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Interactive comment on "The influence of subducting slab advance and erosion on overriding plate deformation in orogen syntaxes" *by* Matthias Nettesheim et al.

Anonymous Referee #1

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General comments

The work by Nettesheim et al. uses numerical models to investigate the effect of subducting and overriding plate velocities on overriding plate deformation, shear zone structures and erosion patterns. The topic is of general interest, but I believe this work needs a big improvement before being suitable for publication. In terms of modelling, I think more models are needed to really understand the results and the effects of the initial setup choices. In terms of style, I think the conclusions are not clear and the message of this paper is not conveyed. Moreover, the discussions need to be expanded and re-worked, since as they are now they are mostly a repetition of the results.

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Discussion paper

Specific comments

I think the use of the terminology “plate corners” is used in an erroneous way. The authors show in Figure 1 what they consider plate corners. However, I do not understand the logic behind these choices. I can see how the regions highlighted by the red circles in the Aleutian and Himalayas can maybe be considered as corners, but I’m struggling to see corners in all the other circles. In South America or Indonesia, for instance, those are simply regions of curved trench, I see no corners there. And they have an opposite curvature too, which does not match the definition used at the beginning of the Introduction. Moreover, if those in South Sandwich, Mariana, Caribbean are plate corners, then why not consider corners the edges or changes in trench curvature in other subduction zones like Tonga-Kermadec, Calabria, Aegean, New Hebrides, and many more? I think the authors should be very careful in using a terminology that I found vague and wrong. Moreover, except for the places labelled in the figure, the other regions are hardly, if not never, mentioned in the manuscript, so I do not see the point of saying that those red circled regions are plate corners and then never mention them.

An other definition that I find confusing and, in my opinion, wrong is what the authors define “slab advance”. First of all, it is confusing and counter intuitive that the model called “full slab advance” is the one where the slab has null velocity and the overriding plate is moving towards the trench. Secondly, Heuret and Lallemand (2005) do not define slab advance as the “migration of the overriding plate towards the down-going plate” as suggested by the authors (page 2 lines 5-6). Instead, they talk about “upper plate advance”, which I believe is much more appropriate here to describe the model in which the overriding plate (and not the subducting plate) is moving towards the trench. This is not just semantic, but an important point because I am not sure that slab advancing is the cause of what the authors observe in the models. If the slab was advancing in the models forces might be distributed differently and stresses might be accommodated in different regions compared to these models in which is the upper

plate that is forced towards the trench.

Results and conclusions of this work are based on solely 3+1 models. How do the authors know the effect of the indenter geometry (paragraph 4.1) if there are no models with different indenter geometries? I think this work needs more models. The authors should at least show results from models with the 3 different types of velocities in a setup with a straight trench and no changes in slab dip. How do the shear zones forming in the overriding plate look like with a straight trench? And how do they compare to the models with a curved one? This would really help understanding the effect of the chosen geometry.

Considering the regions that this work aims to study (mostly Himalayas and Alaska), I am puzzled by the choice of the subducting plate geometry in the models. Those areas are slab edges and they have a shape that is more similar to a cusp than a smooth convex arc as modelled here. My point is that, although I do understand that models are inherently simplified and cannot be exactly like nature, I am not sure this is the best geometry to use to model those areas. The authors should discuss more in details their choice and, perhaps, even consider a different initial geometry.

The Discussion part needs to be more exhaustive. Most of the text in the Discussion is just a repetition of the results with no or little interpretation. The differences between the models are described, but why are those difference present? What is causing them? What is the effect of the chosen 3D shape? Again, a comparison with models with straight trench would help with this. For instance, would a straight trench produce slower exhumation rate? What is the effect of the chosen plate velocities? Why are these results important? How do they compare to natural cases (not only in terms of uplift rates, but also in terms of structures)? Are these 'plate corners' the only places with rapid exhumation? Can there be other causes for it other than the geometry? What is the main message of this paper? All these points are examples of what can help expanding the Discussion, improving the conclusions and the impact of the paper.

These are lithospheric scale models and, thus, do not include mantle flow. What do the authors think would be the effect of the mantle flow especially on the evolution of stresses and topography?

Info on velocity and temperature boundary conditions should be given for every boundary. For instance, what are the temperature conditions at sides (at x and y 0 and 800km)? What are the velocity boundary conditions at the bottom and the top? Also, from the plots it seems to me that the top boundary is free slip and not free surface. If this is the case, how is the topography computed?

I'd suggest a more comprehensive explanation on thermochronometric ages. If a reader is new to this technique will not be able to follow the paper and understand the results.

Paragraph 3.1 would be easier to follow if the 'pro-shear band', 'retro-shear band', and ' basal detachment' would be labelled explicitly in Fig. 3 and 4. Paragraph 3.2 and Figure 6. The model "full slab advance" is the only one that shows subsidence between between the structures the left and right of the S-line. This is worth mentioning and discussing.

Technical comments

Table 2 has two vsub in the header.

Fig. 1: Spell out the acronyms in the caption

P1, line 16: Change "around plate plate corners" to "around plate corners"

P2, line 18: Remove 's' from impacts: "Slab advance and erosion impacts"

P4, line 11: Specify what is the thickness range of the weak layer that decouples the plates

P5, line 13: What is the initial surface elevation?

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P6, line 19: Unit of strain rate is wrong, shouldn't it be s-1?

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