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Editorial

Ten Years of TerraSAR-X—Scientific Results

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Abstract: This special issue is a collection of papers addressing the scientific utilization of data acquired in the course of the TerraSAR-X mission. The articles deal with the mission itself, the accuracy of the products, with differential interferometry, and with applications in the domains cryosphere, oceans, wetlands, and urban areas. This editorial summarizes the content.

Keywords: synthetic aperture radar; TerraSAR-X; SAR interferometry; land subsidence; precise orbit determination; geometric and radiometric calibration; PSI

1. Introduction

We commemorated the 10th anniversary of the TerraSAR-X mission on June 2017. TerraSAR-X is a German SAR satellite operating in X-Band. Its twin satellite TanDEM-X was launched three years later in June 2010. Both satellites serve the TerraSAR-X and the TanDEM-X missions and have provided images of superb quality since then. For the TerraSAR-X mission just one of the satellites is employed while the TanDEM-X mission always supplies a simultaneously acquired image pair, serving the goal of a global digital elevation model. The satellites were developed in the scope of a public–private partnership between the German Aerospace Center (DLR) and Airbus Defense and Space.

This special issue addresses the scientific utilization of data acquired in the course of the TerraSAR-X mission.

2. Peculiarities of the TerraSAR-X Mission

TerraSAR-X is characterized by numerous operational and experimental modes of its SAR instrument, unfolding a wide parameter space, e.g., multiple polarizations, along-track interferometry and a variety of SAR imaging modes with resolutions down to 0.5 m in range and 0.25 m in azimuth. Despite being well beyond their design lifetime of 5.5 years, both satellites are still fully functional, deliver high-quality images without any performance deterioration, and have enough consumables for operation into the 2020s.

From the very beginning, the high resolution data of the TerraSAR-X mission complemented the European medium resolution missions in C-Band and the Japanese L-Band missions. Not quite unexpectedly, it was especially the high resolution that revealed many new insights into SAR scattering, which led to a large number of scientific publications. The expectation that the interferometric coherence over distributed scatterers and longer time spans would be low in X-band was confirmed. But it was more than compensated by a real surprise: the high resolution and the small wavelength revealed a very high number of point-like reflectors in urban and even in natural environments, which

gave rise to some ground breaking new methods such as urban SAR tomography and new applications in 3D point localization and deformation mapping of buildings and of infrastructure.

3. Contents of this Special Issue

The 20 papers of this special issue cover six major disciplines. Five papers [1–5] deal with interferometric applications for land surface deformation mapping. A key success factor here is the high resolution, which enables the mapping of smaller landslides, of single buildings and of infrastructure.

Another five papers [6–10] demonstrate the success of TerraSAR-X in the field of oceans and wetlands exploiting the high resolution and the multi-polarization capabilities of TerraSAR-X. As it turned out, not only the space segment but also the ground segment performance such as reliability and fast near real-time services contributed to the success of TerraSAR-X in maritime applications. Three papers [11–13] cover such operational aspects and the scientific and operational use of TerraSAR-X data.

Four papers [14–17] deal with the radiometric and geometric performance validation and with the new methods which made TerraSAR-X the first SAR sensor with geodetic accuracy. Two papers about mapping urban environments [18,19] and one about the cryosphere [20] finalize the different topics covered in this special issue.

From the 25 submissions for this special issue, 20 could be accepted and 5 had to be rejected or were withdrawn.

Of course, this collection is only a snapshot in time and many more papers have been published in the years before, demonstrating the success of this mission. A quick search for TerraSAR-X on Google scholar delivers more than 20,000 results!

4. Summary and Outlook

At the time of writing more than 235,000 individual data takes were acquired. Of those, 100,000 were initiated for scientific purposes and 1636 scientific proposals have been submitted to DLR to work with these data. Numerous scientists benefitted from TerraSAR-X which is a benchmark in geometric and radiometric accuracy—getting even better after ten years of operation.

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