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Interactive comment on "Coseismic deformation field derived from Sentinel-1A data and slip inversion of the 2015 Chile Mw8.3 earthquake" *by* R. Zuo et al.

Anonymous Referee #1

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The paper "Coseismic deformation field derived from Sentinel-1A data and slip inversion of the 2015 Chile Mw8.3 earthquake" present surface deformation associated with the past year Chilean earthquake evaluated using the new ESA satellite Sentinel 1-A in wide swath mode. The data are then modeled with a very simple (probably oversimplified) model using an elastic half space and simulating the fault plane as a single flat surface. The fault slip computed by this inversion is then used to compute Coulomb failure stress and compared it to the aftershock distribution. The paper, in particular the last two part of it is very problematic from a scientific point of view. The English of the full paper need major reworking, with presence of many colloquialisms (eg. line 29 "huge" earthquake), sentences that do not make any sense (e.g. line 52 it reads like

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if modern geodesy we can deform the crust), strange use of technical terms (e.g. line 13 “small-dip” single plane fault instead of shallow dip), very strange use of adverbs and conjunctions (e.g. line 29 “from” instead of “of”), and even subordinates sentences without verbs. Due to the level of English, the concepts within the text are very hard to understand and I am wondering if some of the largely negative comments I have on the scientific content are indeed related to this problem. From a scientific point of view, although the paper present results really relevant to natural hazards, the reason why the paper was submitted to this journal is never stated (it seems that the only problem is to figure out if the dip end of the seismic rupture is 30 or 50km deep without any explanation about the why we care (despite the large implication in the evaluation of the seismic hazard). The inversion scheme is not completely justified (single flat surface) nor the resolution of the inversion is analyzed. The use of a flat surface also has implication in the analysis of the coulomb stress vs aftershock location (more on this later). The discussion and conclusions make me worry that the authors have not fully understand the analysis they are doing (is it really a big results that using ascending and descending data improving the inversion? It is very well known that the use of ascending and descending data provide a full 3d displacement field while the use of only one of the two provide at most 2d displacement and more likely only line of site deformation). The paper is missing in one of the most important aspect of the use of sentinel wide swath. As explained on the text the use of wide swath does allow observations of the near and far field in a single image but it presents lots of challenges that are not explained in the text at all (I was hoping that I was missing supplemental material!). I realize that this paper was submitted before the paper of Grandin et al (2016, doi:10.1002/2016GL067954) but it is interesting to note that just last week they published in GRL an analysis of the technical challenges to process sentinel data exactly for the same event while this explanation is completely missing in the present manuscript. I am pretty sure that the authors are aware of these chalanges since the results in this manuscript are very similar to the one of Grandin et al. but no mention of them was made in the current version of the paper. To conclude I want also to point out

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that the results of the Coulomb stress calculation are biased by the choice of a single flat fault plane in the fault slip inversion (explained more later).

Principal criteria review -Scientific Significance Does the manuscript represent a substantial contribution to the understanding of natural hazards and their consequences (new concepts, ideas, methods, or data)? 3 Fair. The reason why the results are useful for seismic hazards are even not touched a single time in the paper.

-Scientific Quality Are the scientific and/or technical approaches and the applied methods valid? Are the results discussed in an appropriate and balanced way (clarity of concepts and discussion, consideration of related work, including appropriate references)? 3 Fair. Apart from the lack of description of the methodology to process the data from this new satellite, the paper is missing completely an explanation of the resolution of the fault slip inversion, an explanation of why the simplification of a simple single plane geometry for the fault is sufficient (I think it could but then one would get the problem showed in the Coulomb stress calculation). Furthermore the last part of the paper fail in recognizing that the approximation of a bending subduction plane with a flat surface bias the location of the aftershock with respect to the selected fault plane.

Presentation Quality Are the scientific data, results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of technical and English language, simplicity of the language)? 4 Poor. I have already explained the problem with the English but also thing like presenting the interferogram as a phase figure instead of the unwrapped displacement make the paper very hard to understand.

