Improvements to the position coordinates for the Australian corner reflector array and new infrastructure to support SAR calibration and multi-technique validation at the Yarragadee fundamental geodetic station

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Geoscience Australia (GA) continues to work with the Sentinel-1 Mission Performance Centre team, as part of an effort to support the European Space Agency (ESA) with the routine calibration of the Sentinel-1 constellation using corner reflectors (CR) in the Surat Basin array in Queensland. This paper provides an update on radiometric and geometric calibrations being supported by the CR array. A collaborative project involving GA, ESA, DLR, and University of Zurich under the Fiducial Reference Measurement for SAR (FRM4SAR) initiative, demonstrated the potential for improvement in the absolute location accuracy of SAR products by using modelled coordinates of the CR apexes rather than the existing coordinates associated with an auxiliary benchmark on the CR infrastructure. Analysis of Sentinel-1A IW (TOPS) products covering 56 passes from Oct 2014 to Aug 2017 TerraSAR-X ScanSAR products covering 7 passes from April 2017 to September 2017, using modelled CR apex coordinates showed improvement in range residuals between observed and predicted values for absolute location.

Following the analysis, re-surveying of the 40 Surat Basin corner reflectors was undertaken with funding support from Digital Earth Australia in June 2018, to obtain the actual coordinates of the corner reflector apexes in order to achieve the higher location accuracy without the use of the apex coordinate model. At each site, a suite of terrestrial observations were made in a local network. These measurements have been connected to the ITRF through GNSS observations of existing reference marks at each site. The result is an accurate (centimetre-level) determination of the CR apex coordinate at each site in terms of ITRF. The new ITRF coordinates will be posted to the CEOS SAR Point target database where this information is maintained for use by SAR satellite operators for calibration of their sensors. The outcome of this project is improved intrinsic location accuracy of Sentinel-1 data specifically, but will also contribute to better consistency in the quality of data generated from different SAR sensors.

The Yarragadee Geodetic Observatory in Western Australia is a fundamental geodetic station operated by GA that co-locates four geodetic techniques (GNSS, VLBI, SLR, DORIS). In August 2018 the station was equipped with two 1.5m trihedral CRs, making it one of only four stations globally to co-locate SAR calibration infrastructure with the other geodetic techniques (along with Wettzell, Germany, GARS, O'Higgins, Antarctica, and Metsähovi, Finland). The CRs are permanently mounted on deep concrete foundations, with one oriented each for ascending and descending SAR orbital passes. The CR boresights are aligned for 40° incidence angle to allow measurements from radar beams between 25° and 55° incidence angle. Results from the preliminary assessment of the 1.5m CR at Yarragadee will also be covered in this paper. Preliminary analysis of Sentinel-1 and TerraSAR-X data showed that the newly installed CRs are clearly detectable, with a Signal-to-Clutter Ratio (SCR) of >44 dB in TerraSAR-X spotlight images and ~20 dB in a Sentinel-1B IW image. These values agree with the SCR determined for 1.5m CRs at Wettzell and Metsähovi. Geodetic coordinates for the two CRs will be derived from terrestrial survey data collected at the time of installation and made available in due course.