Anniversary in space – five years of TerraSAR-X

15 June 2012

Five years ago today, at 04:14 CEST on 15 June 2007, the German TerraSAR-X radar satellite was launched from Russia's Baikonur Cosmodrome in Kazakhstan. This marked the beginning of a new era in satellite remote sensing for Germany. Designed to operate for five years, the satellite has now completed its nominal service life but it remains in excellent condition; it is expected to continue functioning for several more years.

"TerraSAR-X has now been operating almost flawlessly for five years. The satellite's propellant consumption has been low, the solar arrays and radar instrument are in good condition, and all of the redundant systems are still available. We could not have hoped for more," says Michael Bartusch, TerraSAR-X mission Project Manager at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) Space Administration.

Dependable and high-precision

TerraSAR-X was constructed by Astrium on behalf of DLR and is the first Earth observation satellite to be developed entirely in Germany. Thanks to the on-board radar instrument, Earth's surface can be surveyed regardless of weather conditions, cloud cover or availability of daylight. The satellite has been providing unique datasets with resolutions down to one metre since the beginning of the mission. By so doing, TerraSAR-X has completely fulfilled its mission objective – the provision of high-quality X band Synthetic Aperture Radar (SAR) data for research and development purposes as well as for scientific and commercial applications. From the beginning of 2008, commercial distribution of the data has been performed by the German division of Astrium Geo-Information Services, Infoterra GmbH.

The high accuracy and dependability of TerraSAR-X data has enabled scientists from a wide variety of research fields to develop entirely new applications and processes. In particularly high demand are time-sequenced images, which enable changes in a specific region to be precisely determined.

Glaciers and wood frogs

This applies to the observation of glaciers in Greenland, for example. Their flow rates allow them to be used as indicators for global warming. In a research project being carried out by the Institute of Applied Physics at the University of Washington, the 20 most significant outlet glaciers are surveyed five times a year. Special attention is paid to Jakobshavn Isbræ, one of the fastest-moving glaciers in the world. TerraSAR-X is currently the only remote sensing satellite capable of supplying images for the project at the required resolution and time intervals.

The German radar satellite is even putting wood frogs in Northern Canada under the microscope for climate researchers. The eight-centimetre-long amphibians are also climate indicators; changes in climate and habitat immediately affect the sensitive population. The frogs breed in small ponds that form during the thaw period following the harsh winter and then dry out. Using high-resolution images from TerraSAR-X, scientists from the Terrestrial Wetland Global Change Research Network can now see when the frog ponds form and how they evolve over time. Previously, the usual method used was to set up microphones and use the sounds emitted by the frogs to work out what was happening. With remote sensing technology, biologists can now use entirely new methods.

Berlin Central Station

TerraSAR-X has also found a completely new application in the observation of important infrastructure components. This applies to bridges and, especially, safety-critical facilities such as dams. Using the latest processes, the radar satellite's images can be used to detect deformations down to the millimetre range with high accuracy. In collaboration with Technische Universität München, DLR Oberpfaffenhofen has demonstrated this for Berlin Central Station; over the course of a year, the steel complex deforms by up to 1.8 centimetres vertically and between 1.5 and 3.5 centimetres horizontally. The TerraSAR-X images reveal the seasonal differences with millimetric accuracy; the steel structure expands during the warmest months of the year, being largest between June and September. During the cooler parts of the year, the material contracts and the station 'moves' back to its previous state.

Natural catastrophes and major events

TerraSAR-X makes important contributions during natural catastrophes, major incidents and humanitarian relief efforts. To provide the best possible help on site, emergency services need comprehensive, detailed, up-to-date geographical information – regardless of the time of day or weather conditions. This is not a problem for TerraSAR-X, and this is why DLR is a member of the International Charter 'Space and Major Disasters'; the radar satellite has supplied emergency cartography data for natural disasters such as the severe earthquake in Haiti in 2010, the floods in Pakistan in 2011 and the earthquake and tsunami in Japan. Most recently, TerraSAR-X was used during the Champions League football final in Munich, for a test by the German Federal Office of Civil Protection and Disaster Assistance (Bundesamt für Bevölkerungsschutz und Katastrophenhilfe; BBK) of situational awareness during major events.

