Review on the manuscript “Constraints on the Lithospheric Structure and Rheology of Northern Chile from 8-year Post-Seismic Deformation following the Mw 8.1 Iquique Earthquake”, submitted to EGU Solid Earth by Cresseaux et al.

Dear authors, associate editors and editors,

The manuscript of Cresseaux et al. explores a multitude of crustal and mantle rheologic parameters to best predict the surface displacement after the Iquique earthquake observed by GNSS and InSAR time-series. This is not an easy tasks as the observations have spatial and temporal gaps that need to be filled by using some assumptions, and the two main processes the authors study – afterslip and visco-elastic relaxation – are overlapping but occur on different time-scales.

The synthesized geodetic observations provide (to my knowledge) a new level of completeness of this event and the visco-elastic model is very advanced with many model parameters to be tested. Next to some best-fitting rheologic constraints the main finding (as I understood it) is that a cold nose is needed to reproduce the observed displacements.

I have nothing to criticize on the data analysis, modeling and interpretation, but was overwhelmed by the abundance of parameter tests presented in the manuscript. While this might be very enlightening for modeler experts, the amount of parameter tests might be a bit overwhelming for the general audience that wants to learn more about this particular event. Maybe a few more figures could move to the supporting material and the Results/Discussion/Conclusion could be focusing on a few less points? I will trust the authors on whatever they prefer. But in any case the text should be revised for clarity and English grammar and wording. I will list my main questions or comments below, followed by many smaller comments on the text and figures that can be dealt with rather easily.

I hope the authors find those comments useful. *Sabrina Metzger, Potsdam, Mai 27, 2026*

Key issues/questions

- **Potentially reduce the abundant model tests in the main text** I was overwhelmed by the many tests and technicalities which made it hard to filter out my learnings. Do you see a possibility to reduce the number of parameters presented in the main text and refer to some of them in the supporting material? Can you somehow better highlight the geologic importance of this heavy-geophysical method approach for non-experts? Would it be interesting for example, to elaborate on the afterslip patch depth and extent, whether location and amplitude agrees with previous findings, for instance?
- **Chi-Square tests** It remains unclear to me how you weight the InSAR against GNSS ChiSquare-fits against each other. In other words: How do you derive the red vertical line in Figures 7/8G? Is an objective (1:1) comparison of all four input data sets possible (horizontal vs. vertical vs. asc./dsc. LOS) or should there be a relative weight between them? Does the InSAR fit depend on the number of InSAR samples you use? Is there an inter-parameter comparison even, so the one model that suffices all parameters best?
- **Use of geographic expressions** You use many geographic expressions (Altiplano, Cordillera, Volcanic Arc) but do not introduce them in a map, which would be very helpful to non-local-experts.
- **Use of precise and complete terms** Please carefully review the manuscript for precise naming of terms and correct English (which probably can be done by one of the senior co-authors). For example, avoid the use of the very generic terms “data” and “model” and use “surface

displacement", "geodetic observations", "predicted displacement" etc. . Avoid sentences like "Figure X shows this and that", instead say "This and that (Figure X)." I provide many suggestions for the first half of the text, then stopped due to time constraints.

- **Order in presenting the best model parameters and parameter boundaries** When reading the text, I found it irritating to read of your results (=best-fitting parameters) already in the section where you introduce the model design and refer to a table to read about the model a parameter boundaries. At the end of section 4.3 you then greatly discuss the parameter boundaries (which people already have explored in the table before). Why not providing numbers at all in Section 4 but refer to the Table, and then later in the results, list and discuss the best-fitting model parameters?
- **Role of fluids** I did not see any discussion on the role of pore-pressure diffusion following large earthquakes as it has been postulated (e.g. Pena et al., 2025, https://doi.org/10.1038/s41467-025-65013-6). Are such processes not needed, if a cold nose is included in the model? Can you elaborate on this topic?

Minor comments on the text

L20: Check reference-command

L30: "South American" instead of "Brazilian"? Is there an "is" or "has" missing before "thinning"?

L43: Rephrase "of the monitoring of the deformation" – it reads a bit weird. Replace "GPS" by GNSS (method instead of brand) and introduce the abbreviation. Also "InSAR" on the next lie.

L46: delete "that is"

L48: Delete "of the geometry in order"

L50: Delete "against the data" and use "The continuous deformation field…"

L51: "of the source kinematics" or "of the deformation source"?

L55: "Andean Cordillera"?

