Sentinel-1 – Earth's topography as a coloured pattern

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The radar system on board the European Space Agency (ESA) Sentinel-1A satellite has been imaging Earth's surface in 250-kilometre swathes since April 2014. Now, scientists at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR), working under a contract from ESA, have created the first interferogram from this data – showing the topography of Earth as a coloured pattern. The image shows the result of processing two data sets acquired over Corsica and Genoa on 7 and 19 August. "On the same day that the second acquisition was performed, we were able to produce this world-first interferogram and, in doing, so demonstrate the feasibility of this technology," says Richard Bamler, Director of the DLR Remote Sensing Technology Institute. The aim of this development is the continuous monitoring of the movements of Earth's surface in the millimetre range.

Terrain Observation by Progressive Scans (TOPS) is the new acquisition mode that Sentinel-1 employs to continuously scan Earth in 250-kilometre swathes with a resolution of five metres perpendicular to and 20 metres along the flight direction. In future, this technology will allow several Sentinel-1 satellites to regularly image Earth's entire landmass with an unprecedentedly short revisit interval. A great advantage of this type of sensor is that it can systematically image Earth unhindered by cloud cover – both during day and night. The phase and polarisation information present in the images will be used for a wide range of applications such as producing up-to-date topographic maps, observing vegetation or measuring the movement of geologically active regions from space with millimetre precision.

Large areas in short times

Numerous methods for the generation of interferograms have already been developed for the DLR-operated German radar satellite TerraSAR-X. "While TerraSAR-X delivers high-resolution images with the world’s best geometric accuracy, Sentinel-1 delivers mid-resolution images – but with an enormous coverage," explains Bamler. Entire countries and continents can be mapped with the 250-kilometre-wide image swathes within days. "In a few years, time series will exist for every point on Earth, containing valuable information for research into glaciers, ice sheets, oceans, volcanoes, earthquake zones and geological changes." Radar interferometry is often required for this research.

The demands placed by TOPS on interferometric processing are so high that, until now, only a few teams in the world have mastered it. At DLR’s Remote Sensing Technology Institute, an operational processor was developed for exactly this purpose under contract from ESA. It was only once Sentinel-1A finally reached its final orbit, in which it returns to the same position after exactly 175 orbits or 12 days, that DLR scientists were able to generate an interferogram from two acquisitions taken over the same area, but at different times. These results are an important contribution to the technical verification of the Sentinel 1 mission and have confirmed the satisfactory characteristics of the data to ESA and its users.

In future research projects, the Sentinel-1 and TerraSAR-X missions could complement each other. A deformation map showing subsidence and uplift over Germany is one possibility. "On detecting threatened areas with Sentinel-1, a more accurate analysis with high-resolution TerraSAR-X data would follow." The high-precision elevation models of the TanDEM-X radar mission could also be used to geometrically correct Sentinel-1 interferograms.

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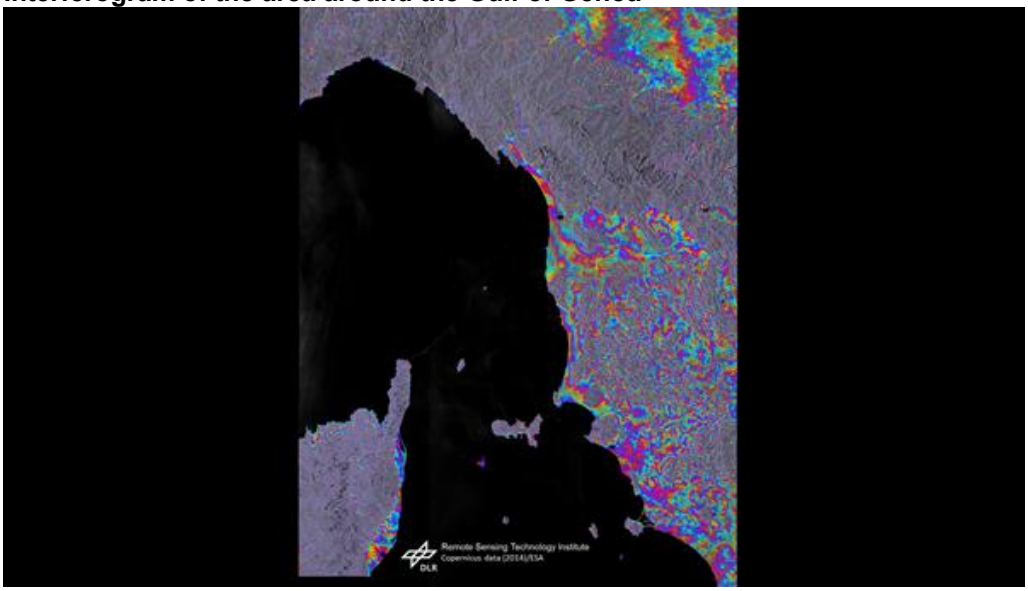
Interferogram of the area around the Gulf of Genoa



This interferogram, created by the German Aerospace Center (DLR), shows the area around the Gulf of Genoa. The area covered corresponds to eight acquisitions by the conventional ESA ERS/SAR and Envisat/ASAR sensors. The island of Corsica can be seen clearly at the bottom left, and the island of Elba is in the centre of the image. In the northeast corner, part of the Po Valley appears particularly striking. In this relatively flat area, the coloured phase image shows typical large-scale patterns in contrast to the mountainous regions.

Credit: Copernicus data (2014)/ESA/DLR Remote Sensing Technology Institute.

Sentinel-1

The European Earth observation satellite Sentinel-1 will provide radar images of the entire Earth. These are processed and archived at the DLR site in Oberpfaffenhofen.

Credit: ESA.

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