… and TanDEM-X

Over the past five years, the German TerraSAR-X satellite mission has successfully supported or enabled a wide range of relief efforts and projects. Since June 2010, the satellite has been in good company; TerraSAR-X has been orbiting the Earth in close formation with its almost identical twin, TanDEM-X. Together, they are creating a highly accurate digital elevation model of Earth. With its own unchanged mission targets still in focus, TerraSAR-X has been meeting all expectations here as well.

About the TerraSAR-X mission

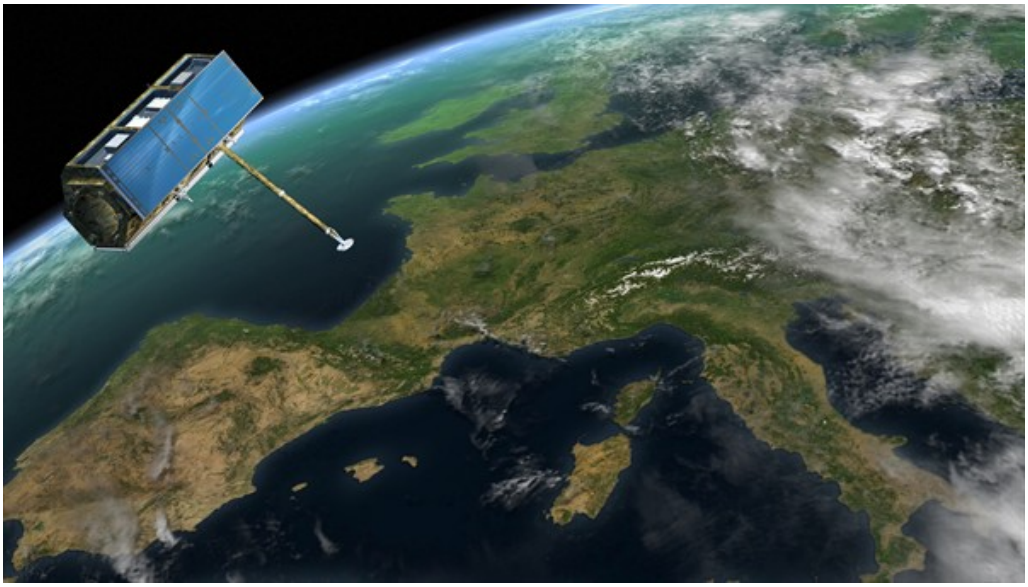
TerraSAR-X is being implemented on behalf of DLR with funds from the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi). It is the first German satellite manufactured under what is known as a Public-Private Partnership DLR and Astrium. DLR is responsible for using TerraSAR-X data for scientific purposes; it is also responsible for planning and implementing the mission as well as controlling the satellite. Astrium built the satellite, shared the costs of developing it and is sharing the costs of operating it. Infoterra GmbH, a subsidiary company founded for this purpose by Astrium, is responsible for marketing the data commercially.

Contacts

Bernadette Jung
German Aerospace Center (DLR)
Public Affairs and Communications: Oberpaffenhofen, Weilheim, Augsburg
Tel.: +49 8153 28-2251
Fax: +49 8153 28-1243
Bernadette.Jung@dlr.de

Michael Bartusch
German Aerospace Center (DLR)
Space Administraton
Tel.: +49 228 447-589
Fax: +49 228 447-747
Michael.Bartusch@dlr.de

The German radar satellite TerraSAR-X



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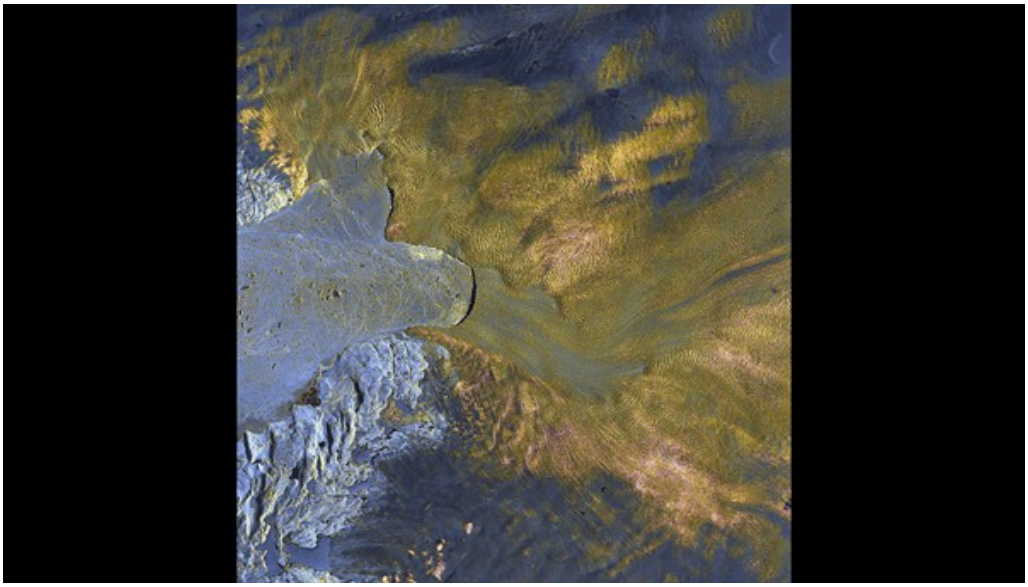
Credit: DLR (CC-BY 3.0).

