Nat. Hazards Earth Syst. Sci. Discuss.,
doi:10.5194/nhess-2015-342-RC2, 2016

Natural Hazards and Earth System Sciences
Discussions

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 #2

Received and published: 23 March 2016

This paper studies InSAR data collected for the 2015 Chile earthquake, in order to determine the fault geometry, the slip distribution and the related distribution of Coulomb stress change, to be compared with the aftershock distribution. The English usage is very poor along all the paper length. I found difficult to follow the description of the work made on INSAR observation, but I am not a specialists of the subject. The motivations of the study, the choice of the inverted data together with their advantages, and the impact of results are not enough discussed. Some specifications are not given for result reproducibility. Some results are not interpreted correctly.

Scientific Significance: 3 Fair. Currently, elastic half space inversions and computation of Coulomb stress changes for planar dislocations requires almost standard tech-

niques. Unfortunately, another paper recently provided a more resolved information about this earthquake, by jointly inverting also other kinds of data and using a more complex geometry of fault (curved surface) and elastic structure (Melgar et al. 2015 doi:10.1002/2015GL067369).

Scientific Quality: 3 Fair. Results of the Coulomb stress analysis (see below) can be obtained and interpreted more correctly. However, concerning the slip distribution (the extent along dip, the shallow elongation along strike and the relative location with respect to the main-shock hypocentre) the present results are similar to the ones obtained by Melgar et al. (2015). Likely due to the "equal weight" (lines 191-192), results of the joint inversion (ascending plus descending INSAR data) do not differ significantly from those obtained using only descending data. At the same time, model residuals (Figure 2 I-L) are not discussed, so that the joint inversion is not completely justified.

Presentation Quality: 4 Poor. Besides the poor English usage, the LOS displacement increments shown in figure 2 are scarcely interpretable. Some of the used parameters are not specified. Aftershock hypocenter locations should be evidenced also in cross sections together with the rupture extent (Figure 4c). The same saturating values of Coulomb stress (min/max in the colour palette) should be used both in Figure 4a and 4c. The two tables can be more comprehensively organized.

To be publishable, the paper should improve the presentation and compare its results with that obtained by Melgar et al (2015), with trying to interpret the differences in the light of the different resolving power of the data used and the different modelling assumption made.

Detailed comments:

Line 70, 212 and 218 "shear" -> "Coulomb"

Line 142: "Firstly": Before making the linear inversion for the slip distribution, authors make the nonlinear joint inversion (of both ascending and descending data) for the fault geometry (optimal model ,results shown in Table 2). Unlike the inversion for the slip distribution, in the nonlinear inversion authors do not consider separately ascending and descending InSAR data.

Line 151-152 I agree with referee 1: the criterion used to choose the smoothing factor ïĂÍ\beta) and its chosen value should be declared.

Line 160 “is to the surface” -> “is put at the surface of the elastic half-space”.

Table 2 misses the average value of slip and rake assumed or estimated. Parameters fixed or estimated should be distinguishable in Table 2. In Table 2, rather than in Table 3, I would suggest the authors to compare the results of the optimal model with evidences from USGS and GCMT.

Table 3: it is necessary to declare the shear modulus (or rigidity) value used to estimate the seismic moment, as reported in the last three rows. On the contrary, here reporting the same data concerning dip and strike as in Table 2 is unnecessary. Reporting the maximum slip together with the depth of the down-dip edge of the rupture, according to the different data sets, should help readers in understanding how the inferred results depend on the particular data set. Please check the rake angle estimated with descending data which is declared as 110° at line 177.

Lines 178, 185 and 194. I am surprised that the “fitting degree” (not defined) is so high, giving the results shown in Figure 2 I-L.

Line 181. What is the “scope” of the slip magnitude? Concerning the lower slip values or seismic moment estimated with ascending data, referee 1 gives an interpretation more articulated and convincing, than the one given by the authors. The displacement observed at a GPS station is a useful constraint to solve for the true displacement observed in the LOS direction.

Line 211. Stain->Stein. I agree with referee 1: likely aftershocks appear below the fault, because the true fault curvature is neglected. Often, the distribution of the seismicity

hypocentres, possibly relocated, in a vertical cross section, allows us to delineate the true dip of the mainshock fault.

Line 214. In general, the distribution of aftershock is not used to choose the “receiver fault mechanism”. If the concern are aftershocks, the best thing to do is considering their focal mechanism in order to determine the” mechanism of the receiver fault”. As said, aftershock alignments suggest the geometry of the “source fault” (where the mainshock occurred), therefore choosing this geometry for the “receiver fault” coincides with assuming that aftershocks occurred on faults with the same fault mechanism as the source fault. We cannot state that the authors chose this last strategy because in this paper the source fault does not have the same dip as inferred from aftershock alignments.

Line 218-222: The following two statements are scarcely supported by Figure 4 results: 1) “(we) find aftershocks (depth in 20km-30km) locations correlate well with the areas having increased Coulomb stress”, 2) “most areas with increased Coulomb stress appeared beneath the main shock fault plane, which is consistent with the location where aftershocks took place.”

1) Actually in Figure 4a the majority of aftershocks seems to be shadowed (negative coulomb stress change) by the main rupture. This suggest that the 30 km of depth of the map view is above the down-dip edge of the rupture at least close to line B-B’ (as also stated at lines 19, 278, 295). If this is true, the positive Coulomb stress values within the horizontal projection of the fault rupture likely are not due to the slip distribution, given the absence of asperities (regions of no slip) within the rupture surface, as evident from Figure 3c. In obtaining this result, a role may have the change in the receiver dip with respect to the source dip (see last point), or numerical problems due to fault discretization near the fault plane, evident mainly in cross sections (Figure 4c).

2) In Figure 4c, below the fault plane, the most reliable positive feature is the off-fault lobe of Coulomb stress, which is located at a distance of about 200 km. It is due

to tensile stress changes caused by the main rupture (the so-called antithetic lobe). However few of the aftershocks reported in Figure 4b seem to locate there.

Lines 273-275 Sentence to be rewritten for clarity.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., doi:10.5194/nhess-2015-342, 2016.