Potential of global SAR positioning for geodic applications – Lessons learned from TerraSAR-X and Sentinel-1

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With our implementation of geodetic techniques for data processing and data corrections, spaceborne Synthetic Aperture Radar (SAR) has attained the possibility of fixing global positions of dedicated radar points at the low centimeter accuracy level. Such points can be created by passive radar corner reflectors, and the positioning method relies on the inherent ranging capabilities of SAR sensors. Thus, we may refer to the method as SAR imaging geodesy or geodetic SAR.

Determining accurate long-term global positions of objects on the Earth's surface is typically associated with Global Navigation Satellite Systems (GNSS) and one of the core elements of modern space geodesy. In order to do so, high-grade geodetic equipment with constant power supply, as well as the possibility for data transfer are required, limiting dense application on a large scale and poses difficulties for very remote areas with little or no infrastructure. Whereas certain regions like Japan or the San Andreas Fault are densely covered by GNSS such coverage may not be achievable everywhere on the globe.

To improve the situation, we present a concept of jointly using SAR and GNSS for expanding geodetic positioning to applications requiring long-term coordinate monitoring. In future, the use of cost-effective passive reflectors in X-band SAR or low-cost battery-powered active transponders, which are currently in development for C-band SAR, could provide global coordinates anywhere where SAR imagery is acquired under multiple incidence angles. The main requirements are precise orbit determination, processing of the SAR imagery omitting geometric approximations, as well as the rigorous correction of perturbations caused by atmospheric path delay and signals of the dynamic Earth. If a reflector or transponder already has known reference coordinates, e.g. from co-location with GNSS, the perturbing signals can be mitigated for the surrounding radar points by applying differential SAR positioning techniques similar to differential GNSS, provided that all the points are included in the same radar image. In this contribution we discuss the geodetic SAR methods with respect to our experiences gained with the TerraSAR-X mission, and present first results of experiments carried out with Sentinel-1 data.