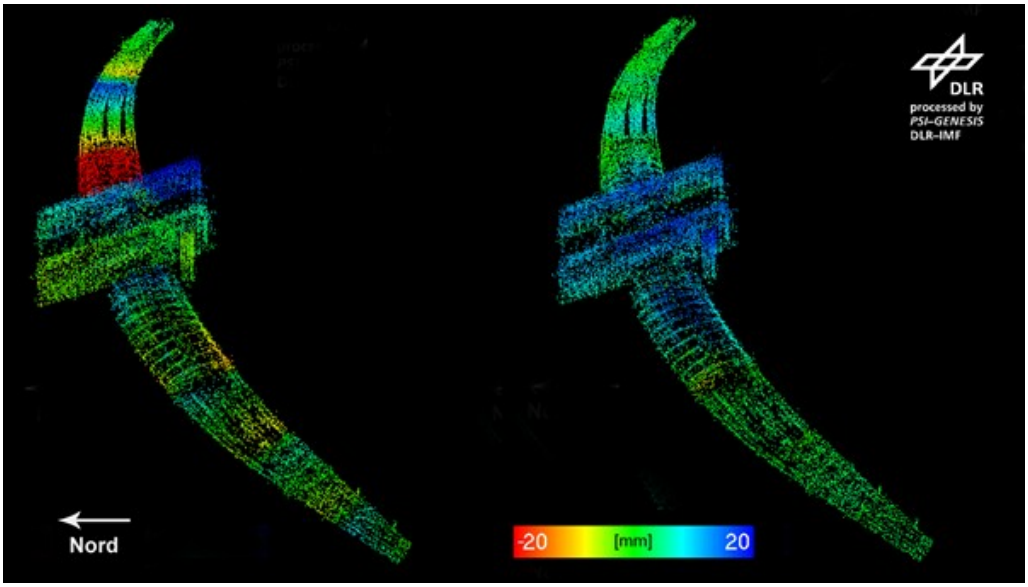
Jakobshavn Isbræ at risk



Jakobshavn Isbræ, in Greenland, is one of the fastest-moving glaciers in the world; the mass of ice is advancing up to 35 metres per day towards the sea, and is threatened by climate change. The progress of glacial melting can be documented by comparing satellite images acquired in different years. The processed radar data shows the glacier structure in false colour. Smooth ice surfaces are coloured blue; magenta shows prominent structures like crevasses, while yellow indicates roughened surfaces and thus clearly marks the flow movement. It can be seen that the ice sheet advances to a narrow zone (left-hand side of image) and eventually breaks abruptly into the ‘smooth’ open sea.

Credit: DLR.

