# The Earth Seen from Space by Radar Remote Sensing: A Vision for 2025

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In a changing and dynamic world, high-resolution and timely geospatial information with global access and coverage becomes increasingly important. Constellations of radar satellites will play a major role in this task, since spaceborne radar is the only sensor that has all-weather, day-and-night, high-resolution imaging capability. Examples of applications for such a constellation are environmental remote sensing, road traffic, hazard and disaster monitoring, geoscience and climate research, as well as reconnaissance and security related tasks. Long-term vision is a space based sensor web that provides a view of our planet like we are used to see with Google Earth, but with high-resolution images and relevant geospatial information being updated every few minutes.

A prominent example of the state-of-the-art is the German satellite mission TanDEM-X, the first radar interferometer in space that employs two satellites operating in a closely controlled formation flight. The primary objective of TanDEM-X is the generation of the Earth's topography with unprecedented accuracy as the basis for a wide range of commercial applications as well as for scientific research. It is expected that this data set will become a reference in geosciences and remote sensing applications [1], [2], [3].

TanDEM-X has an ambitious time schedule to reach the main mission goal. The operational bi-static data acquisition has started in December 2010. The next two years are dedicated to the global digital elevation model (DEM) acquisitions, followed by six months of additional acquisitions to cover difficult terrain with extreme topography. The distance between the satellites are optimized in each phase of the mission for DEM performance and varies between 150 and 500 meters. The global DEM data set will be available by mid 2014.

*Figure 1 -TerraSAR-X and TanDEM-X flying in close formation. The distance between the satellites is optimized in each mission phase for optimum performance and varies between 150 and 500 meters.*

The vision for spaceborne radar remote sensing looks exciting. Future SAR mission concepts with digital beamforming technology in combination with large reflector antennas are being developed which will outperform the imaging capacity of current SAR systems by two orders of magnitude. These highly innovative concepts will allow the global observation of dynamic processes on the Earth's surface with hitherto unknown quality and resolution. One example is the mission proposal Tandem-L which is distinguished by the high degree of innovation with respect to the methodology and technology. Examples are the polarimetric SAR interferometry, multi-pass coherence tomography, the utilization of the latest digital beamforming techniques for increasing the swath width and imaging resolution, as well as the close formation flying of two cooperative radar satellites with variable adjustable spacing. The Tandem-L mission concept is based on the use of two radar satellites operating in L-band (23.6 cm wavelength). The utilisation of the synthetic aperture radar technique (SAR) enables high resolution imaging of the Earth's surface independent of weather and time of day; it therefore offers the ideal basis for the continuous observation of dynamic processes on the Earth's surface. The goal of Tandem-L is to image the land mass interferometrically once a week and by this to provide urgently needed information for solving pressing scientific questions in the areas of the biosphere, geosphere, cryosphere, and hydrosphere [4], [6], [6].

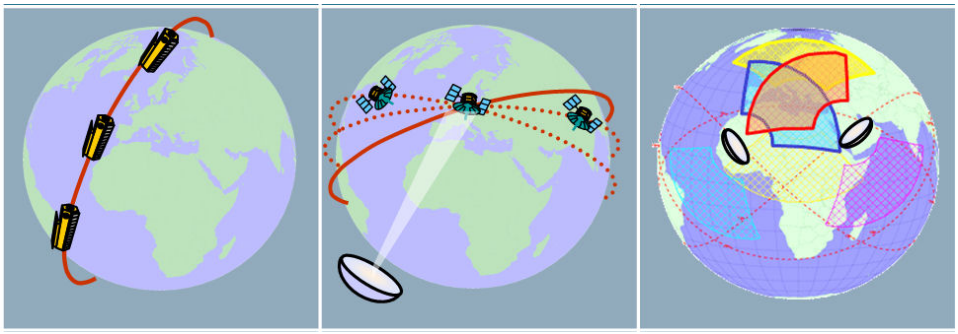

*Figure 2: Concepts for a future constellation of radar satellites for quasi-continuous monitoring of the Earth. Left: Low Earth Orbit (LEO) satellites, middle: Geostationary Earth Orbit (GEO) transmitter with LEO receivers, right: Medium Earth Orbit (MEO) satellites.*

New spaceborne radar technologies will also allow the implementation of a constellation of radar satellites for reliable and systematic monitoring of the Earth's surface (cf. Fig. 2). It will unlock the door to a future global remote sensing system for the continuous observation of dynamic processes over the Earth, as it currently exists for weather prediction, where a network of geostationary satellites is used.

## References


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