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Phase unwrapping issue in DInSAR measurements in aspect of surface displacements on mining areas

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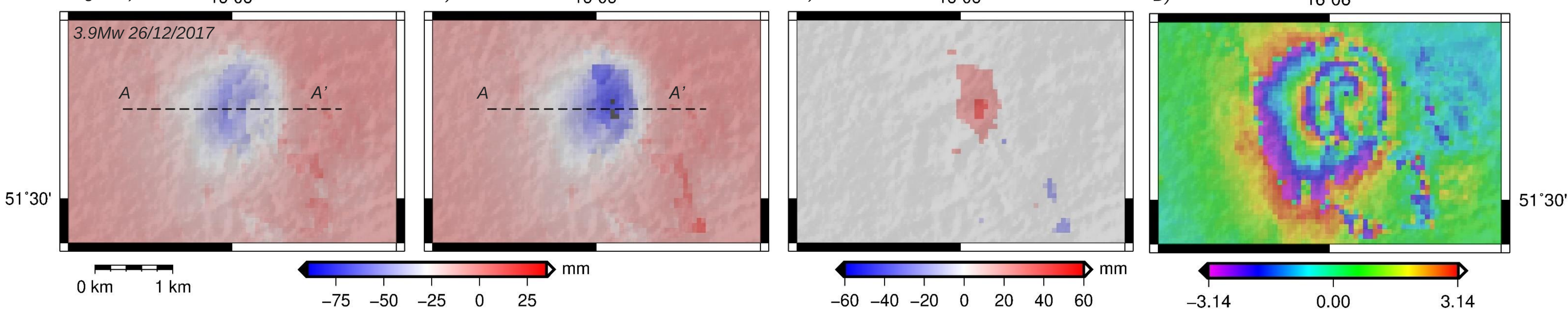
Fig. 1 A) B) C) D)



Introduction

SAR interferogram include information about a displacement in wrapped form – modulo 2 π. Demodulation of phase (phase unwrapping) enable to restore true phase values and then interpretation of acquired information. Poor data quality and large or very small surface deformations cause phase discontinuities that make unwrapping process difficult and may generate incorrect results.

Study Area

In our research, we focused on two subsidence basins located in the Legnica-Głogów Copper District (Fig. 2), where copper ore is mined underground. In the exploitation area occur induced seismic shocks, which cause additional permanent land subsidence of a few centimeters. The LGCD area is both urbanized as well as agricultural and forest areas, therefore the interferometric phase may be de-correlated (Fig. 2D and 4D), which result from changes in land cover. In addition, the observed displacements have a relatively small scale, so any interferogram disturbances can cause an incorrect measurement result. In our study, we used Sentinel - 1 data for two induced seismic events from December 2017.

Fig. 2

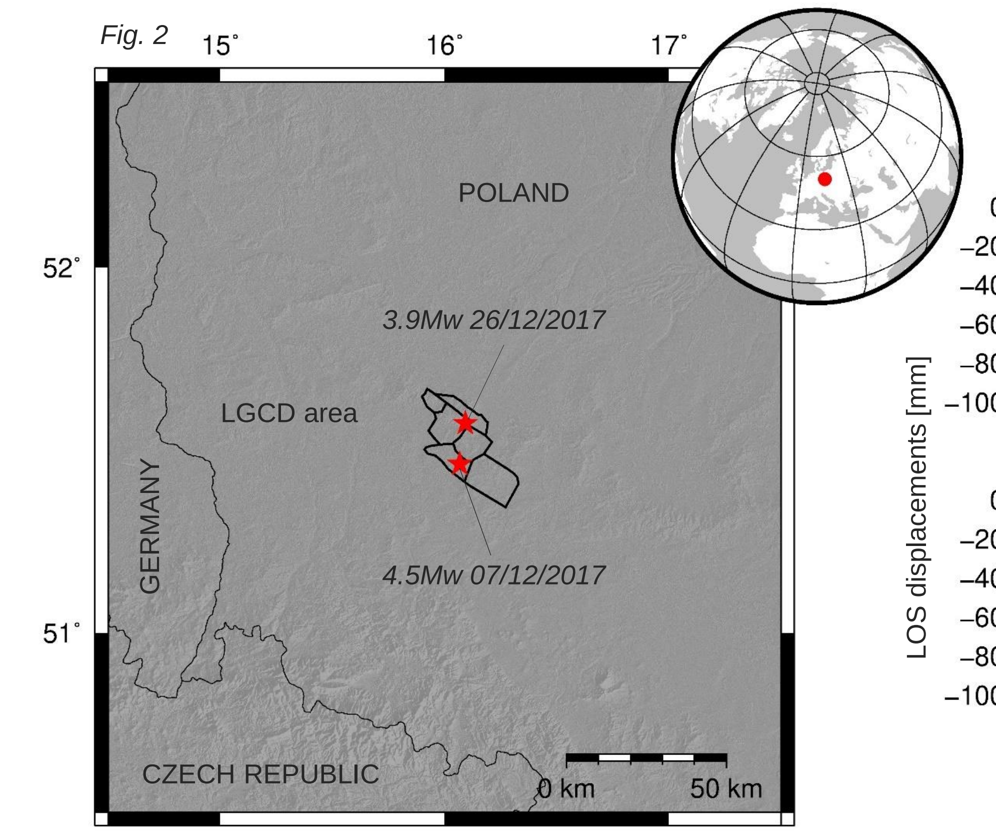
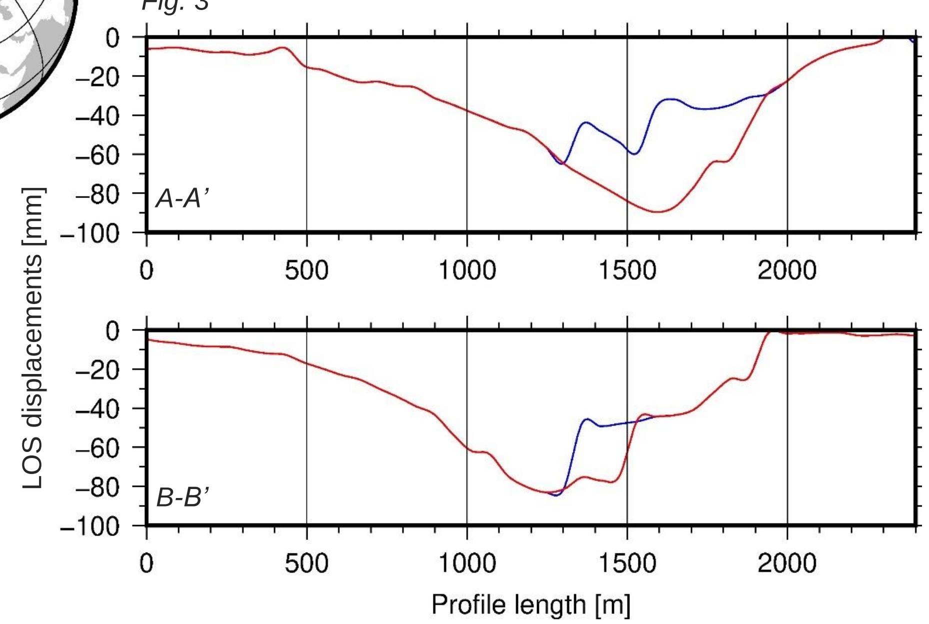


