised.

Replies to Reviewer #2:

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.

"The authors studied the impacts of the Tibetan Plateau (TP) on the Pacific Meridional Overturning Circulation (PMOC) using NCAR CESM. They found that removing the TP in the model leads to the establishment of the PMOC via a combined dynamic effect of Ekman downwelling and the thermodynamic effect of saline water subduction. The authors further examined the impacts of the Rocky Mountains and found that the Rocky Mountains play a trivial role in modulating the MOCs in both Pacific and Atlantic."

"This paper is very interesting and potentially contributes to our understanding of the TP impacts on the PMOC. I thereby strongly support this manuscript to be published in Journal of Climate after the authors satisfyingly address the following issues."

Response: Thank you very much for these encouraging comments and specific suggestions.

Major comments:

1. *How long will the subduction process take in the North Pacific? Schneider et al. (1999, cited in the paper) shows a timescale of about a decade, whereas the authors illustrate the subduction process via several snapshots in 140 years. Following the ventilation thermocline theory, the authors can also estimate the timescale based on baroclinic Rossby wave speed. To further clarify the subduction process, could the authors show the propagation of PV anomalies on an isopycnal plane (sigma=26, 26.5 or 27)? And the latitude-time diagram of anomaly propagation (similar to Fig. 6 in Schneider et al. 1999)?*

Response: Thank you very much for these suggestions. Qualitatively, the subduction processes examined in this work are similar to those examined in Schneider et al. (1999). However, there are some important differences. In Schneider et al. (1999), subduction starts in the central North Pacific, and goes south-westward and downward to roughly 15°N, along a relatively shallow isopycnal level ($25-26\sigma_\theta$). This process takes about 20 years and reaches the depth no more than 500 m. In our work, subduction starts in the western Pacific (close to the western boundary), and goes eastward and downward all the way to the eastern Pacific along 40-50°N, and then goes south-westward along a relatively deeper isopycnal level ($26-27\sigma_\theta$). This subduction can reach 1500-m depth and takes a longer time of more than 100 years. The timescale is determined by the advection velocity on roughly $26-27\sigma_\theta$ level, which can be, of course, thought as the higher order baroclinic Rossby wave.

To see the timescale of high-salinity surface-water subduction, we plot the longitude-time, depth-time, and latitude-time diagrams of anomalous salinity in Fig. R12. The longitude-time diagram (Fig. R12a) shows that the western high-salinity water takes about 10-20 years to reach the eastern Pacific. The continuous eastward transport makes high-salinity water reach maximum in 150 years. The depth-time diagram (Fig. R12b) shows a timescale of about 150-200 years for the high-salinity surface water reaching about 2000 m. The latitude-time diagram (Fig. R12c) shows that the lower-ocean (500-1000 m) high-salinity water that comes from the upper ocean takes about 200 years to reach the equator. Therefore, even for the initial establishment of the PMOC, the total subduction timescale is much longer than 100 years, longer than the classic subduction process related to the thermocline dynamics.

