Long Term Geodetic Monitoring Using Active C-Band Radar Transponders And Sentinel-1 - First Results

Eineder M.[1], Gisinger, C. [1], Brcic, R. [1], Gruber, T. [2], Oikonomidou, X.[2], Heinze, M.[2]

[1]Remote Sensing Technology Institute, German Aerospace Center (DLR)
[2]Chair of Astronomical and Physical Geodesy, Technical University of Munich (TUM)

ABSTRACT

Reliable and accurate long term geodetic monitoring with SAR requires the installation of either passive corner reflectors or, alternatively smaller active devices. We report our first results using novel off-the-shelf transponders or electronic corner reflectors (ECRs) for geodetic measurements with Sentinel-1 C-band Synthetic Aperture Radar (SAR) data. For this purpose we set up a triangular arrangement consisting of one trihedral corner reflector and two active ECRs at the campus of German Aerospace Center (DLR) in Oberpfaffenhofen, Germany. We describe the practical aspects of such ECRs as well as first radiometric characteristics. Moreover, we present geometric accuracy numbers derived from imaging geodesy [1], [2], i.e. absolute radargrammetric positioning, as well as from interferometric phase measurements.

In the frame of the ESA project SAR-HSU (ESA AO/1-9172/17/I-BG-Baltic+) with the goal of monitoring tide gauges with SAR to connect the height systems of neighbor states (Sweden, Finland, Poland, Estonia,) – some of them are severely influenced by postglacial uplift - a test installation with 11 ECRs surrounding the Baltic Sea is being set up. Due to the long baselines involved and the large waterbody in between, SAR interferometry cannot be used for differential height change measurements. Instead absolute SAR measurements for each single point shall be evaluated. The technique has been demonstrated to achieve cm-level accuracy with high resolution TerraSAR-X data and a ranging accuracy of about 6 cms with Sentinel-1 data. While we have demonstrated this accuracy with CRs, no experience exists so far with active ECRs.

To assess the accuracy and stability of the ECRs we set up a small validation setup at DLR Oberpfaffenhofen. Our set-up consists of one mechanical 1.5 m CR and two ECRs placed in a triangle with baselines of approximately 100 to 350 meters.

The geolocation of SAR sensors can be evaluated by comparing the reference coordinates of point targets with the measured image data in the 2D SAR image space (range and azimuth). The comparison is performed on an image by image basis, using the precise orbit solution of the SAR satellite as well as corrections for atmospheric path delays, solid Earth tidal deformations, and Sentinel-1 specific system corrections. The details of our methods are summarized in [3] and [4].

At our DLR test site two Sentinel-1 ascending geometries and one descending geometry are usable, each with a temporal sampling of 6 days.

First analysis of the passive CR coordinates shows measurement standard deviations of 1 – 5 cm in range, depending on the swath and about 50 cm in azimuth. Especially the range values are excellent values as expected from earlier experiments. The azimuth values are somewhat worse and need to be investigated further.

However, the ECRs show a ranging standard deviation of 12 cm, which worse than expected from their radar cross section which is stronger than that of the passive CRs.

This effect needs to be investigated closer and compared with interferometric differential phase measurements as soon as more passes are available.

In our talk we provide detailed results concerning the accuracy in absolute ranging, in relative interferometric measurements and also practical experiences with the installation and operation of the ECRs.

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