Nat. Hazards Earth Syst. Sci. Discuss., 2, C1802–C1807, 2014
www.nat-hazards-earth-syst-sci-discuss.net/2/C1802/2014/

Natural Hazards and Earth System Sciences
Open Access
Discussions

Interactive comment on "Process-related deformation monitoring by PSI using high resolution space-based SAR data: a case study in Düsseldorf, Germany" *by* D. Liu et al.

Anonymous Referee #2

Received and published: 8 August 2014

The article is about monitoring the surface deformation within the city of Düsseldorf, Germany, during the construction of an underground railway line. The authors generate a time series of deformation by applying the persistent scatterer module of the StaMPS software package to 20 Terra-SAR-X images. Finally, they show the results of the processing and display the deformation behavior of several extracted persistent scatterers. At one single point the InSAR time series has been compared to an independent deformation time series of leveling data.

General remarks: The article is very short and besides the processed data not much is shown or explained. The only outcome of the paper that has been stated in the conclu-

sion is, that InSAR is a reliable tool for monitoring within the accuracy of mm, although no statistical evaluation has been done. Such an evaluation, however, has been done already 7 years ago by Ferretti et al. (Submillimeter Accuracy of InSAR Time Series: Experimental Validation). Therefore, the article does not claim any new findings or results. The paper is poorly structured and definitely has to be cross-checked properly by a native speaker, as there are countless articles missing and several other cases where better wording could have been used. I found this point somewhat surprising, as one of the co-authors seems to be a native English speaker... Therefore, I think that the article is not publishable in its current form and substantial effort in increasing the scientific content and outcome of the article has to be made.

Nevertheless, I think the data with regard to the monitoring of a tunnel construction is interesting and could be publishable, if properly analyzed. I strongly suggest the authors to broaden their discussion and to make a more detailed statistical analysis of the persistent scatterers (PS).

For example:

-The authors could use the same software package to also use the SBAS (small baseline subset) method to probably increase the number of PS and/or to compare the performance of both methods (PS & SBAS). For TSX data the pixels are seldom stable in phase and amplitude over a long time, therefore, SBAS could improve the number of pixels in the result...

-A distance of pixel to tunnel vs pixel deformation statistic.

-Another very helpful step would be to display the deformation velocity with a continuous colorscale.

-What is the height of the strongly deforming buildings? Might some of the deformation be related to residual height phase caused by the buildings?

-Can the authors get a map where the compensation injections have been done?

There is a lot that can be done in order to increase the scientific content of the article and to be able to broaden the discussion. Below I give a detailed list of comments.

Detailed comments:

Introduction:

4815 L 1-5: Interferometric Synthetic Aperture Radar (InSAR) and Persistent Scatterers Interferometry (PSI) produce a time series of deformation on a succession of time-ordered images, in principle allowing people to investigate temporal characteristics of deformation patterns (Massonnet et al., 1993; Bamler and Hartl, 1998; Osmanoglu et al., 2011; Liu 5 et al., 2014).

InSAR and PSI do not produce anything, these are methods that can be used to . . .WORDING!

4815 L. 5-8: Several InSAR/PSI techniques have been developed for deformation monitoring in the past years (Berardino et al., 2002; Lanari et al., 2004; Hooper et al., 2007; Pritchard and Fielding, 2008; Sowter, 2010; Li et al., 2011; Crosetto et al.,2013; Sowter et al., 2013).

I dont understand why Pritchard and Fielding; Li et al. have been cited here? They haven't done any method development with regards to basic 2-pass InSAR or PSI in these papers? Please remove these references as they are misleading.

4815 L 10-12: However exciting these developments people have made, there are still challenges when applying PSI to monitor subtle deformation by removing signal contamination from, i.e. atmosphere and DEM errors.

I cannot understand the first part of the sentence . . .GRAMMAR!

Methodology:

4815 L 25-26: An adaptive filtering technique was employed to clarify the fringes and to reduce noise (Goldstein and Werner, 1998).

What is the filtering coefficient that has been applied?

4816 L 1-3: When an interferogram stack is ready, an initial selection based on amplitude analysis determines the PS probability for individual pixels, which is followed by a phase analysis in an iterative process (Hooper, 2006).

It would be helpful if the process is being described better and more precisely, dispersion amplitude (which values used). In which way the phase is analysed? I.e. Phase stability. . .

4816 L 3-5: Moreover the deformation signals of the PS pixels are isolated from the residual phase due to DEM error, atmospheric delay and noise terms. How the deformation signal is isolated? The authors describe that in the analysis and discussion-that belongs in the method section. . .

Analysis and Discussion:

4817 L 1-5: Fortunately, the variation in atmospheric retardation between passes is correlated spatially and may be estimated by a low-pass filter in the spatial domain (Hooper, 2006). Similarly, estimating other terms, such as the orbital error and DEM error, is also carried out by the StaMPS approach.

I suggest to move this part to the method section.

4817 L 11-18: In order to convert the deformation in LOS to the vertical direction, direction cosines in analytic geometry were applied. In other words, the direction cosines actually are the percentages of the real displacement along three directions: vertical, N–S and E–W. The actual movements are always underestimated if only LOS dis15 placements are used. In this study, the movements were assumed as purely vertical based on a priori knowledge. As the incidence angle is around 35, we found an underestimation of approximate 19% of purely vertical movements when using the LOS values.

This is a very strong assumption. In order to show that there is no horizontal motion,

please also provide a map with the E-W displacement, as the N-S displacement is anyway almost neglect able. Nevertheless, I suggest showing at least once the deformation velocity in radar LOS (line-of-sight). The underestimation of 19% is compared to which value?

4817-4818 L.29-L. 10: The different components of the interferometric phase: deformation phase, DEM error, atmospheric error, orbit error and noise are described in Eq. (1) (Hooper,2006). _dint = _def +_DEM +_atm +_orb +_noise (1) The final four error terms contaminate the deformation phase. By low-pass filtering the unwrapped PS phases in time then high-pass filtering in space, StaMPS is able to estimate the spatially correlated error, which is to be subtracted. The remaining phase component will be only related to deformation while spatially uncorrelated error terms can be modelled as noise. In whole StaMPS processing, no predefined deformation model is required. Therefore, there is a possibility to derive a non-linear deformation signal.

Please also move this part to the method section.

4818 L. 10: The Time series of one PS point approximate 20m far away from the control point is plotted in Fig. 7. 4818 L.14-17: Along with the tunnelling, a levelling survey was carried out near to the start point by the State Capital of Düsseldorf. Therefore, the levelling result has been used to validate the PSI approach here, which indicates very few discrepancies (Fig. 7).

Please mark the control point of the leveling survey in your figures and also where the points of the PS time series have been taken.

Figures:

1. Add a small inset map showing the AOI in a wider map (Germany, Europe).

3. Please make the the x-axis labels nicer, more detailed. The default stamps version is not so nice. Add the detailed dates on the circles of each acquisition.

4,5. As mentioned above: I suggest deformation in radar LOS, continuous colorscale,

eventually adjusting the minimum and maximum value to see details around the excavation line.

6. Show control point and PS point of Fig. 7, combine with fig. 7, continuous colorscale.

8. Show PS point of Fig 9, combine with Fig 9, continuous colorscale?

9. Please re-arrange dates at y-axis to x-axis. Don't see the point of the above baseline plot, it is also not mentioned in the text. Either remove it, relate to it in the text or make it readable.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 4813, 2014.