In conclusion I do not think if the paper should be rejected or be reconsidered after major revisions.

More detailed review points:

Line 11 and line 124 (and I think in other points). What is the meaning of half circle

convex to the east? First you do not have the full displacement since the deformation in the west area is masked by the sea. Second a point source would always give a "circular" area of deformation. Do you want to say that the deformation is not elongated in the along strike direction (that is an interesting observation suggesting a small aspect ratio between length and width of the fault)

Line 13 You can have small angle dip or shallow fault but not small-dip fault

Line 29 What is the meaning of a huge earthquake? you should avoid to use term like huge big small since are all relative terms. For example the 2015 "huge" earthquake is pretty small with respect to the 1960 event. From is the wrong word Line 30 Take away of which More than say "at the latitude. . .." I would say at the location of the earthquake.

Line 32 Why "begins" the subduction? The subduction started at least 40Myr ago and definitely does not start geographically in this location. . .

Lines 34-40 Please rewrite the full sentence. Try to use less subordinates, and be more descriptive. Also put the references in the correct position in the sentence. If the meaning of the sentence allows it put the references at the end.

Line 40 In a statement like this you should specify from when to wen

Figure 1 More than the epicenters of the past events it would have been nicer the area of rupture (it could be derived by many publications, eg the referenced one of Vigny). Some text is not readable (e.g. "South Amarican plate" or Chile trench). Dots for aftershock andsimbles for cities are too similar.

Line 51 Why it is important to understand the subduction zone? Here it would be a perfect place to explain why it is important for natural hazards

Line 52 I think "obtain" is the wrong verb. It sounds like if geodesy is deforming the crust.

Line 55 Which one is "this issue"

Line 61 remove great

Line 64 remove both the, and downloaded (I suppose that if you process the data you obtain them somehow)

Line 66 You do not have “three different constraints” but you do three different inversions of three different dataset

Line 68 Why additionally?

Line 70 this is the main point that make the paper possibly important!

Line 86 I would say postseismic deformation more than aftershock deformation. There are multiple processes that can lead to postseismic deformation and afterslip is only one of them (and also not entirely explained by seismic deformation).

Line 97 What do you mean by many times? What are you really doing to do this critical step? How many times? Are you using a montecarlo method (if I read many times I would assume that). I am wondering if the jump visible in the residuals (panel I, J, and L in figure 2) are related to problems in this process.

Figure 2 Why not unwrapping the images? From the phase image for example I can not see in any way what you state in line 132.

Line 123 While is not the correct word, probably when will be more appropriate

Line 124 Half circle convex is a pretty bad description! And does not means anything

Line 126 why within??

Line 126-132 needs to be completely rewritten it is very hard to understand. In particular since the unwrapped deformation is not presented in any figure.

Line 138 How do you see from focal mechanism that the surface trace closely follows the trench axis???

Line 138 Is a single fault plane a good approximation. It could be but it would strongly

bias the determination of the lowest point of slip on the fault plane. In particular if like in this region the Benioff-Wadati plane (thus likely the slab itself)seems very much bending and the slab in this part of the trench is not a shallow dipping slab.

Line 136-164 (VERY IMPORTANT!!!) Since your results are influenced very strongly by the choice of the parameterization of your model (thus the taxellation of your plane or the size of the patches), and by the selected smoothing (beta) you MUST explain how do you select the best smoothing factor and how good is the resolution of your model. Without this explanation the results are essentially meaningless, in particular regarding the depth of slip on the fault. I need to say that the paper of Melgar et al 2016 (also out the past week on GRL) obtain from seismic and geodetic data a similar slip pattern than the one found in this manuscript, suggesting the results be correct. Another very important point is if the resolution (and best smoothing) is the same for all 3 inversions.

Line 153 “half space model using Okada” add (1985) at the end of line

Line 159 Is the rake fixed for all patches or every patch can have a different rake and the range is the value for the different patches.

Line 160 “to the surface” I think “to the trench” would be more correct.

“steadily modified” what is the meaning of this? Which method did you use to modify the parameters?

