Dear Editor,

We are glad to receive the review report and would like to express our sincere thanks to you and the reviewers. Without the constructive comments from the reviewers, the quality of this manuscript cannot be significantly improved. All the comments and suggestions have been carefully considered to revise the manuscript. Detailed reply to all comments and the associate manuscript modifications are given below.

Comments from the Anonymous Referee #1

Line 21: I suggest to remove "at least for".

Reply: *Thank you for your comments. We revised this sentence (line 21).*

Lines 189-190: I still believe that thickness of 100km for oceanic lithosphere of 50 Myr is unrealistically large.

Reply: *We appreciate this comment. In our models, we imposed a constant initial 100 km lithosphere for plate older than 50Myr. We agree to the reviewer that the lithosphere thickness is significant large, based on the standard half-space cooling model. However, if the entire model uses half cooling space, the half-space cooling width (spreading rate times plate age) will be very large, far beyond the size of the model. So, given the initial setup of the model, we set the initial temperature distribution of the oceanic plate, consisting of the half-space cooling model and thermal equilibrium part. On the other hand, the plume-ridge interaction in our models mainly occurs between the plume and ridge, where the lithosphere temperature structure follows the standard half-space cooling model. We believe that the thickened lithosphere does not affect the conclusions of our study.*

Line 210-211: You have to keep the sequential order of figures in the text (first Fig. 3a then Fig. 3b). The same is for line 362.

Reply: *We appreciate your advice and have revised the manuscript carefully.*

Line 219: “As the plume eventually flows upward along the increasingly sloping base of the plate near the MOR“ This part is not clear, please re-write it.

Reply: *We improved the sentences (lines 218-220).*

Line 226: I suggest to remove this sentence.

***Reply**: We appreciate this comment. We removed this sentence in the text.*

Lines 240-242: The branches of the spreading plume head move significantly faster than the overriding plate. Therefore, plate drag actually slows down the spreading of the plume branches in this model case“ I do not quite agree with this part. Since velocity of plume materials are much higher (> 10 cm for right and ~ 5 cm for the left branch) than plate drag (8 mm/yr), therefore, one can conclude that the effect of plate drag is negligible in this case. One can also conclude that higher velocity of spreading plume may slow down the plate drag. That is an interesting issue which can be investigated by looking at the velocity of the overriding plate before and after plume uprising (to see any changes).

***Reply**: We agree with you and removed this sentence. Indeed, the velocity of plate in the models do not change over time by imposing constant internal boundary velocities in the lithosphere. The velocity of plume branches are much higher than plate, which may slow down the plate drag in turn. We appreciate this comment which triggers us a lot of thinking. The condition that triggers spreading plume to slow down the plate remains intriguing but unclear. More experiments are required to test to investigate the mechanism in the future.*

Lines 255-256: “divergent stresses are sustained in the overlying lithosphere (Fig. S4), but no weakening or yielding occurs (Fig. S6).“ What do you mean by divergent stress? In Fig. S4, one sees the change in the stress in the lithosphere which indicates that the lithosphere is weakened (it is also indicated in the figure caption).

Reply: *Thanks for your comments.* The buoyant plume changes the stress state of the overlying oceanic plate when it interacts with the lithosphere. The divergent stresses here means that the stress state in the lithospheric region affected by mantle plume changes, compared with the normal lithospheric stress state. *We have made revision in the main text (lines 252-253).*

Line 258: “However, thick and cold lithosphere prevents magma from extracting (Fig. S4).“ The lithosphere in Fig. 3 is even colder and thicker (as the spreading velocity is lower). The reason here is the low melt flux due to small plume.

Reply: *Thanks for your advice. We revised this sentence (line 255).*

Figure caption of Fig. 5 c and d: Please indicate that the(c) and (d) are representing the results of ridge-ward and plate-drag flow, respectively. Is the average dynamic pressure the same in both model (I do not think so)? Please show the location of yellow box in Fig. 5a as well and modify the caption accordingly.

Reply: *Thanks for your advice. We have made revision in the main text (line 285).*

Lines 326-327: The last sentence of this paragraph is not clear. Please re-write it. Besides, you did not explain 5d in the text. Please explain this Figure in the text as well.

Reply: *Thanks for your advice. We have improved this sentence in the main text (lines 325-326).*

Figure caption of Fig. 6: Please indicate in the caption that U and R stand for half of spreading rate and plume radius. Please do the same for Figures 7 and 8.

