The TanDEM-X DEM – Status of the New Dataset for Studying Topography of the Global Impact Crater Record

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TanDEM-X Mission

Between December 2010 and March 2015 the German Aerospace Center (DLR) operated the X-band radar satellites TerraSAR-X (TSX) and TanDEM-X (TDX) in close formation as a single-pass SAR interferometer. One of the mission's purposes during this phase was data acquisition in bistatic mode over the entire Earth's land surface. These data are processed to finally yield a global digital elevation model (DEM) with unprecedented accuracy [1]. Its performance (Table 1) will considerably exceed the currently existing terrestrial DEMs, e.g. from SRTM in 2000. Both its global coverage and high accuracy make it a unique data source for the studies of terrestrial impact structures.

Parameter	Requirement
Coverage	global
Pixel spacing (independent pixel)	12 m
Absolute vertical accuracy (90% linear error)	10 m
Relative vertical accuracy (90% linear point-to-point error)	2 m (slope < 20%) 4 m (slope > 20%)

Table 1: TanDEM-X DEM requirements.

TanDEM-X Mission Status

Interferometric data acquisition for DEM generation started with two global coverages in the timeframe December 2010 – March 2013. This was followed by two mappings of Antarctica, interleaved with gap filling activities and a period from August 2013 – April 2014 where the satellite configuration was re-adjusted to allow imaging of difficult terrain with opposite viewing geometry. Early 2015, all acquisitions had finally been accomplished [2].

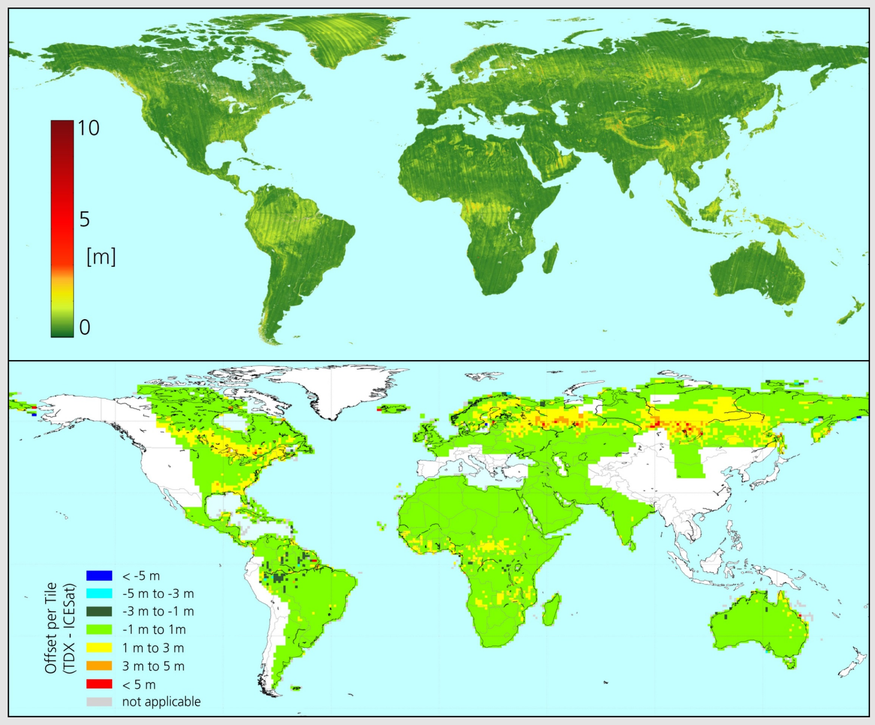
The acquired data were divided into individual scenes, so-called Raw DEMs, of ~30×50 km² extent. About 500000 Raw DEMs have been generated from slightly more than 4 years of TanDEM-X in-orbit operations as a single-pass interferometer.

Fig. 1 (right – top): TanDEM-X DEM relative height accuracy prediction, as derived from 300 m × 300 m coherence quicklooks. Antarctica is omitted. (image courtesy: B. Bräutigam, DLR-HR)

Fig. 2: (right – bottom): Final TanDEM-X DEM status of absolute height offsets from a comparison between TanDEM-X and ICESat data points. The largest offsets occur where volume decorrelation is expected (forest canopy areas). Antarctica is omitted. (image courtesy: B. Bräutigam, DLR-HR)

TanDEM-X DEM Status

The DEM is delivered in tiles, each having a size of about 110×110 km². More than 19000 tiles are required for achieving global coverage. As of May 2015 65% of Earth's land masses are available as final DEM. The >10000 DEM tiles are compliant with the requirements. The absolute vertical accuracy even exceeds the specifications by a factor 10. It is expected that the complete TanDEM-X DEM will be available by mid 2016. DEM access for scientific purposes will be granted via an AO proposal scheme.



Impact Structures in TanDEM-X Raw DEMs

The Raw DEMs have an accuracy already very close to the specification of the final DEM (Table 1). Early impact crater results confirmed the excellent quality of this dataset [3]. Meanwhile we continued a systematic investigation of all confirmed impact structures from the Earth Impact Database (EID) at the Planetary and Space Science Centre of the University of New Brunswick/Canada.

