Radar DSMs

Satellite imagery is becoming increasingly important for creating Digital Surface Models (DSM) covering countries, continents or even the global entire landmass. If a scene is recorded from two or more viewpoints, DSMs can be extracted from the overlapping images. A DSM consists of a set of geo-referenced points, often fixed on a regular raster, with each cell assigned a height value and depicting trees, building roofs and other manmade objects on the Earth's surface. In contrast, the height values of a Digital Elevation Model (DEM) refer to the bare ground and are derived from a DSM using semi-automatic filtering to remove houses, trees and other above-ground objects. To arrive at a reliable product, human editing remains, as a rule, a must.

When the sensors are onboard satellites, DSMs can be made from either optical images captured by passive sensors, or active-sensor images. Both sources enable extraction of height data from overlaps by means of stereogrammetry, which can be carried out semi-automatically using matching software offered by photogrammetric vendors. Both optical and radar stereogrammetry (radargrammetry) compare the strength of corresponding patches to generate height data. However, synthetic aperture radar (SAR) also enables DSM generation by comparing the phases of return signals reflected from the same spot. This technology - interferometry - has been of growing interest since the launch of ESA's ERS-1 in 1991. This satellite orbited precisely and stably until March 2000, while the distance between the antennas of two consecutive images - baseline - could be kept short; conditions that highly improved radar DSM accuracy. The know-how gained since the dawn of ERS-1 has resulted in the making of detailed and accurate radar DSMs /DEMs on a regular and commercial basis.

What are the advantages of Interferometric SAR (InSAR)? Radar can operate day and night and is only negligibly hindered by clouds and haze. Compared to optical stereo images, InSAR data processing can be highly automated, as is the case for Lidar, while the error rate is lower. In areas with high coherence InSAR is an outperformer. If the land cover of the spot is (almost) similar in the overlaps, coherence will be high; this occurs if the time lapse is small and neither natural nor manmade objects has changed in the interim. Since TanDEM-X, operational since the start of this year, captures overlaps without time lapse, lack of coherence is not so much of an issue today. So are there no more issues at all? Processing of InSAR data requires a sequence of knotty steps demanding huge computer power. Baseline accuracy, that is the distance of radar antennas between two recordings, should be high: for example 1mm to meet the 2-m height condition of TandDEM-X DEMs. For an in-depth treatment of DEMs generated from space, see page 27.