Line 162 How does this value compare with slab dip from models like slab1 (Hayes et al 2012)?

Line 164 What kind of resolution test did you make? Any results to show? It seems to me that 10km resolution at depth 50km could be to high resolution. . . (but it is possible to obtain it, if this is the case it needs to be shown).

Line 182 It seems you should have enough point to constrain the deformation also for the ascending data alone pretty well. I am wondering if the problem is the unwrapping

and the fact that the far field within your image is not really at 0 displacement (thus you get smaller displacement at surface than the real one. I am also wondering if the optimal smoothing in this inversion is different from the optimal smoothing in the other inversions

Line 185 It seems to me that the area of slip from the ascending data only is much smaller and the slip is really smaller so it seems strange that the 2 magnitudes are so similar (unless the color scale for the figure 3 is pretty bad and the slip and area of slip are after all not so different).

Line 192 Why did you use the same weight for the ascending and descending in the combined inversion? What does happen if the two weight are different?

Line 193 Symmetric with respect to what?

Line 197 Not a big surprise! The combined dataset allow you to study the full 3d deformation at the surface (or if we assume that northsouth deformation is not so well constraint in the wide swath, at least a full 2d deformation! Not a surprise it is defined better the fault slip. It would have been nice to see a map of the unwrapped deformation from ascending, descending and combined.

Figure 3 It is very hard to read. I would take away topo-bathy and have a better colorscale (for example going to a light color where you do not have deformation).

By the way the paper of Melgar et al in GRL show the presence of different patches with higher slip. I am wondering if your results would also have them with different smoothing and/or different colorscale or your resolution is not good enough to have such patches.

Line 210 It seem that you are not using your fault slip but the one from Lin 2004 and Toda 2004. Be sure to put the reference in the correct place in the sentence

Line 212 it is not that have great influence in earthquake activity but that can trigger seismicity already ready to go. I would rewrite this sentence.

Line 214 (very important) Assuming a single flat fault plane, your model does only approximate the geometry of the plate boundary interface or of the slab. As for the focal mechanism the best plane you will get is mainly influenced by the area with the largest slip (thus shallow). Since the slab in this area is not shallow dipping it is clear that the slab surface would tend to be lower than the one of the fault plane you are inverting for. THIS DOES NOT MEAN THAT SLIP ON YOUR PLANE INCREASES THE LIKELYHOOD OF EARTHQUAKE DEEPER THAN YOUR PREFERED SLIP MODEL! Figure 4b is perfectly compatible with the Benioff Wadati plane in the area. This is why before I was asking a comparison with Slab1! Probably your slip inversion should have been done on a surface following the seismicity more than on a flat surface. This is the real meaning of your figure 4b! By the way it is also important to point out that the location of the aftershock in the figure is from teleseismic and not relocated!

Line 219 In figure 4a it looks like if you have more events in the blue areas than in the red areas. You state that your computed Coulomb stress correlate very well with seismicity distribution. How do you compute the correlation? I am wondering if the seismicity in the blue area is in reality is around patches that did not rupture during the main shock as indicated by Melgar et al. (2016).

Figure 4 A is the seismicity window for depth? B I can not see the blue line but I think the fault interface more than be a line is a curved plane. C it would be great to have seismicity also in this figure.

Line 247 You must show resolution tests!

Line 270 “half circle”????

Line 270-277 I can not understand what you are discussing here. Half circles, NS symmetric, connective rupture? No clue... By the way I am not expecting the subduction of nz uder sa to behave the same along the trench since there are huge differences in things like slab dip! How do you know about barrier or locking, coupling? You have only coseismic data not pre-seismic! What does your paper says about segmentation? I am

pretty sure that a Mw8 would not have uniform slip without any barrier at all (indeed seismic data show significant complexity in the rupture)

Line 284 Not really until you show the resolution tests

Line 297 more than speaking of % of fit it would be nice to give the metric used for the inversion (eg L2)

Line 296-300 I do not agree with this conclusion based on the comments given before.

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