L56: replace "into" with "during"

L57: "segment of the subduction zone"

L65: "observed at 300 km distance from…"

L75: Delete "the" before the date

L76: Delete "been"

L100: ""that goes from raw data to" reads weird. Can you delete this and rephrase a bit?

L111: Explain ITRF, respectively, is it relevant or could it be dropped?

L112: "into displacement time-series" (for clarification)

L113: what do you mean by misclosure? Phase closure of interferometric loops? Or a comparison of the two time-series results? Please explain.

L115: Replace "phase delay" with "displacement"

L116: "signals" instead of "screens". "are" instead of "is". Provide a reference for the trajectory model. Probably Bevis & Brown 2014?

L121: “relaxation time tau” (add the tau symbol)

L125: The estimation of the secular loading rate v and the signal strength of the post-seismic relaxation A”

L130 “cumulative LOS displacements”

L131: “far-field InSAR information unaffected by a post-seismic signal”

L132: Delete “choose to”. “cumulative” instead of “cumulated” (also later)

L135: “linear function of range and azimuth” = “linear ramp” or “linear plane”. Clarify what you fit to what (InSAR to the GNSS reference frame, I assume?)

141: “GNSS time series [analysis]”?

143: It would be informative to add one more sentence with infos on “Data processing” : From what to what format using which software. (You explain it below so maybe reshuffle the sentences a bit.)

145: “RINEX”? Before and after this sentence you talk about processing so maybe reorder the sentences somewhat. It is unclear to me what is the same as in Bertrand et al. and what is new in the detailed processing explanations.

147: Explain NNR

153: Can you reword the statement “allows us to avoid the contribution“ and instead say something like “we assume that the remaining signals are insignificant for this work” or so.

156: “do not have sufficient data”

160: Mention that what you provide is an Euler pole rotation with lat/lon/angular rate.

163: “trajectory model following Bevis and Brown”. What is the difference between the Bevis/Brown approach and the Marill approach?

171/172: Is there a proper reference for these influence radius numbers, where one can read how they are derived?

172: “moment magnitude”

185: What is the difference from this equation to the last term in Equation 2? Nothing really, I guess, so maybe you can skip it?

190: “time-series contains only data shortly after the earthquake”

197: The detailed explanation of the RMS could be skipped (or simply mention that it is an estimate for the goodness of fit between observation and model).

201: “If the time-series only begin several months after…”

207: “We consider…” Rearrange the text fragments in this sentence, it reads a bit weird.

217: This cyan-sentence is better placed in the figure caption than here.

220: bring → provide, deliver, produce

228: Delete “The” in “The Figure2”

290: “with coherent amplitude despite”?

233: trench-perpendicular

235: “published under the MIT license”: This reads a bit weird and/or could be a legal issue, as MIT is not affiliated with the authors?

239: “1900 km from the trench towards west and 2100 km towards east”

242: “horizontal direction, the bottom in the vertical direction”

249: “Five” instead of “5”

251: Delete this sentence and add “The structural parameter…” directly to the before sentence (no new paragraph).

257-260: From how you phrase it it is unclear to me whether these statements should be here (model design) or more belong to the discussion. It sounds like you tested various models and show that what you found matches the findings of others. If so, then I would move it to the discussion.

261: “low velocity (weak) zone”?

Table 2: Delete the first “Elastic”, or replace “for the…” with “used in the model”. No comma after rho. I also suggest to write “v_p” and “v_s”, or somehow reduce the space between “V s” and “V p”.

285: Delete “use a simple approach” and write “kinematics”.

286: The second equation looks so complex, I would not put it in line with the text but on an extra line.

293: “We explore ten…” “Three” instead of “3”, “four” instead of “4”.

299: No new paragraph here, you are still counting your varying parameters. The same in line 306.

312: Can you be more precise, e.g. saying “between the observed and predicted surface displacements” and explaining HOW you determine the best model? (By visual and quantitative best-fit, for example, RMS etc.)

315: “offsets” instead of “data”

317: “GNSS and InSAR observations”

318: no comma near the end of the line

325: “Chi-square-fits”? Or “ratios”?

327: Is dispersion another term for root-mean-square?

331: “InSAR displacement map”

333: Where does the 1.4826 come from?

340: “ignoring the component along North-South”

342: we compare observed and predicted surface displacements along…”

348: “GNSS time series show”

348ff: Is it worth discussing the outliers from the general observation in Figure 3 (time constant increases with distance from trench), i.e. BN01 at the coast, and the high variations in the intermediate-field? You have an idea why you see these details?