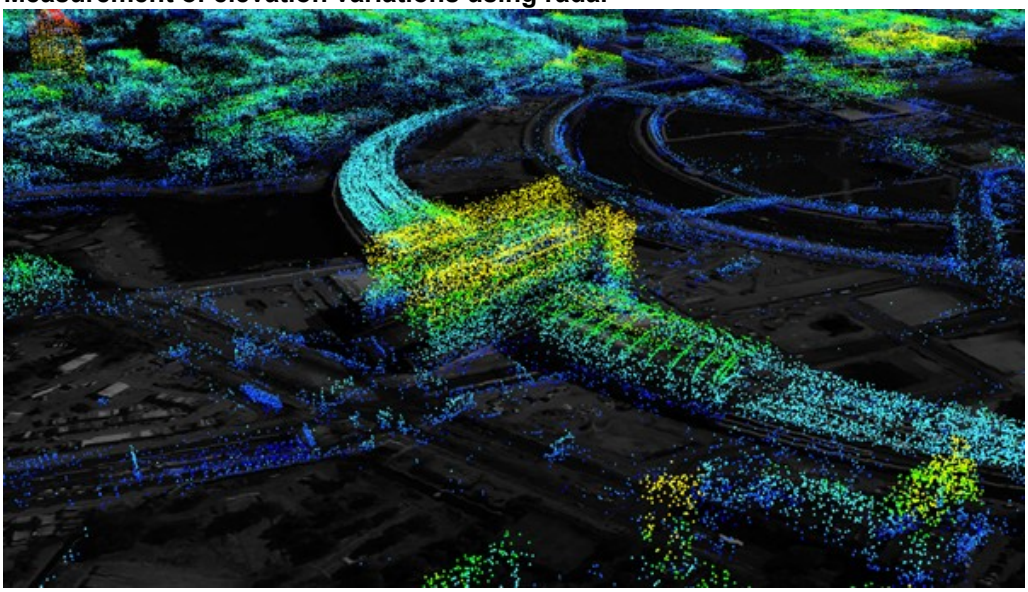
Berlin Central Station on the move



Using TerraSAR X data, Berlin Central Station was measured horizontally and vertically over the course of a year. In the warm season, the steel structure of the building expands; in winter, it contracts again. Based on the coloured dots, the maximum deformation in the course of one year can be seen to be in the millimetre range. The horizontal movement is visible in the left-hand image, and the vertical movement of the station structure is shown in the right-hand image.

Credit: Stefan Gernhardt, TU München.

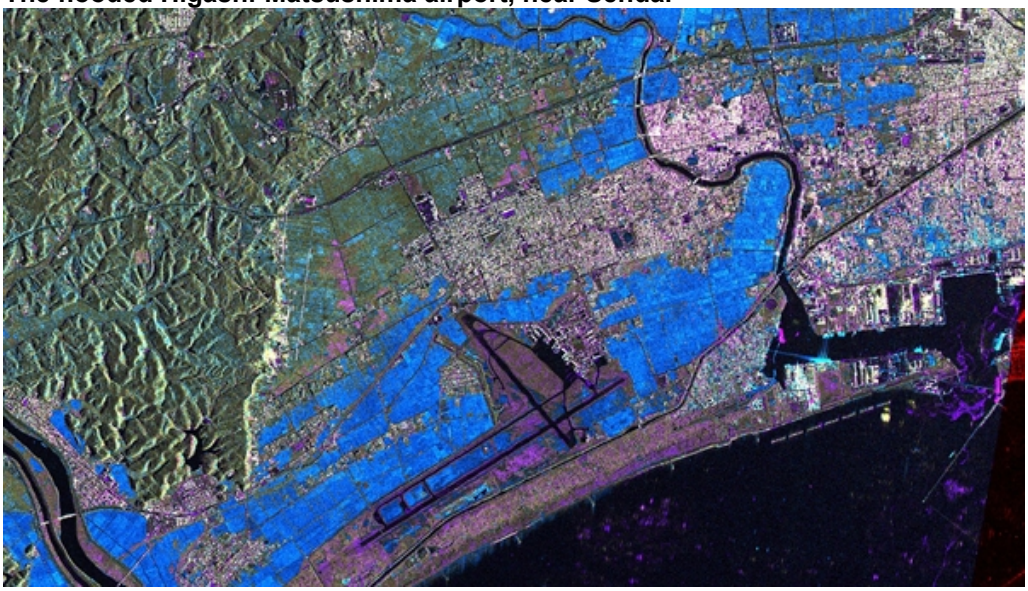
Measurement of elevation variations using radar



Radar view from above; this data analysis reveals variations in the height of the station and its surroundings. The yellow and red markings in the dot cloud show elevation changes in the millimetre range.

Credit: DLR.

The flooded Higashi-Matsushima airport, near Sendai



This radar image, acquired by the German Earth observation satellite TerraSAR-X on 12 March 2011 at 21:43 CET, shows the impact of the tsunami on Higashi-Matsushima Airport and the port of Ishinomaki, near Sendai, on the east coast of Japan. The blue areas indicate the flooding; the magenta-coloured areas show the extent of the destroyed infrastructure.

Credit: DLR.

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