Solid Earth Discussions

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Comment on se-2021-53

Carla Braitenberg (Referee)

Referee comment on "Forearc density structure of the overriding plate in the northern area of the giant 1960 Valdivia earthquake" by Andrei Maksymowicz et al., Solid Earth Discuss., https://doi.org/10.5194/se-2021-53-RC3, 2021

The research aims at defining a density structure of the continental forearc in the northern segment of the 1960 Valdivia earthquake, to date the highest magnitude event ever recorded with seismologic and geodetic instruments. The area of study is of general interest due to this landmark event, which generated free oscillations of the earth observed for the first time. The authors present a density model that aims to explain the observed terrestrial and satellite gravity data and to demonstrate a segmentation of the continental wedge, both along and across the subduction margin. The authors propose that the inhomogeneous structure of the overriding plate controls the process of stress loading during the interseismic period, due to rigidity variations. This point is interesting, but at the present stage of the work the link between the density structure and the rigidity variations and stress pattern is suggested qualitatively, but lacking a quantitative estimate. The general assumption made in the Discussion chapter is, that denser crust is more rigid. This assumption could be supported by some numbers, so as to define what the expected changes in elastic parameters are and which the uncertainties. In the discussion it is mentioned that in the northern profile, P1_Toltén, the density model can be compared with the velocity model reporting Vp values- the authors could use density and velocity along the profile to calculate the elastic parameter changes, in order to support their hypothesis.

The authors further propose that the varying width along the margin of the MWU and CC domains could be due to varying friction at the interpolate boundary. Since friction at a sliding interface is the product of the normal stress component to the surface and the friction coefficient, I wonder if the authors could use the density model to calculate the normal stress and then make implications on the frictional coefficient and possible presence of fluids.

Concluding, I propose the authors use their density model to quantitatively support their implications on the seismotectonics. In the following some specific problems are addressed.

Specific problems

- It is discussed that gravimetric lineaments have been defined, partly based on previous publications, partly defined in the present paper. At first sight these lineaments are not seen the BGA, so the authors need to define how the determine the presence of a lineament.
- The English Grammar must be improved- I attach a pdf with many small corrections
- The relation between the gravity field and the mega-faults for the Andean Subduction margin has been discussed before, but these papers are missing- I propose these findings shall be included in the introduction. They have been produced by Researchers as Orlando Alvarez and co-authors (https://scholar.google.com/citations?user=MDsDjEcAAAAJ&hl=en). These have also demonstrated the interaction of the morphology of the subducting topography on the angle of subduction.
- Line 92: give a few words on how the right lateral strike slip system relates to the oblique subduction. Give some more details on the crustal seismic fault mechanisms present in the area.
- Line 139:" normal gravity correction (subtracting the theoretical gravity of the WGS-84 ellipsoid), Free-Air, Bouguer, and Terrain corrections": give more details, as different standards exist. Give the formulas for the corrections. GPS give elliposidal heights, which geoid was used to obtain normal heights? Did you define gravity anomlay or disturbance? up to which radius did you make the topographic correction? Did you first calculate simple Bouguer and then terrain correction? did you use a higher resolution DTM for the near field? What is the estimated error on the final gravity acquisition? Did you have coincident old and new datapoints and what is the mean difference and standard deviation? What is the standard deviation compared to the GOCE field? Notice you must low-pass filter your data to make the differences with GOCE.
- Line 170: "This linear regional gravity trend is mostly related to a deep continental root below the Andes, eastward from inverted gravity" Linear trend of gravity field: do you mean crustal root and subducting lithospheric plate? You could at least calculate an isostatic root and calculate its gravity field to show that the linear plane resembles the isostatic field. The effect of the subducting plate has been calculated before and could be used or at least mentioned to estimate its effect on your field.
- Line 184: define density background model
- Line 195: here you mention the geophysical models for slabs and crustal thickness- it is not clear why previously you claim to subtract a plane that represents crustal roots of the Andes- the longest period field should be explainable by the slab and crustal thickness variation. Could you use these models to correct for the longest gravity field wavelengths?
- In general, use SI units, that is kg/m^3
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Please also note the supplement to this comment:
https://se.copernicus.org/preprints/se-2021-53/se-2021-53-RC3-supplement.pdf