353: “Afterslip is a relaxation phenomenon on the plate interface…”

356: “of the observations at the coastal stations”

358: “contribution … to our best model”

363: “significant. Although the contribution…”

367: Why should they be sensitive to different processes? Is one producing more vertical uplift than the other, thus canceling out the signal in one LOS-direction?

367: “InSAR displacement maps from both, ascending and descending tracks,…” (be more precise with you descriptions and avoid using terms like “data” and “model”, if possible.

380: “Altiplano”, maybe also “Brasilian craton”. These geographic term is of high importance for the interpretation of your models. For the benefit of non-local experts I suggest you mark the region somewhere in (or in many of) your figures.

385: Apologies if I have overread it, but: Do you explain somewhere how you weight GNSS Chi-Square against InSAR Chi-Square? Are they directly comparable or is there a relative weight between them? In Fig 7G one could also put the best thickness more at 27 or 28 km, no? (Ok, maybe because you did not test these numbers, but only 30 km, I see.) The same question is valid for Figure 8G. How to weight InSAR data points against GNSS?

439: What is your opinion on the influence of pore-pressure changes to such models? (e.g. Pena et al., 2025, https://doi.org/10.1038/s41467-025-65013-6) Do you think they are not needed if a cold nose is included? Should (in the ChiSquare analysis vertical and horizontal fits be treated equally from this perspective or not?)

444: In the bracket provide the full parameter name instead of the variable.

454: “long spatial wavelength”

456: “GNSS stations”

458: Consider using plural for “InSAR time-series” (also further up) as they contain lots of data points and rates and offsets.

459: GPS → GNSS

465: Cordillera? (mark it on a map if you mention it and refer to the respective figure).

475: Label the volcanic arc on a map.

479: “seismic” what?

506: “Western Cordillera”?

519ff: The links look long and complex and not very stable on a long-term. I see that the first link could also be shortened by using the data DOI (http://doi.org/10.17178/GNSS.products.SouthAmerica_GIPSYX.daily). I also could not access the peps.cnes.fr webpage with the Sentinel-1 data (offset maps? Full time-series?) and the Brazilian network RINEX files.

Comments on the figures

Figure 1: (Caption) Provide the source of the EQ locations (USGS?) and the convergence arrow and rate (angermann?)

Figure 2: (caption) “projected into LOS”. I suggest to zoom in a bit to increase the details. As of now there is nearly 2 degrees eastern longitudes and 1 degree western longitude and 1 degree southern longitude with no information. Could the white profile be shortened as there is no data to compare to in the following figures? I miss a discussion of this figure. Are you happy with the agreement between InSAR and GNSS? Why and where are the biggest discrepancies?

Figure 3: (Caption) “the vertical grey line separates the two…”

Figure 4: The red color for the explored parameters is painful to distinguish (or not distinguishable at all for readers with impairment), so better choose another color scheme, e.g. you can use very weak colors for the background and then black for the parameters (and all other text in gray).
(Caption:) Technically you do not use the stations, you use the GNSS offsets (or rates) measured at these sites. Is “delimination” an English word? Is there a difference between gray-labeled and black-labeled GNSS stations? Suggestions: “The explored afterslip parameters are patch depth Ad, slip amplitude Aa and patch width Aw.” “Five” instead if “5”. “co- and post-seismic slip patch imposed”.

Figure 5/13: Mark the stations shown here in a map further up for orientation. I suggest to label the y-axis with “trench-perpendicular (mm)” to be clear on it (also in the following figures). Use a stronger color for the measurements – they are hard to distinguish from the error bars. I suggest to sort horizontal time-series on the left and vertical on the right column and add sub-labels a) to l) so that you can directly refer to them in the text, if needed. Also, to quickly grasp the models, it would be good to provide a legend directly in one of the top sub-figures. Would it be helpful for the interpretation to use equal y-axes limits for horizontal and vertical each?

Figure 6: (Caption) “Trench-perpendicular cross sections…”, then delete the second sentence. No need to explain the color code in the caption if it is already explained in a legend (but add the gray InSAR polygon to the legend, too). “displacement” instead of “data”. The dark blue color is hard to distinguish from the black. C and D do not present InSAR, right? You seem to explain E and F twice. I would delete “, 1.4826 times”, but better explain in the text, where this number comes from.

Figure 7/8/9/10: Consider showing only every second h-model, they are very similar and hard to discriminate with this color scheme. “InSAR A149” is incomplete. The legend is incomplete, provide units to the thicknesses at least. Add “(marked by a bright red vertical line)” to the last sentence. “Figure” instead of “figure”.