A Decade of TerraSAR-X and TanDEM-X Operation: A Retrospective on the Performance of the SAR System and an Outlook to the Future

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Abstract

TerraSAR-X and its almost identical twin satellite TanDEM-X have provided high resolution radar images for years and Digital Elevation Models with unprecedented accuracy. The SAR image quality and accuracy has remained constant since launch and is owed to a very stable instrument. A thorough system health monitoring is utilized in order to maintain this stability.

On the one hand a short-term verification of the individual acquisitions constantly exploits satellite telemetry from the SAR instrument and the on-board calibration system. Hence performance changes, e.g. in terms of hardware degradation, can quickly be identified and corrected. For example by monitoring the antenna's T/R modules via pseudo noise gating, dysfunctional modules could be detected in order to re-adjust the system accordingly. On the other hand a long-term system monitoring approach furthermore was designed to detect long-term system parameter trends and degradations that may affect data quality or imaging capabilities. In particular on-ground measurements are evaluated by continuously imaging globally distributed reference targets such as corner reflectors or test sights with a well-known topography. It was initiated with the launch of TerraSAR-X thus provides a variety of long-term parameter time series. Stimulated by this approach a study has been conducted to analyze the impact of solar events like radiation or the annual eclipse due to the satellites' orbit geometry. Although the effects are taken into account by calibration the results provide valuable information to interpret monitoring results and gain a deeper understanding of the system.

In addition to a retrospective of the SAR system, the goal of this paper is also to give a summary of the TerraSAR-X and TanDEM-X mission with focus on the calibration and the systems' functionality. The mission status will concentrate mainly on the performance of the global Digital Elevation Model which was completed in September 2016. Having used precise calibration methods and improved processing algorithms, the dataset shows an outstanding quality. In the end nearly 20,000 tiles with a size of 1° x 1° were generated yielding an overall absolute height accuracy of 3.5 meters and covering more than 99% of the global landmass. As the satellites are still in good condition and consumables are sufficient, the mission was extended to generate a change layer as an update of the global

DEM. By adjusting acquisition strategies and processing methods, fewer acquisitions are sufficient to achieve the same accuracy as for the global DEM.

Furthermore, a brief outline of a proposed future L-band satellite formation is drawn. The ambitious mission shall provide data to help solving pressing climate-related questions. As an example the proposed system will be able to penetrate forest canopy in order to estimate biomass on a global scale. Equipped with a reflector antenna and exploiting the innovative digital beamforming technique, Tandem-L will be capable of illuminating a 350 km wide swath on ground acquiring up to 8 terabyte of data per day. This enables a weekly global coverage, which is a precondition for observing dynamic processes in the bio-, geo-, hydro- and cryosphere.

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