# Systematic influences of digital elevation models on the quality of radar interferometric ground movement measurements

Doctoral thesis of Dipl.-Ing. Diana Walter

## Abstract

In the field of surface deformation monitoring, the interest in radar interferometric measurement techniques increased considerable, particularly regarding the availability of new high resolution SAR satellites. The quality of interferograms has been improved significantly, mainly due to higher repetition rates, and less variations of orbit paths. Furthermore, the range of application was extended by monitoring of single objects for the higher ground resolution of new SAR data. Many examples in publications demonstrate the ability to achievement accuracies in the range of a few millimeters. In order to obtain acceptance in using radar interferometry as a measurement technique in terms of accuracy demands in geodesy and mine surveying, a precise and extensive description and quantification of measurement errors is necessary. Measuring errors are mainly caused by spatial and temporal factors. Systematic errors are caused by imaging geometry, especially by the distance between satellite orbit paths. Precondition for the measurement of ground movements is the use of repeat-pass SAR acquisitions. Interferograms are generated using phase values of the backscattered signals and utilizing an external elevation model for correcting topographic influences. Height errors of an elevation model directly and indirectly lead to inaccuracies in the measured deformations. In practice the impact is commonly underestimated. Especially in areas influenced by mining and in densely built-up urban areas, there is an increase in topography related measurement errors.

Within the scope of this thesis, systematic influences of elevation model errors in interferometric processing and on accuracy of measured surface movements are analysed and quantified. Besides functional description of relationships, analyses of vertical displacement errors in an area influenced by mining are presented using different elevation models, SAR sensors (TerraSAR-X, Envisat ASAR, ALOS PALSAR) and imaging geometries. Study results are shown for areas with continuous topographic changes, urbanized and vegetated areas. The assessment of the geocoding accuracy of elevation models, in relation to height errors are analysed separately.

Validation with terrestrial data shows that real measurement errors are commonly smaller than theoretical errors. Small height errors can cause large phase errors, especially when using X-band sensors in comparison to L-band sensors.

Recommendations for the reduction of topography-related measurement errors are given in this thesis, in accordance with sensor specific acquisition parameters and using suitable elevation models. Enhanced knowledge of height errors occurring in interferograms can be used as an interpretation aid for the estimation of potential errors.