

The Missions TerraSAR-X and TanDEM-X: Status, Challenges, Future Perspectives

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Abstract

TerraSAR-X is a new German radar satellite that was launched in June 15, 2007. It carries a high frequency X-band SAR sensor that can be operated in three different modes and various polarizations. The Spotlight-, Stripmap- and ScanSAR-modes provide high resolution images for detailed analysis as well as wide swath data whenever a larger coverage is required. These high geometric and radiometric resolutions together with the single, dual and quad-polarization capability are innovative and unique features with respect to space borne systems. Additionally several incidence angle combinations will be possible and double side access can be realized by satellite roll maneuvers. The satellite will be positioned in a sun-synchronous 11 days repeat orbit.

TanDEM-X (TerraSAR-X add-on for Digital Elevation Measurement) opens a new era in spaceborne radar remote sensing. A single-pass SAR interferometer with adjustable baselines in across- and in along-track directions is formed by adding a second (TDX), almost identical spacecraft to TerraSAR-X (TSX) and flying the two satellites in a closely controlled formation. With typical across-track baselines of 200 m – 400 m a global Digital Elevation Model (DEM) with 2m relative height accuracy at a 12 m posting will be generated.

The TDX satellite is a rebuild of TSX with only minor modifications. This offers the possibility for a flexible share of operational functions for both the TerraSAR-X and TanDEM-X missions among the two satellites. The TDX satellite is designed for a nominal lifetime of 5 years. Predictions for TSX based the current status of system resources indicate at least one extra year (until the end of 2013) of lifetime, providing the required three years of joint operation.

The missions TerraSAR-X and TanDEM-X jointly share the same space segment consisting of the TSX and TDX satellites orbiting in close formation and are operated using a common ground segment, that was originally developed for TerraSAR-X and that has been extended for the TanDEM-X mission. A key issue in operating both missions jointly is the different acquisition scenarios: whereas TerraSAR-X requests are typically single scenes for individual scientific and commercial customers, the global DEM requires a global mapping strategy. The two satellites will downlink their data to a global network of ground stations: Kiruna in Sweden, Inuvik in Canada, O'Higgins in the Antarctic, and Chetumal in Mexico. The entire processing chain is a new TanDEM-X specific development. However, it consists of individual modules which strongly benefit from the TerraSAR-X and the Shuttle Radar Topography Mission (SRTM) heritage. Major design drivers result from the acquisition strategy which requires the combination of several (global) coverages and application of multi-baseline processing techniques based on supporting intermediate products.

The TDX satellite was launched on 21st of June 2010. The first three months of the commissioning phase were dedicated to calibration and performance verification and revealed calibration accuracies and overall performance of the TDX SAR system and its products as good as for TSX. Comprehensive testing of the various safety measures has been performed in parallel to check-out activities on the new ground segment elements. In a Formation Flight Review early October “green light” was given for entering the close formation, which was achieved on October 14th. Bistatic DEMs are being acquired since then. The bistatic commissioning phase of the TanDEM-X mission concentrated on checking out the complete bistatic chains from acquisition planning to bistatic and interferometric processing and generation of so-called raw DEMs. Key features of the mission like the synchronization system and the determination and calibration of the baselines had to be verified for operational bistatic imaging and fully automated elevation model generation. Global DEM acquisitions have started after successful completion of an extensive test and verification program in December 2010.