Solid Earth Discuss.,
https://doi.org/10.5194/se-2019-11-RC3, 2019
© Author(s) 2019. This work is distributed under
the Creative Commons Attribution 4.0 License.

Interactive comment on "Improving subduction interface implementation in dynamic numerical models" *by* Dan Sandiford and Louis Moresi

Hana Cizkova (Referee)

hana.cizkova@mff.cuni.cz

Received and published: 2 April 2019

Manuscript presents a detailed analysis of the properties of entrained weak layer that is often used in numerical models of subduction to decouple the plates. The authors demonstrate that this weak layer is changing its width both spatially and with time. After entering the subduction channel at the trench it increases width and then thins again as the subducting plate is coupled with the mantle flow below the overriding plate. This thinning, that may temporarily result in a decoupling weak layer actually yet thinner than the prescribed initial thickness, may result in locking of the subduction in case of lower resolution and certainly affects the subduction evolution. The authors explain this phenomenon using an analogy with a boundary-driven Stokes flow in a two layer material with boundary condition changing from free-slip to no-slip and back.

They then introduce an improvement to the standard weak layer approach (called here embedded fault) where the thickness of the weak layer is controlled and modified during the subduction evolution. This approach prevents transient thinning of the lower part of the decoupling layer and potential coupling of the subducting and overriding plates in case of lower resolution.

I find this paper very interesting. The weak layer approach is often used in subduction modelling while the numerical aspects of the implementation of this decoupling are seldom discussed or even mentioned. I therefore very much appreciate this systematic evaluation of the problem and suggested solution using ad hoc control of the layer thickness. The crutial point of the paper is made in fig. 12 where the authors illustrate that in their embedded fault approach low resolution has much smaller effect than in standard weak layer approach. This paper thus provides the reader with a recipe how to tackle the problem of decoupling the plates with an entrained weak layer – one may either use the suggested embedded fault approach, or use resolution high enough to resolve the thinned interface in the transient stage at the beginning of subduction. Alternatively, as just briefly mentioned in the discussion, this problem may be suppressed by nonlinear rheology, but that of course brings other complexities into the play.

The manuscript is nicely and clearly written and the topic fits the scope of Solid Earth, therefore I recommend it for publication. I only have couple of suggestions for mostly minor corrections.

1. You may perhaps explicitly mention that the weak layer has constant viscosity. The reader has to dig up this information by combining the sentence stating that except of subduction interface the rest of the domain is deforming according to composite rheology (at the end of paragraph 20 page 22 in Appendix) and the information in Table A2 (unless I overlooked this information somewhere else).

2. I don't see the logic in the order of figures – they are sometimes ordered and referenced rather randomly. Figure 1 is not referenced in the text.

3. Page 2, par. 25, line 4: remove of
4. Page 5, par. 5, line 5: an solution -> a solution
5. Page 5, par. 10, line 3: though -> thought
6. Page 6, par. 5, line 3: a initial -> an initial
7. Page 6, par. 20, line 5: a element -> an element
8. Caption Figure 11: Fig. a -> Fig. 12a
9. Page 22, par. 15, line 3: We -> we, mechanism -> mechanisms
10. Table A2: domain depth 100 -> 1000

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2019-11, 2019.