Fig. 3



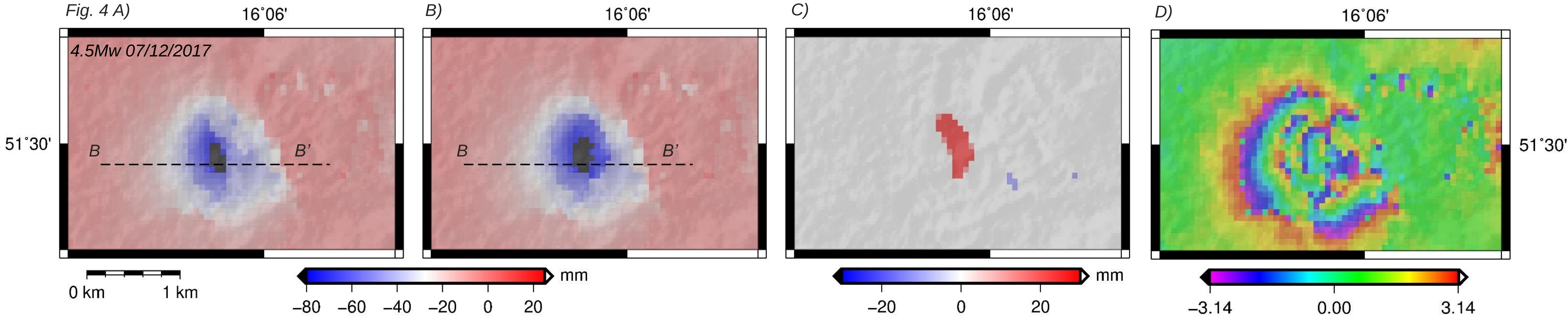
Method

We used the Statistical-Cost, Network-Flow Algorithm for Phase Unwrapping (SNAPHU) [1]. By default, it is assumed that phase values for adjacent pixels should not differ by more than half the cycle (π). We observed that in places where the interferometric fringes are disturbed, values of subsidence are lower than values for areas where fringes are regular (Fig. 2A and 4A). For this reason, we have increased the possibility of a phase difference between two pixels from halfway through the entire cycle (i.e. 2π) by changing the deformation factor. For this reason, we have increased the possibility of phase difference between two pixels from half to the entire cycle (i.e. 2π), by changing the deformation factor.

Results and Summary

In both cases, disturbances of interferometric phase occur in the eastern part of the tested area. Our approach allowed to obtain a more accurate measurement of displacements in this region of the lowering basin (Fig. 1B and 4B). Our approach allowed to obtain a more accurate measurement of displacements in this region of the subsidence basin (Fig. 1B and 4B). In both cases, the subsidence values increased, and the basin assumed a more natural and symmetrical shape (Fig. 3), consistent with the theory of influence function at mining areas. Simultaneously, we did not observe any changes in the measurement values in other areas (Fig. 1C and 4C). The obtained results are promising and indicate the requirement to consider the value of the deformation factor in some cases of the phase unwrapping process at mining areas.

Fig. 4 A) B) C) D)



Figures descriptions and Citation

Fig. 1 Subsidence basin where on 27/12/2017 a 3.7 Mw induced shock was observed.
Fig. 4 Subsidence basin where on 07/12/2017 a 4.5 Mw induced shock was observed.
A) Line of Sight (LOS) displacements for default parameters
B) LOS displacements for deformation factor parameter equal to 1 (cycle)
C) Difference between A and B
D) Wrapped phase
Fig. 2 Area of interest located in SW Poland
Fig. 3 Cross sections for both susbsidence basins

[1] C. W. Chen and H. A. Zebker, ``Network approaches to two-dimensional phase unwrapping: intractability and two new algorithms,'' Journal of the Optical Society of America A, vol. 17, pp. 401-414 (2000).