Absolute Positioning of Active Radar Transponders from Sentinel-1 Observations — Experiences and Results

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Abstract

Geodetic monitoring using SAR, requires long term stable and accurate measurements. As an alternative to large passive corner reflectors, smaller active radar transponders have become commercially available off-the shelf. We report results using these Electronic Corner Reflectors (ECRs) for geodetic measurements with Sentinel-1 C-band Synthetic Aperture Radar (SAR) data, after collecting observations for one year from 12 different stations.

In the frame of the ESA project SAR-HSU, 10 ECRs surrounding the Baltic Sea in Sweden, Finland, Poland and Estonia, as well as two ECRs located at the campus of German Aerospace Center (DLR) in Oberpfaffenhofen, Germany have been installed. 3D absolute positioning for each of the 12 ECRs has been conducted following the procedure described in Gisinger et al. 2015 and Gruber et al. 2020. To achieve refined absolute positioning with SAR, precise orbit solutions of Sentinel-1 are used and corrections for atmospheric path delays, solid Earth tidal deformation, and Sentinel-1 specific system corrections are applied. Additionally, the processing accounts for ECR specific corrections biases per incidence angle, the phase center difference between ascending and descending geometries as well as electronic delays within the transponders. The results are analyzed in terms of ECRs' characteristics and performances. Moreover, the accuracies of the geodetic positions are evaluated by comparing them with reference coordinates in terms of their internal and absolute accuracies using confidence ellipsoids as described by Gisinger et al. 2017.

In the paper detailed results for the geolocation and accuracies of ECR positioning using Sentinel-1 observations are provided as well as experiences with the off-the shelf transponders are summarized.