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Interactive comment on "The effect of mountain uplift on eastern boundary currents and upwelling systems" *by* Gerlinde Jung and Matthias Prange

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Response to Reviewer #1 for the Manuscript: "The effect of mountain uplift on eastern boundary currents and upwelling systems" by Gerlinde Jung, Matthias Prange

We are grateful for the referee's additional comments which helped us to further improve the quality of the manuscript.

Anonymous Referee #1 (Received and published: 12 May 2019)

Modern coastal upwelling systems initiated and intensified since the Neogene. However, the reasons for their strengthening throughout the Miocene and Pliocene remain unclear. In the paper, the authors carry out sensitive experiments to investigate the impacts of mountain uplift on the three upwelling systems. The authors carefully diagnose

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Discussion paper

the model outputs, in particular clearly illustrate the feedbacks behind the upwelling responses. The paper is well written. I would recommend its publication after considering the suggestions below.

General comments: 1. The author should introduce the vertical mixing schemes in the model. In addition to the background vertical mixing, does the model include other vertical mixing param- eterizations, for example the tidal mixing, the eddy mixing. Some of these mixings are also influenced by changes in winds. In other word, when the topography is modified, the changes in winds will also influence these vertical mixings. If these vertical mixings remain unchanged, there are some uncertainties included in the current simulations.

=> We added some information on the vertical mixing scheme of CCSM3 to the model description of paragraph 4.1. Through the KPP scheme wind-stress directly affects vertical mixing coefficients.

2. The uplifts of the Andes and North American Cordillera induce significant cooling around the adjacent upwelling regions. The authors should potentially compare some model outputs with existed proxy data?

=> It is not possible to directly compare our model results to proxy records quantitatively due to the fact that the model experiments do not intend to represent a specific time span in Earth's history and only test the effect of a change in only one boundary condition out of many changes that occurred since the late Miocene. Nevertheless we now confront our model results with the range of SST changes from proxy studies of the major EBUS regions in the discussion section where we also discuss the limitations of our modelling approach. And we added one sentence in the introduction to make the goal of our sensitivity experiments clearer.

3. For the cross-section analysis, I recommend the authors could also do that with an averaged latitude zone over the upwelling regions, especially for the vertical velocity response, rather than using a specific latitude.

=> Since the upwelling area is very limited in its longitudinal extent and additionally the longitudinal position varies largely with latitude it is not feasible to average the signal over latitudinal zones. This would lead to an unnecessary smoothing of the signal. In our opinion it is therefore more useful to investigate the signal at the location of its maximum effect.

4. I am interested in the thermocline depths changes around the three upwelling regions and their potential impacts on the cooling strength.

=> We revised the vertical cross-section plots (Figs. 10-13) by changing the color scales to see the temperature variation with depth in more detail and by adding the temperatures for the control run with high mountain elevation. From visual inspection of these figures it appears that the changes in thermocline depth and structure are quite complex in some cases. As expected, the most evident relationship between surface/upper-ocean cooling and thermocline shoaling is found in the Benguela upwelling region.

Specific comments: 1. Page 3 line 15 : “Neogene” not “Neogen”

=> done

2. Figure 1 and 9-12, Please denote each panel with alphabet letters.

=> done

3. Figure 8b, please explain why choose the depth of 47m here rather than 70m?

=> We chose the depth of 47m in the case of the North American uplift, since this is where the maximum signal of vertical velocity change is found. This is also explained in the manuscript. We now additionally added a note on that in the figure caption (now Figure 9).

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