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Climate of the Past Discussions

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

Anonymous Referee #2

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This manuscript explores the impact of different mountain uplifts on eastern boundary upwelling systems, through a set of sensitivity experiments to topography run with CCSM3 model. It echoes a previous publication by the authors, but this particular ms appears as a generalization assessment of the previous results that were obtained for Africa and the Benguela upwelling system. This contribution is particularly interesting as the authors attempt to decipher amongst several mechanisms that can lead to sea-surface temperature changes in the EBUs regions, namely changes in Ekman pumping, changes in surface turbulent fluxes, changes in radiative forcing and horizontal heat advection. Authors show that different mechanism are at play depending if California, South America, or Benguela EBU is considered. The MS will fit well in Climate of the Past, still I suggest some clarifications / improvements that are somewhere

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between minor and major.

First, the “uplift history” part could be improved. Despite uncertainties, numerous papers have been published in the last decade that help constraining the elevation history of the different mountain ranges considered. For example: For the Andes, (Garzione et al., 2008, 2014; Leier et al., 2013) . For Africa see (Moucha and Forte, 2011; Wichura et al., 2010, 2015). Having a more complete review of the literature on these paleoelevations could in turn fuel a discussion on the relevance of sensitivity experiments to assess the EBU evolution: If topography was already partly uplifted during the Miocene, would the later phases of uplift involve changes in elevation strong enough to trigger the atmospheric and oceanic dynamics mechanisms invoke in the paper ?

Second, I acknowledge the effort to validate the model, but this part (5.1) is the weakest of the manuscript in its present form. The authors use their control experiment, which they acknowledge have different boundary conditions than present-day (orbital parameters and lad surface conditions, specifically), to compare to data or higher resolution modelling. Moreover they do not provide actual figure of differences of Ekman pumping between their simulation and data/validated model. I would suggest to rewrite this part, use a “true” preindustrial simulation, and compare and show the anomalies with available upwelling climatologies. See for example Yi et al. (Yi et al., 2018) for such climatologies. Lastly, figures show strong Ekman pumping on oceans western boundaries. It would be relevant to explain these signals. I think that at some point, either in part 5.1 or in the discussion, the authors need to discuss the need (or not) of high spatial resolution to correctly represent upwellings in GCMs.

By the way, fig. 4 to fig 6. It would be easier to follow the text if the figures depicted NOTOPO and CTL-NOTOPO, rather than CTL and CTL-NOTOPO.

The results are well-presented, but could be improved by a deeper analysis of the links between uplift and atmospheric physics/dynamics. Some diagnoses (maybe different geopotential heights, slp and air-temperature) could help the reader understand how

surface winds and cloud covers are affected by the topography. I was also wondering if removing the topography would alter subgrid-scale parameterizations of moutain drags, and in turn alter the atmospheric dynamics. The ms would be more complete if authors could elaborate a bit on that.

The cloud radiative forcing (CRF) change between experiments with and without uplifted mountain ranges is well-described and seducing. I think the discussion could still be improved by (1) giving a bit more information about the main characteristics of cloud parameterizations in CCSM3 and (2) mapping the CRF changes both in LW and SW, to confirm the invoked mechanisms. At some point a discussion on CCSM3 ability to represent correctly cloud cover along mountain ranges will be necessary.

Suggested refs:

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