Solid Earth Discussions

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Comment on se-2021-137

Anonymous Referee #2

Referee comment on "The effect of low-viscosity sediments on the dynamics and accretionary style of subduction margins" by Adina E. Pusok et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-137-RC2, 2022

This manuscript describes a series of 2D geodynamic models that focus on the role of sediment thickness and viscosity on subduction dynamics and accretionary/erosive style of the margin. The study is well-organized and a systematic modeling approach is adopted. The manuscript is well-written and outcomes are relevant to better understand how interface properties affect subduction dynamics. However, I think a more detailed explanation on the physical processes controlling the models behavior is missing.

Major comments:

- Abstract should be more detailed on the results of the study and include an explanation on the processes
- Since viscosity of sediments is critical, the method section should include more details on the choice of the orders of magnitude of sediment viscosity. Where does the choice of using 15 km-thick weak crust come from? More importantly, since the thickness of the weak crust remains the same in all the simulations and only sediment thickness is varied, have you checked that the thickness of the magmatic weak crust (dark green layer) has no influence on the results?
- Lines 279-280: I am not sure that this is a good way to classify a margin as erosive. A probably better way would be to measure the area of triangle ABC and check if this increase or decrease through time. This could be also useful to understand the behavior of unstable accretionary wedge (see following point)
- The behavior of the model with highly unstable accretionary wedge (SubSed04_100) is really interesting and probably deserves more attention. For example, figure S7 shows the temporal evolution of the convergence rate. It would be interesting to understand if the decrease in convergence rate corresponds to an increase of the sediment subducted and/or variations of subduction geometry (cf. Brizzi et al. 2021)
- I think the manuscript should include a figure more informative on the role of sediment

thickness and viscosity (and upper plate thickness) on convergence velocity, radius of curvature, etc. At present, figure 4 shows correlations among diagnostic parameters colorcoded by margin style (erosive or accretionary), but I am not fully convinced of the classification criteria used to distinguish them (see point 3). As the authors acknowledge, the thickness of the sediments is less relevant compared to their viscosity for the margin style (table 2 shows that an erosive margin can form also when the sediment thickness is 10 km, given that viscosity is high). Similarly, the upper plate thickness, which controls the downdip extent of the viscous coupling, seems to be important for e.g. plate velocity (see also Brizzi et al 2021). For example, the high-angle accretionary wedge case makes me think to the influence of the plate interface length, which influences the integrated shear stress. When the wedge is growing, the plate interface is smaller, resistance to subduction is lower and convergence rate is higher. Perhaps plotting the diagnostic parameters as a function of sediment and upper plate thickness, and sediment viscosity could help defining a hierarchy.

Minor comments:

- Lines 6-7: sentence is unclear. What is the geometry of the global subduction system?
- Lines 14-15: This could be more specific. How does the viscous coupling relates to the thickness and viscosity of sediments?
- Line 16: this sentence should be probably moved up, before writing about the results. Also, I would suggest to specify what these diagnostic parameters are.
- Line 36: what is the morphology of the subduction interface? Please clarify
- Line 47-48: Funciello et al 2008 is based on analog experiments.
- Line 105: This doesn't seem to be addressed in the paper. I would remove.
- Line 151: Why did you choose to simulate ocean-ocean subduction instead of ocean-continent? What are the properties of the upper plate and why are they different from the subducting plate?
- Line 155: This sentence is confusing. Please clarify
- Line 163-164: I would add the tested sediment thicknesses and viscosities here. Also, what is the density of sediments and crust?
- Line 169: What are the subducting plate parameters? Please specify
- Line 188: In my opinion, a sediment thickness of 5 km as the lowest end member is a bit too high. Natural subduction zones can have a (trench) sediment thickness < 1km. Is this choice related to the model resolution?
- Line 189-191. The sentence is unclear. Please clarify
- Line 207: Marker 2 instead of marker 3
- line 249: are you sure that slab buoyancy is constant? Brizzi et al. 2021 shows that the amount of sediments subducted influences slab buoyancy.
- Line 291: lubricates and promotes
- Line 297-300: it is really difficult to see what the authors state about interface dynamics from the velocity field in figure 2. The colorbar for velocity is also quite impossible to read. I suggest to use a different colorbar and include a zoomed version of the interface in figure 2
- Line 321: Parentheses for the reference are missing
- Lines 394-395: the finding that a bigger accretionary wedge promotes high radius of curvature is consistent with results from Brizzi et al 2021