As of July 2015, of the 188 database entries, about 80-90 are expected to show a surface imprint. Most of them could be mapped using 1-2 TanDEM-X Raw DEMs. A few required mosaicking of up to 9 individual scenes and only 6 have to await the availability of the DEM tiles because of their large diameters. The smallest unambiguously detected structures are simple craters with a diameter of about 400 m. Their rims clearly sticks out of the surrounding terrain as expected for simple craters. Besides DEM related products, also the X-band amplitude signal is available. Combination with the DEM yields a different view. Fig. 3 shows a variety of DEM products for the Ouarkziz structure.

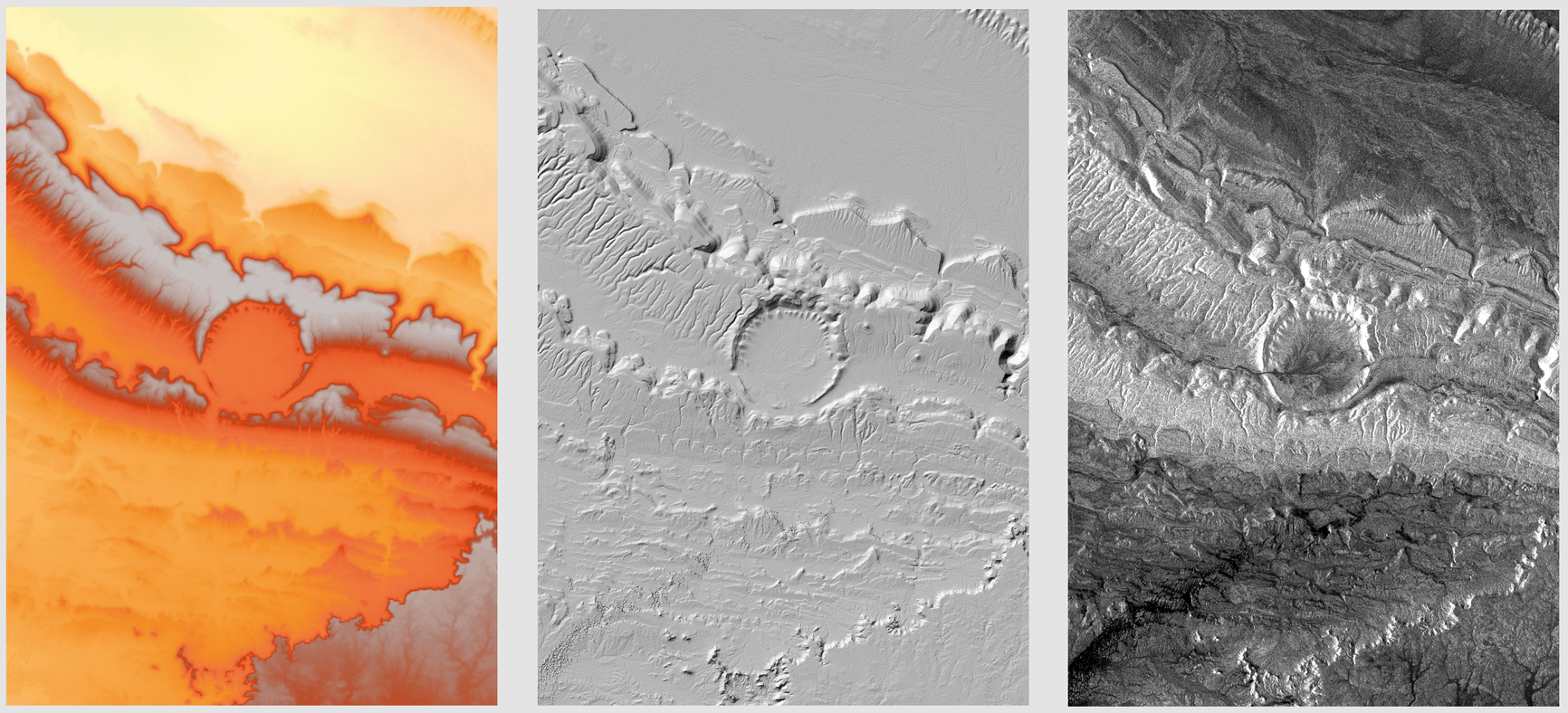


Fig. 3: The Oaurkziz structure in Algeria. From left to right: color coded digital elevation model data (elevation = 415-730 m), hillshaded relief (Sun elevation 45°, Sun azimuth 315°), X-band amplitude, Right top: hillshaded DEM, Right bottom: hillshaded DEM with underlying X-band amplitude. North is always up.

[1]: Krieger et al., TanDEM-X: A radar interferometer with two formation-flying satellites, Acta Astronautica 89, 83-98, 2013.
[2]: Zink et al., TanDEM-X Mission Status, ISPRS Archives, XL-7/W3, 1345-1352, 2015.
[3]: Gottwald et al., Mapping terrestrial impact craters with the TanDEM-X DEM, in Osinski and Kring, eds., Large Meteorite Impacts and Planetary Evolution V, GSA SP518, 2015, in press.

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DLR Deutsches Zentrum für Luft- und Raumfahrt