



## Comment on se-2021-98

Anonymous Referee #2

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Referee comment on "Crustal structure of the Volgo-Uralian subcraton revealed by inverse and forward gravity modeling" by Igor Ognev et al., Solid Earth Discuss.,  
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The manuscript on the crustal structure of the Volgo-Uralian subcraton presented by Igor Ognev, Jörg Ebbing and Peter Haas is well written, clearly organized and pleasant to read. The authors use an original two step inversion procedure to recover the crustal structure of the study area in order to take advantage as much as possible of the available gravimetric and seismic data to constrain their results. The authors make a fair discussion of their results with an interesting comparison to other existing models. Below are my detailed questions, comments and suggested corrections, mainly aimed at improving the clarity of the manuscript on some specific points.

### Main questions and comments

- In the two step inversion procedure, it is sometimes difficult to follow which parameters are inverted from which data and where the seismic constraints are used. The schematic workflow of figure 2 could be completed by some additional details (Moho depth  $z_{ref}$ ,  $\Delta\rho$  range, a priori information, inverted parameters, hyperparameters...).
- l. 145: "In addition, topographically corrected GOCE...": What about the data on satellite height? Aren't they topographically corrected as well?
- l. 156-157: For the LAB, could the highest density contrast boundary significantly differ from the isothermal boundary and to which extent could the depth difference impact the results?
- l. 178: Could you add any reference for the value of the thermal expansion coefficient?
- l. 179: "Slightly modifying Eq. (1)": Could you explain a little bit more how you go from Eq. (1) to Eq. (2)?
- l. 220-222: Does one tectonic region correspond to a spatially constant  $\Delta\rho$ ?
- A few details on the inversion are missing and could be helpful to the reader (eg. l. 230-231). What is the  $\Delta\rho$  step? On what are the  $\Delta\rho$  and depth ranges based? Could you provide any references? What is the grid spacing (see. point no 9)?
- I do not fully understand how the trade-off is made between the gravimetric inversion residuals and the fit to the seismic data (eg. l. 231, this is related to my point no 1). How is the Moho adjusted to the seismic data (eg. l. 253)? On which criteria? How do you deal with the uneven spatial distribution of the seismic data (eg. l. 277-278)? For this last question, I understand that you do not take it into account but that you are

aware of this in the discussion of your results which seems fair to me.

- l. 238 "extended by 2500 km": This value is to be compared to the extent of the study area and the size of the elements of the model.
- l. 240-241: "triangulated polyhedrons in-between vertical cross-sections": I am not familiar with kind of "hybrid" modelling. Out of curiosity, what are the advantages?
- Fig. 6-7: It seems that there is a long wavelength signal left in the residuals. Has a regional/long wavelength signal been removed from the data? If not, why not? I think that it could help but the relevance of such correction might be questionable at this scale. What do you think about this long wavelength signal and the (ir)relevance of a correction of the data before the inversion?
- l. 321: "also manifested a considerable misfit": I am confused with this statement while the fit was described as "acceptable" a few lines before.
- The discussion and conclusion mention that "the 3D forward gravity modeling revealed a considerable gravity misfit in the central part of the study area" (l. 408-409). However, I could not see this feature on the figures shown... until I saw the supplementaries. I think that figure S2 deserves to be moved to the main article as the maps show features that are widely discussed. You might combine fig. 10 and S2b if it is not too small to remain readable.
- Fig. 9: I do not understand this figure with negative thicknesses. Are these variations?
- Fig. 10: The map would be more readable if the same information and colorscale was shown as background and in the triangles. If you showed the seismic Moho depth in the triangles, the reader would more easily see the areas where the color of the triangle significantly differs from the background color.

## Minor corrections

- l. 64: add comma before "at 1.8 Ga"
- l. 68-69: unexpected change of paragraph
- l. 144: remove comma after "That is why"
- l. 144-145: "on satellite height" -> Could you precise what is the satellite height ("ie. xx km of altitude") so that we can more easily compare to the other data?
- l. 159: "The main petrophysical parameter": Why "main"? What other petrophysical parameter do you have in mind?
- l. 165 and 208: "1/2 of the depth of sedimentary strata in km": not clear enough. What is the depth of the strata? Top, bottom, middle?
- l. 264-266: This sentence is quite complicated. Could you rephrase (split) it for more clarity?
- l. 279-280: "were assigned" makes me think the value is fixed beforehand while it is a result -> "resulted in"?
- l. 299: "The main product": What are the other products?
- l. 318 (caption of fig. 8): "6th later" -> "6th layer"
- l. 337: "fit of" -> "fit between"