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Combined DInSAR-PSInSAR approach for increasing the quality of deformation map estimation in the area of underground mining exploitation

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Monitoring the deformation of the mining ground surface is crucial to ensuring the safety of residents, workers and the protection of all infrastructure in mining areas.The Polish realization of the European Plate Observing System project (EPOS-PL and its continuation EPOS-PL+) aims to build an infrastructure to monitor the deformation of the ground surface caused by extensive underground mining activities in the area of Upper Silesian Coal Basin in Southern Poland. Among many geodetic and geophysical approaches for monitoring, two different Interferometric Synthetic Aperture Radar (InSAR) techniques have been applied, also taking the advantage of the big set of freely available and with shorter revisiting time (6 days) Sentinel-1 satellite data. In the current study the Differential InSAR (DInSAR) and the Persistent Scattered Interferometry (PSInSAR) approaches are compared, evaluated and integrated. Various processing strategies are tested aiming to increase the quality of the produced integrated deformation maps. The optimal processing strategy should accurately detect stable areas, estimate the small deformation, as well as the maximum deformation gradient occurring in the center of the subsidence bowl directly in the excavation area.

One of the main error contributors to the Sentinel-1 data is the water vapor in the atmosphere that might slower the radar signal and modulate the results. Thus, the atmospheric artefacts have to be minimized since they are one of the main effects that limits the accuracy of interferometric products. In the PSInSAR approach high-pass and low-pass filtering has been used, while in the DInSAR approach – estimation of the Atmospheric Phase Screen has been made based on polynomial surface estimation using stable coherent points. Comparison of the one-year cumulated deformation for the area of Rydułtowy mine in Poland with ground truth data such as static GNSS measurement on reference points shows that PSInSAR results are more accurate. However, due to the linear deformation model required in the PSInSAR processing the areas in the center of the subsidence bowls were not estimated. Therefore, the difference between PSInSAR and DInSAR results was used for the refinement of the DInSAR deformation map. This refinement was made based on various statistical approaches (e.g. polynomial interpolation, kriging, inverse distance weighted-IDW). The results of IDW and kriging shows the best performance and allowed to minimize errors associated with DInSAR approach and provide a more accurate deformation map in the area of mining as well as provided the opportunity to capture maximal deformation

gradient.