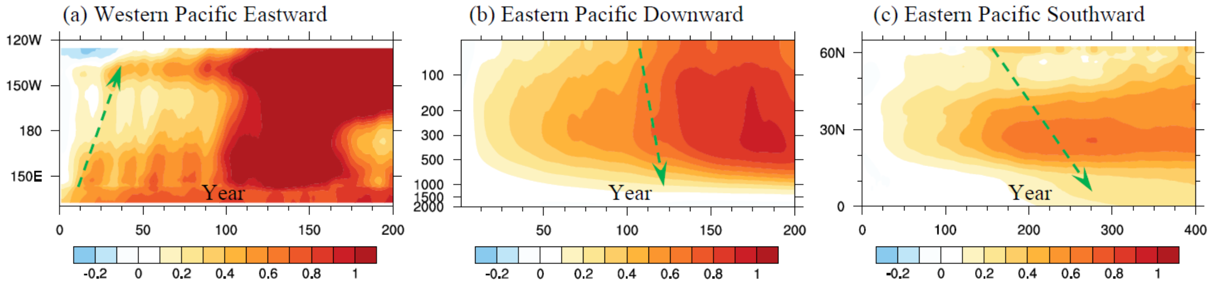

Fig. R12 (a) Longitude-time diagram of high-salinity water averaged over upper 100 m and 40-45°N latitude band. (b) Depth-time diagram of high-salinity water in the eastern Pacific averaged over 170°E-240°E and 20-40°N. (c) Latitude-time diagram of high-salinity subsurface water in the eastern Pacific averaged over 500-1000 m and 170°E-240°E. The green dashed arrow shows (a) eastward, (b) downward, and (c) southward propagations of the high-saline water.

2. *How can we understand the results from the perspective of global MOCs or the Thermohaline Circulation? First, how does the Southern Ocean change? How will Antarctic Bottom Water (AABW) spread in the Pacific and Atlantic Oceans, considering it will significantly alter the vertical stratification in these basins and the MOC strength/structure (c.f., Shin et al. 2003, Liu et al. 2005, Ferrari et al. 2014, Zhu et al. 2015, Jansen et al. 2018)? Also, how will an energetic PMOC alter global ocean ventilation and carbon circle? The authors may want to reference Liu and Hu (2015) and Burls et al. (2017), both of which have shown the deep ocean ventilation change by an established PMOC, and make further discussions.*

Response: Thank you very much for these suggestions. Fig. R13 shows mean global meridional overturning circulation (GMOC) in Real, NoTibet, and its change in NoTibet (with respect to Real).

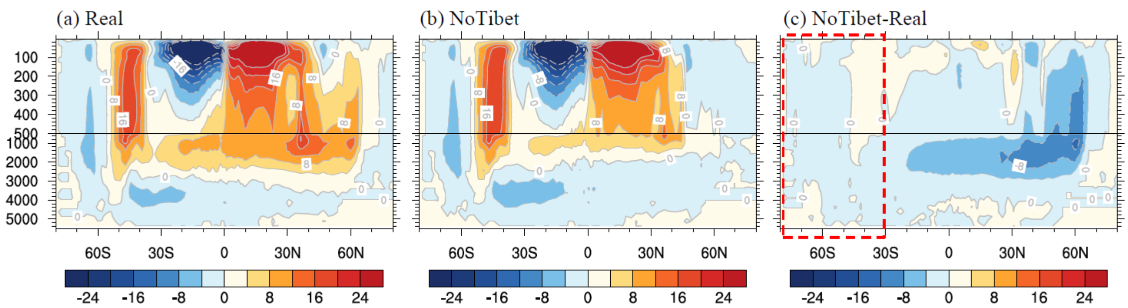

Fig. R13 Climatological GMOC in (a) Real, (b) NoTibet, and (c) its change in NoTibet (with respect to Real).

The GMOC does not change too much in NoTibet, because the see-saw changes of the AMOC and PMOC **north of 30°S**. More interestingly, **south of 30°S**, the MOC in the SO (enclosed by dashed red rectangle) is roughly unchanged also (Fig. R13c). The reason is that the wind forcing over the SO does not change much (please refer to Fig. R5b, and our replies to Reviewer #1).

Recently, we integrated NoTibet to year 1400. Fig. R14 shows temporal evolution of the Antarctic Bottom Water (AABW). The AABW remains unchanged for 700 years after the TP removal, and is eventually intensified by 8 Sv in year 1400. Fig. R14 shows that the AABW has a much longer response timescale than the PMOC (~100 years) and AMOC (~200 years). It is interesting to see a second time enhancement of the PMOC after 800 years, followed by the intensifying of the AABW. We will work on this issue in the near future.

