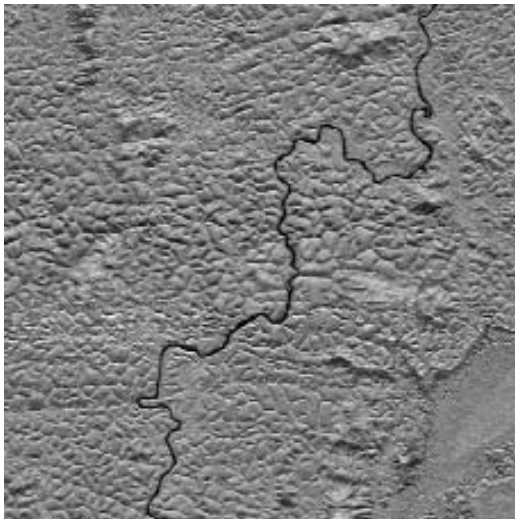
INSTITUT CARTOGRÀFIC DE CATALUNYA

V. Image cartography

Cartography from radar images

June 2005/Version 2



Example of a derived DEM and the resulting image of the south of Venezuela.

Radar remote sensing is almost exclusively based on SAR (Synthetic Aperture Radar). These are active sensors, in other words, they use their own source of illumination of the terrain and can operate on cloudy days or during the night. Furthermore, they are not particularly influenced by the weather, except in the case of very heavy rain. These characteristics make them highly appropriate for use in cartographic applications with poor illumination (high latitudes in winter) or in areas with very heavy cloud cover (tropical zones).

SAR technology supports the creation of very high resolution images of the terrain using an antenna of reasonably small dimensions. Basically, it emits an electromagnetic pulse, within the microwave region, and analyzes the return, from which it builds the image. In principle, this image presents two values, one of intensity that measures the percentage of return of the signal, and another of phase, related to the distance traveled from the illuminated object. If the sensor is multifrequency this pair of values is obtained for each of the frequencies, and furthermore, if it can operate with multiple polarizations, a pair of values for each of those available is achieved.

Applications

Since it is an image, the SAR sensor makes it possible to create image image cartography of the territory, in the same way that a sensor operating in the visible or near infrared part of the electromagnetic spectrum does. The image map of Catalonia 1:250 000 produced with ERS-1/2 images is an example of this type of cartography. Images of different frequencies or polarization models may also be combined in order to achieve an image in false color, which could be achieved with the images from the ASAR sensor of the ENVISAT satellite.

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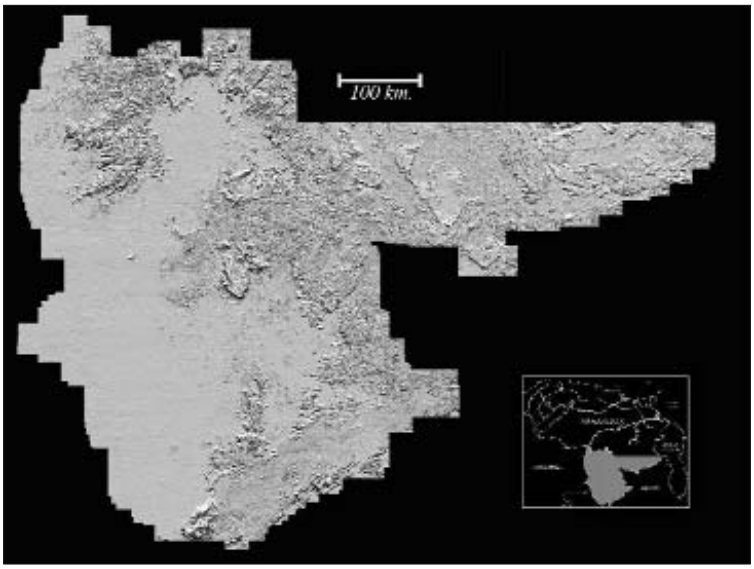
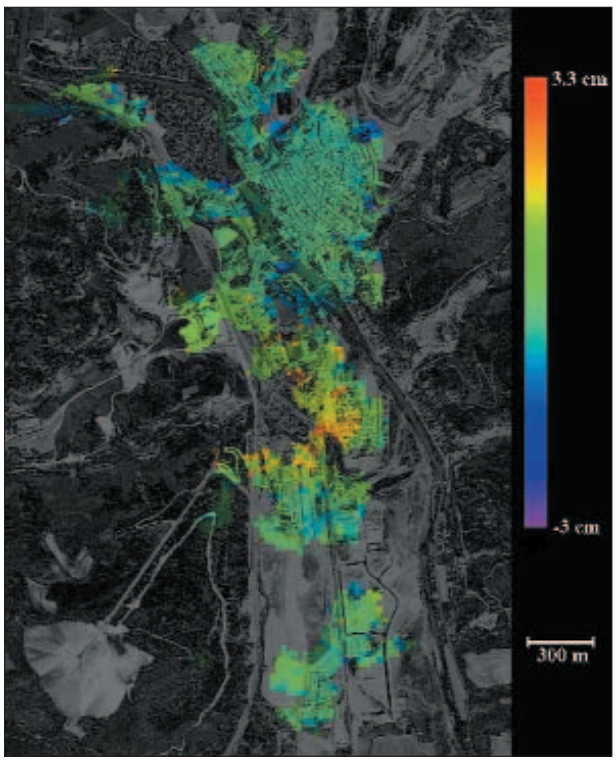
The fact that the SAR sensor provides a phase signal that contains information about the distance from the object means that terrain elevation models may be derived from this information. For this inteferometric application, work is undertaken with pairs of images of the same zone, which are differentiated by a small separation of the SAR antenna when each of the images is captured. With pairs of SAR ERS-1/2 interferometric images the ICC has developed an elevation model of Tierra del Fuego (Argentina) with an RMS error of less than 15 meters.

When working with airborne interferometric SAR technology, a higher quality of the derived Terrain Elevation Model (DEM) can be achieved, as well as improved resolution in the resulting image. As an example of a project that has used this technology, mention may be made of CARTOSUR, coverage of 250 000 km^2 of the south of Venezuela with image and contour lines.

An application that is slightly different from interferometric technology makes it possible to analyze the changes in height that occur in the territory between successive SAR image runs. These changes, which can be as small as a few centimeters, make it possible to monitor subtle changes in the terrain, such as cases of subsidence caused by volcanism or other factors. In particular, the ICC has studied the process of subsidence in certain parts of El Bages due to the dissolution of saline terrains by underground water streams using multi-temporal series of ERS-1/2 images, with very high degrees of coincidence with traditional geodetic work.



Coverage of the CARTOSUR project.



Study of the subsidence process in El Bages.