Nat. Hazards Earth Syst. Sci. Discuss., 3, C3403–C3407, 2016
www.nat-hazards-earth-syst-sci-discuss.net/3/C3403/2016/

Natural Hazards and Earth System Sciences
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Interactive comment on "InSAR observations of the 2009 Racha earthquake, the Republic Georgia" *by* E. Nikolaeva and T. R. Walter

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Received and published: 7 May 2016

Dear Anonymous Referee #1,

Thank for your comment on our manuscript "InSAR observations of the 2009 Racha earthquake, the Republic Georgia". We carefully considered all your comments and questions. Next, we offer detailed responses to them.

>My main question is: why have not you chosen more SAR data?

Reply: We appreciate this remark and accordingly improved the text. In fact, there are very few SAR acquisitions for this area of central Georgia and for the studied time period (2008-2010) available in the European Space Agency archive, not allowing a detailed deformation study. There are no ERS data available at all. Envisat_ASAR_IM

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data are available for the date 2009-09-06 and 2009-11-15 (same track 178). However, these scenes only partly cover the area investigated. Envisat_ASAR_WS data are available from different tracks. Also, a coherence of these scenes is low due to the sensitivity of the C-band to the vegetation. Therefore we concentrate on the Japanese mission ALOS PALSAR, and here use all available data. In the revised manuscript we also note, that nowadays with the availability of modern satellites and background missions (e.g. Sentinel), the availability of data for future earthquakes will certainly be improved.

>Abstract 1) Justify the selection of the SAR data. Why had not been chosen other sensors with larger coverage?

Reply: In the revised version we clarify the availability of SAR data in the study area (see also point above). The abstract was changed accordingly: 'We considered all available SAR data images from different space agencies. However, due to the long bandwith and the frequent acquisitions, only the multi-temporal ALOS L-band SAR data allowed us to produce interferograms spanning the 2009 earthquake.'

>2) Authors used many ambiguous comments in abtract, (i.e line 16: in good agreement)

Reply: We appreciate this comment and improved the abstract. Ambiguous comments and imprecise wordings were deleted.

>Data and Methods: 3) Line 1, page 4701: The SRTM at 90m resolution was substracted. This must be rephrase (i.e: the phase component associated to the topography present in the scene, was removed from the interferograms using the SRTM 90m data)

Reply: We corrected a text following your recommendation: 'The phase component associated with the topography was removed from the interferograms, considering the Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM) at 90 m reso-

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lution'.

>4) Line 9 page 4701: mentioned the atmospheric delay substracted. However, ALOS PALSAR data has not suffer much of this atmospheric but hte ionospheric effects are more important

Reply: We did not identify a long wavelength visible effect in our presented interferograms, which is often observed in L-band SAR data [1]. [1] G. Gomba, A. Parizzi, F. De Zan, M. Eineder, S. Member, and R. Bamler, "Toward Operational Compensation of Ionospheric Effects in SAR Interferograms : The Split-Spectrum Method," pp. 1–16, 2015.

>Results: InSAR: 5) Figure 3 e-g does not exist. Please review figure numeration.

Reply: We corrected the numbering of the figures.

>6)Extra figures needed. Wrapped interferograms are more important to identify error and noise in the interferograms, since the unwrapped are also interpolated, not allowing to identify error sources and other effects present.

Reply: We are agree that wrapped interferograms are sometimes helpful to identify noise in the interferogram, as well as phase jumps. We will add a wrapped interferogram as example in the appendix (please, see in the supplement).

>7) Authors use again ambiguous comments such as good quality (line 12 page 4702) and slightly poor quality (line 20 page 4702). How do you quantify that? Could you please explain and correct the text accordingly?

Reply: We used words 'good' and 'poor' quality based on coherence information. High coherence (higher than 0.7) was identify as a 'good' quality of image. We will clarify these comments based on coherence introduction: 'One post-seismic interferogram has a slightly poor coherence (coherence is lower than 0.4) (Fig. 2 (h)).'

>8) Please generate more interferograms covering the area using other slave image.

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The effect you mentioned that can be interpretated as earthquake induced deformation can be an effect present due to one single SLC image used in all the interferograms (as you mentioned the slave image, line 17 page 4702)

Reply: For instance, the possible pair 20090904-20100607 (with different slave) has big spatial and temporal baselines, accordingly a coherence is very low and we are not able to extract any useful information. There is again the problem of the limited number of SAR data for this research.

>Discussion: 9) Comment the sentence: "based on InSAR data, we can assume that the fault plane may be shallower to the surface". How can you support this afirmation?

Reply: We re-phrased this sentence as: ‘based on the CMT solution, the dip of the fault might be steeper close to the surface, which was also confirmed by InSAR observation’.

>10) Line 25,26 page 4704 :"Limitations mainly may come from the quality and quantity of the InSAR data". Why had you chosen only ALOS PALSAR data? Should not you have chosed all the available SAR data over the area in order to not have limitations due to input data? Why have not you explorer the same procedure using also Envisat ASAR, TerraSAR-X or RADARSAT data?

Reply: Please, consider our comment in the beginning. Also, we tested C and X-band images for the central Caucasus and found that these bands work well only locally, where decorrelation due to land use or vegetation is minor.

Please, find our improved manuscript in the supplement.

Thank you for your comments which improved paper.

Best regards,

Elena Nikolaeva and Thomas Walter

Please also note the supplement to this comment:

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http://www.nat-hazards-earth-syst-sci-discuss.net/3/C3403/2016/nhessd-3-C3403-2016-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 4695, 2015.