



## **Use of PS/DS- interferometry to determine the onset of an uplift episode in Böblingen triggered by geothermal probes**

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Since the beginning of 2011, building damage in connection with an uplift of the subsoil has been reported from two places in the city of Böblingen. It is very likely that the uplift phenomenon is due to a swelling process in an anhydrite layer below the city caused by geothermal probe drilling in October 2006 / January 2007 and September / October 2008. From mid-2011, the uplift areas and uplift rates are well documented based on various geodetic surveys, as well as the success of renovation measures that started in October 2014.

For the years before, considerably less observation data is available. In particular, the initiation of the uplift signals in space and time was not fully clarified. The aim of the current case study was to quantify the relationship between the drilling phases and the onset/acceleration of the anomalous displacements. The work focusses on an investigation of the accuracy with which appropriate breaking points in time series with irregular sampling could be determined.

For this purpose, 62 scenes of the C-band radar satellite Envisat from the years 2003 to 2010, recorded from two adjacent, overlapping tracks were processed using a modified StaMPS algorithm. The approach includes a refined preprocessing of distributed scatterers (DS) using adaptive neighbourhoods for coherence matrix estimation and phase triangulation coherence maximisation for extracting the DS signals. The resulting map of LoS displacements shows increased rates in the two known damage areas in the city of Böblingen, which are interpreted as uplift. Three distinct phases of surface displacement with rates up to up to 17.5 mm / year could be identified. Projected into the vertical, the accumulated uplift between October 2006 and October 2010 reaches than 40 mm.

The specific questions of the study were addressed by fitting physically meaningful kinematic models to the observed time series of individual PS points. Key statistical parameters of the derived model parameters as a function of signal noise, acquisition interval, recovery rate, and different satellite constellations were quantified on the basis of simulated data, and a method was developed for deriving meaningful statistical parameters from single data series. For the real PS time series observed in Böblingen city, the precision of the beginning of the uplift event lies between 40 and 180 days. It improves to about 20 days for the weighted average of PS data series at a distance of up to 430 m from the wells. The most probable start date is 05/11/2006, 24 days after drilling commences. The short time delay would support the hypothesis of a chemical reaction in the subsurface, triggered by the influx of water along the bore holes. However, causality cannot be proven by observation based correlation analyses.