Reply: *We appreciate your advice. We have made revision in the main text.*

Line 355: Please modify this part as: “Green and red triangles are markers used for buoyancy flux calculations of left and right plume branches, respectively." Please do the same for Figs. 7 and 8.

Reply: *Thanks for your advice. We have made revision in the main text.*

Fig S8: What are the dashed curves? Please explain them in the caption.

Reply: *Thanks for your advice. We revised the caption in the supplementary material.*

Lines 365-371: I suggest to remove this part. Because there is not strong evidence for that in your models (they do not show any reduction of viscosity with time). Moreover, all of your models (both ridge-ward and plate-drag) show decrease of plume temperature in time.

Reply: *We appreciate this comment and agree with the reviewer. We removed this part in the main text.*

Figure 8: In this figure only models of Figure 9a are shown. Please also show the models of Figure 9b-d.

Reply: *We appreciate your suggestion and replot the Figure 8.*

Figure caption of Fig. 9: This figure shows the effect of half spreading rate and plume-ridge distance on ridge-ward vs plate-drag motion. Please correct the caption.

Reply: *Thanks for your advice. We have revised the caption in the main text.*

Line 429: "Fast-spreading ridge promotes plume material dragged " This is true for plumes near the ridge. Please correct it.

Reply: *Thanks for your comment. We have made revision in the main text (line 425).*

Lines 446-447 : "We discuss the viability of this potential explanation by comparing with geological and geophysical observations (Fig. 10). " Please re-write this sentence.

Reply: *Thanks for your comment. We have reworded this sentence in the main text (lines 446-447).*

Lines 481-483: I cannot understand what is the message of this part. Please rephrase this part and write it in more clear way.

Reply: *Thanks for your comment. We have made revision in the main text (lines 479-482).*

Lines 503-506: “In this case, plume-ridge distance may play a critical role in the plume-ridge interaction, and could explain the striking difference between the Pacific and Atlantic in terms of the number of plume-ridge interacting vs. non-interacting systems “ This part of text is a bit unclear. Looking at Fig. 11b, I see that 4 plumes in Atlantic and 6 plumes in Pacific are moving towards the ridge. However, the total number of plumes in Pacific is higher than that in Atlantic. Figure 11b shows that a lager fraction (percentage) of plumes in Atlantic ocean is interacting with ridge compared to that in Pacific ocean. In other words, the comparison of absolute numbers of plumes in Atlantic and Pacific is not a good criterion here. It is better to consider the ratio of plumes moving towards ridge and total number of plumes. Please modify the text to clarify this issue.

Reply: *We appreciate this suggestion and agree with you.* It is better to consider the proportion of plumes moving towards ridge and total plumes. Actually, A small minority of Pacific plumes (6 of 16), and a large majority of Atlantic plumes (7 of 14) display interaction with the ridge (Fig. 11a). *We have made revision in the main text (lines 449-450,501-504).*

Line 523: Correct: “mark”

Reply: *We have made revision in the main text (line 521).*

Lines 525 and 526: Correct “comes”

Reply: *We have made revision in the main text (lines 523-524).*

Comments from the Anonymous Referee #3

Since the term “Bouyanc flux” is very important, it is better to define or clarify it somewhere in the text.

Reply: *Thanks for your comments. We have made revision in the main text (lines 339-340).*

Lines 107-109: Markers are not involved in solving these PDEs you list here. All of these PDEs are solved in the Euelrian grids. To avoid misunderstandings, you might need to rewrite this part.

Reply: *Thanks for your advice. We reword this sentence in method section (lines 107-109).*

Lines 172-173: It would be better to indicate the vertical resolution as well.

Reply: *We appreciate your advice. We have made revision in the main text (line173).*

Figure 1(a) In the bathymetry map, a lot of places are much higher than 0 m. I guess your color map is not right. Please check it.

Reply: *Thank you very much for your comments. Indeed, the bathymetry map in 1(a) is residual bathmetry, which is generated by subtracting the oceanic lithosphere subsidence surface from observed depths. Positive is anomalously shallow, and negative is anomalously deep.*

In Figure 6, 7,9, For the legend of colormap, it is better to use “viscosity” instead of “nu”

Reply: *Thanks for you comments. We have replotted the Fig.6,7,9 in the main text .*

Figure 10, It is unclear what the blue arrow means

Reply: *Thanks for your advice. We revised the caption in the main text.*