Response to Reviewers

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The paper presents a set of high-resolution thermo-mechanical simulations aiming to- wards a "nappe theory". The simulations focus strongly on reproducing as many features and attributes documented in the Helvetic nappe system, which guides the choice of input parameters, geometry, and boundary conditions. From a reference simulation, a set of key parameters are varied to test their influence on the simulation outcome. âA˘ c´ First, the viscosity of each material is tested in turn by (i) dropping the viscosity of the basement, (ii) increasing the viscosity of the cover sequence, and (iii) increasing the viscosity of the stronger syn-rift unit capping the rift basins. âA˘ c´ Then the stronger syn-rift unit is replaced by a 4- or 5-layer system involving 2 stronger layers and 2 or 3 weaker units. Three simulations test various thicknesses and configurations. âA˘ c´ Two strain weakening mechanisms (i.e. shear heating and accumulated plastic strain) are tested at various extensional velocities (1 cm/yr and 5 cm/yr). The simulation outcomes are then compared to the Helvetic nappe system.

The paper will be of great interest to geologists interested in nappe tectonics and in particular those interested in the Helvetic nappe system. The paper is well organized, relatively easy to follow, and the figures serve their purpose reasonably well.

The study is an attempt to learn about nappe tectonics from reproducing via numerical simulations the well-documented Helvetic nappe system. However, it remains to be seen whether an all-encompassing "nappe theory" can be extracted from such an approach, for two reasons: âA˘ c´ I would first question in the present context the use of the word "theory". In natural science, a theory is a very robust model established over decades of data collection and analysis and explaining a very large range of unrelated observations. Plate tectonics and biological evolution are two theories. For this reason, I think that the concept of "nappe theory" could safely be replaced by the concept of "nappe model". âA˘ c´ In addition, I think it is pretty safe to state that there is probably more than one way for nappes to develop. Hence, the proposed model is only strictly relevant to the Helvetic nappe system that develops as the result of the inversion of an extended continental margin, and the extrusion of its syn-rift sedimentary infilling. Hence, I think that modifying slightly the title and introduction, to bring a stronger focus on the "Helvetic style" of nappe tectonics, would be beneficial to the paper.

Perhaps the main missing ingredient in the numerical experiments presented here is isostasy and the absence of flexure despite up to 10 km of topography due to crust thickening and nappe stacking. I acknowledge that this issue is touch upon in section 5.2, but it is important to stress that the outcome of this set of simulation will change should the basement be allowed to subside under the weight of the nappe stack.

We added a sentence that the impact of flexure and isostasy on our model results can be tested eventually with larger scale models including flexure and isostasy.

The paper would also benefit from being leaner. I found at places the paper to be unnecessarily wordy, and the description on the simulation lengthy and tedious to read. Rather than describing the evolution of each experiment in great detail (perhaps you can point toward movies or animations instead), it would be best to highlight key differences. The conclusion

needs to be rewritten and shortened. A conclusion goes beyond merely repeating what was said before.

We have added one animation as a supplementary material.

We rewrote and shortened the conclusion and focused on the results relevant for the tectonic interpretation of the Helvetic nappe system.

The supplementary section needs some editing, there are too many spelling mistakes.

We considered and implemented all corrections, from the supplementary pdf. We considered all suggestions and implemented most of them.

Finally, either a code is made freely available, or it is not. Having to ask permission to the author to access the code is, in my view, not sufficient. Codes which are accessible are available online (e.g. underworldcode.org). Chances are that in ten years Underworld will still be available like it was ten years ago.

The code is planned to make publicly available in the near future once the paper describing it is published. The data is not publicly available because of its massive size.

Kind regards, Patrice Rey