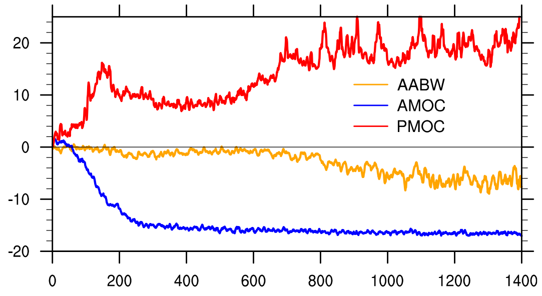

Fig. R14 Temporal evolutions of the PMOC (red), AMOC (blue), and Antarctic Bottom Water (AABW; orange). The index of the AABW is obtained by calculating the minimum value of the latitude-depth streamfunction in the South Ocean south of 60°S, following Swingedouw et al (2008). Units: Sv.

Thank you very much for raising these interesting questions. How and to what extent will the AABW alter the stratification in the global ocean and the PMOC (or AMOC) strength/structure? And how will an energetic PMOC alter global ocean ventilation and carbon circle? We cannot answer these questions in this paper. We want to focus on the mechanisms of the TP affecting the PMOC in this work. However, we are eager to delve into these problems in future.

3. Fig. 2a: Why does the PMOC weaken after 150 years?

Response: We are sorry that we do not know the reason yet. We have also done an experiment with a global flat topography (FLAT) (Fig. R15a). The PMOC shows a slight weakening after 150 years in FLAT, but is much weaker than that in NoTibet (Fig. R15b).

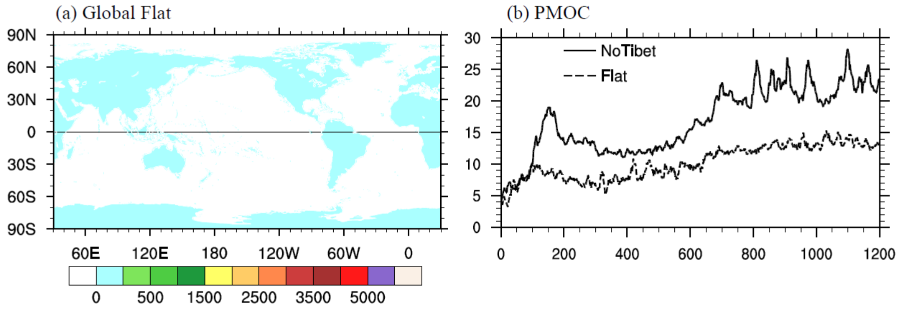

Fig. R15 (a) Global Flat topography (FLAT). (b) The PMOC (Sv) in NoTibet (solid) and in FLAT (dashed).

4. *Fig. 4: Will sea ice retreat in the Bering Sea so as to enlarge the incoming SW and warm the SST? Will an active PMOC increase the northward heat transport, also contributing to the SST warming in the North Pacific?*

Response: Thank you very much for this comment. We re-plotted Fig. 4 and included the SW change with sea-ice margin. Now, it is Fig. 5 in the revised paper. It is shown here as Fig. R16.

Fig. R16b shows that the incoming SW is also increased after the TP removal within the sea-ice cover region in Real, which contributes to SST warming. This SW increase is due to the sea-ice retreat. The low cloud is also increased there (Fig. R16d), which reflects the SW back to the outer space (Fig. R16c) and cools SST. So, the SST increase near the Bering Sea is due to the sea-ice retreat (Fig. R16b).

