Scientific Requirements and Feasibility on an L-band Mission dedicated to Measure Surface Deformation

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Abtract:

DLR is currently studying a space borne mission based two L-band satellites to map Earth surface deformation and vegetation structure from space. In this study the scientific requirements are collected, traded off versus technical feasibility and a mission concept is investigated that provides a global monitoring capability of geo-tectonic threads.

Microwave measurement technologies such as space borne Synthetic Aperture Radar (SAR) and the Global Positioning System (GPS) missions have revolutionized the knowledge of the solid Earth in the past two decades. GPS allows the instantaneous determination of point positions with sub-metric accuracy and tectonic motion measurement with centimetre accuracy. In contrast to these point measurements SAR allows two dimensional mapping. E.g., the measurement of the Earth's topography with interferometric SAR has achieved high technical maturity during and after the US/German Shuttle Radar Topography Mission in 2000. Based on the good results achieved, the data set will be complemented by data with better coverage and even higher resolution with the German TanDEM-X mission in the next years.

Two dimensional mapping of centimetric or even millimetric Earth surface deformations with InSAR has been demonstrated and applied in many cases, but the technique has not yet reached an operational status such as GPS positioning or InSAR topographic mapping. The main reasons are that the signals to measure are small (millimetres to centimetres), the satellite observations short and infrequent and the errors comparatively large. Atmospheric water vapour may cause centimetres of range errors and the ionospheric delay even metres at L-band. In contrast to a GPS constellation, SAR allows only a one-dimensional measurement at a time. Hence, the achievable accuracy depends on a number of parameters such as measurement frequency, geographic position and associated atmospheric conditions and the parameters of the deformation to be expected, e.g. linear/non-linear, 1-dimensional/3-dimensional.

In our paper we present the requirements collected from the scientific needs. We derive the respective product requirements and defined preliminary measurement scenarios for each of them: tectonics/earthquakes, tectonics/volcanoes, landslides, and urban subsidence. The critical error sources are identified and comments on feasibility are given.