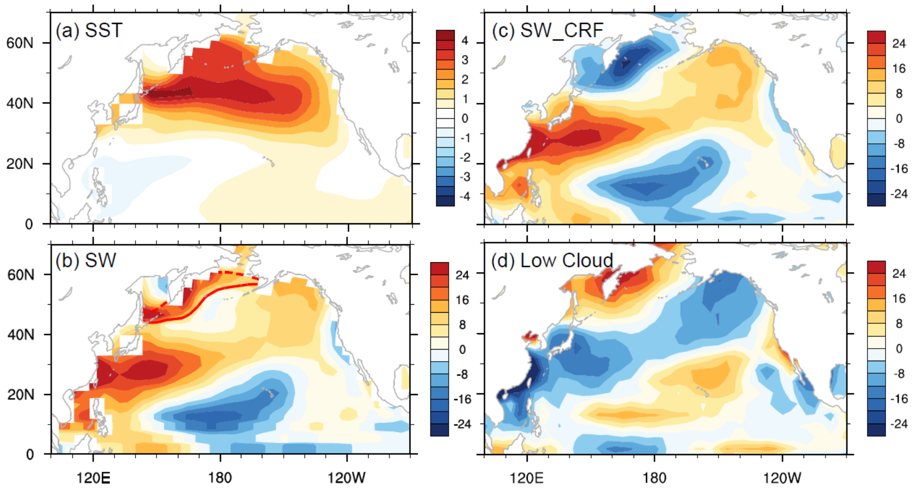

Fig. R16 Quasi-equilibrium changes in **(a)** SST (°C), **(b)** shortwave (SW, W/m^2), **(c)** SW cloud radiation forcing (CRF) (W/m^2), and **(d)** percentage change of low cloud (%) in NoTibet, with respect to Real. The solid and dashed red curves in (b) denote the sea-ice margin in Real and NoTibet, respectively, which is defined by the 15% sea-ice fraction.

The active PMOC can also transport heat northward. However, for the Pacific SST warming north of 40°N, the ocean heat transport (OHT) by the PMOC appears to play a trivial role. Fig. R17 shows the OHT changes in the Pacific and Atlantic. For the SST cooling in the North Atlantic, the weakening of the AMOC does play a role, since the OHT by the AMOC between 40-60°N is reduced by about 0.3 PW. For SST warming in the subpolar Pacific between 40-60°N, the OHT by the PMOC is nearly zero (enclosed by red dashed rectangle).

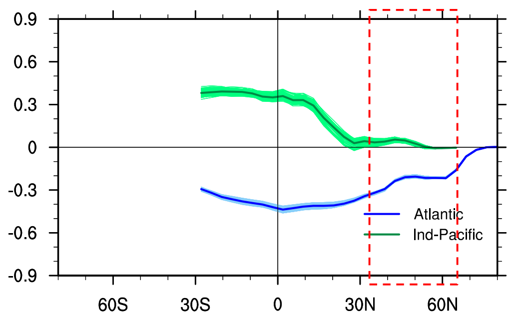

Fig. R17 Changes in meridional OHT (PW, 1 PW=10^{15}W) in Atlantic (blue) and Pacific (green) in NoTibet, with respect to Real. The shading represent the spread of OHT. Positive value represents northward heat transport.

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Replies to Reviewer #3:

Thank you very much for these constructive comments. We have revised the manuscript carefully based on comments from two other reviewers. Please refer to them.

"This work try to demonstrate the effects of the Tibetan Plateau (TP) on the Pacific by using the fully coupled climate model CESM1.0. The control run and Notp sensitive run are same with those in the manuscript JCLI-D-19-0205. The main conclusion, i.e., the presence of the TP may be the reason for the lack of strong deep-water formation in the subpolar North Pacific, since removing the TP would eventually result in the establishment of the Pacific meridional overturning circulation (PMOC), together with the detailed processes seems to be reasonable. Considering the fact that some parts in this paper (model, experiments, and text, discussions) overlaps with another parallel submitted manuscript. I suggest the authors combine these two manuscripts together. Many technical issues are similar to those in the comments for JCLI-D-19-0205."

Response: Thank you very much for these encouraging comments. If we combined these two papers into one, it would be too long. The length of these two papers include 25 pieces of figures, which would far exceed the limit required by *Journal of Climate*. The paper on the AMOC focuses on the thermohaline dynamics, while this paper on the PMOC focuses on both wind-driven and the thermohaline dynamics. We prefer to keep these two papers separate.

Many technical issues raised in JCLI-D-19-0205 are also examined carefully in this paper, including significance test for all changes, the definition of MOC indexes, the introduction, and other related studies/ citations. We appreciate your help greatly.