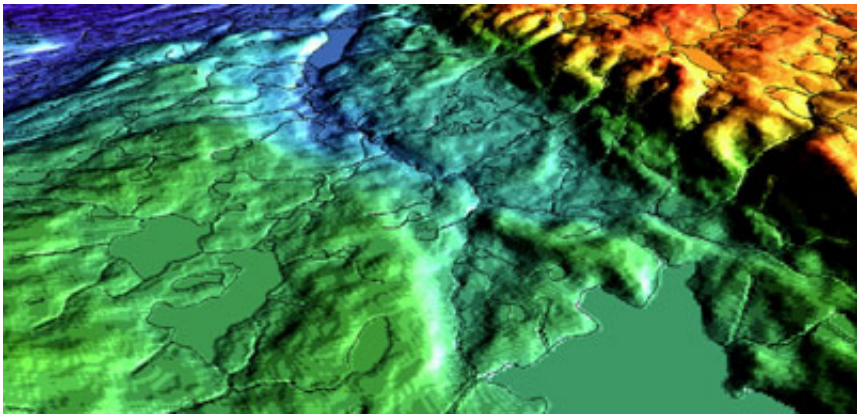
Double views from ERS tandem mission adding depth to Canadian wilderness maps

February 14 2006



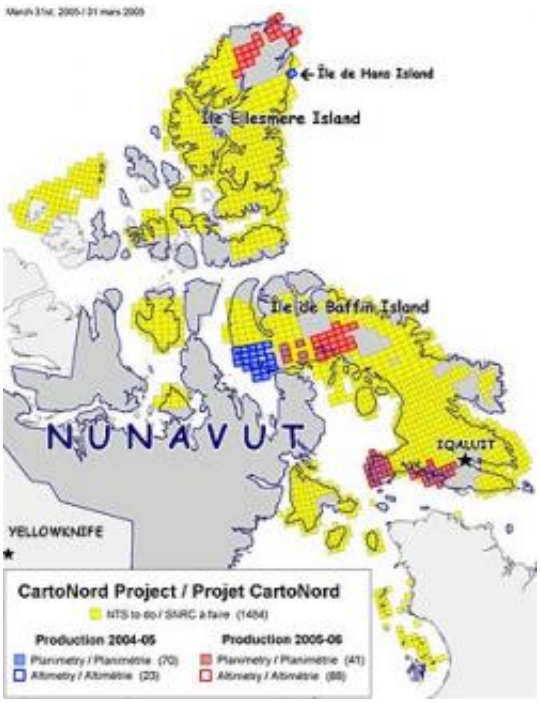
D visualisation of InSAR derived elevation data on Baffin Islan

Unique views of Earth afforded by a pioneering twin ESA radar satellite flight has brought an extra dimension to maps of Canada's newest territory, the results winning praise from the Canadian government.

Nunavut is the latest and also largest territory of Canada: located up in the frozen northeast, Nunavut has a population of only around 29 300 but an area the size of Western Europe. The Canadian government is currently refining and updating its geographic information for the entire country and Nunavut in particular, as a way of encouraging its development.

For the latest of a series of projects charting this region, Vexcel Canada

has completed an additional 21 digital elevation model (DEM) map sheets for the Canadian government agency charged with mapping the nation's topography, or 'lay of the land': the Centre for Topographic Information Sherbrooke (CTIS).



Mapping project area

DEMs are representations of variations in the Earth's surface altitude in digital format which can be used for a variety of applications, including mineral exploration, planning mobile phone networks and selecting routes for pipelines or roads. To be truly useful, DEMs need to have high resolution and extreme accuracy across wide areas. This can be a difficult combination to achieve – unless you are using data from a particular type of satellite.

This is a technique of combining two or more SAR images of the same

site acquired from close to the same position in order to obtain extremely precise information on topography as well as any surface changes occurring between acquisitions. InSAR works like a kind of 'spot the difference': the slightest change in the distance the bouncing radar signals travel causes a shift in signal phase that sets up interference patterns – the resulting rainbow-coloured images being called 'interferograms'.

In practical terms satellite orbits vary slightly, so the ERS satellites did not acquire radar images at precisely the same point in space. In an effect similar to the way overlapping pictures appear stereoscopic with 3-D glasses, such slightly different perspectives on the same landscape contributes to phase shifting due to apparent variations in surface elevation. In this way InSAR is used to derive height elevation across wide areas.

Although now a decade old, the 140 000 image pair dataset from the ERS tandem mission remains uniquely useful today because the brief 24-hour revisit time between acquisitions results in much greater interferogram coherence. ERS tandem coverage also extends above 60º N and S, further than comparable datasets such as the Shuttle Radar Topography Mission (SRTM) – one key reason for its employment by Vexcel Canada. Across the world, the ERS tandem dataset goes on being used in a wide number of ways, from mapping forests to measuring glacial motion.

Vexcel Canada has now produced complete elevation data for 44 map sheets across Nunavut Territory, meeting stringent specifications from CTIS for Canadian Digital Elevation Data (CDED) of better than 7.5 m vertical accuracy at around 20 m postings. The project was completed under a demanding production schedule and resulted in high-resolution Digital Elevation Models (DEMs) and high praise from the Canadian government.

"The 21 CDED files [map sheets] produced by Vexcel are the best 1:50 000 scale DEMS produced using synthetic aperture radar satellite technology that we have ever seen," said Yves Robitaille, Project Manager for CTIS. "Certainly Vexcel met and exceeded our expectations."

For each of the products completed for CTIS, Vexcel leveraged ERS tandem data and its own EarthView InSAR production software, customised to allow for such large area elevation mapping. The ERS data was provided by ESA, while the Canadian Space Agency (CSA) gave support in scientific and technical testing, as well as methodological development towards producing the tailor-made InSAR DEM software.

This achievement results from work carried out for over a decade to exactly understand under what conditions and with what quality DEMs can be produced from ERS Tandem data. Back in 1997, ESA contracted Vexcel Canada (then Atlantis Scientific) to assess the suitability of ERS Tandem data for producing DEMs over the complete North American continent, including the production of a few example DEM products at high latitudes. The results of this study – together with others initiated by ESA - have been instrumental in improving techniques employed by value-adding companies to make better quality DEMs.

The ERS missions

The European Remote Sensing satellites - ERS-1 and ERS-2, launched in July 1991 and April 1995 respectively - were ESA's first Earth Observation spacecraft, each carrying a comprehensive payload including an imaging Synthetic Aperture Radar (SAR), a radar altimeter and other powerful instruments to measure ocean surface temperature and winds at sea. ERS-2 also carries an additional sensor for atmospheric ozone research.

Following the launch of ERS-2 in 1995 ESA linked the two spacecraft in

the first ever 'tandem' mission which lasted for nine months. During this time the increased frequency and level of data available to scientists offered a unique opportunity to observe changes over a very short space of time, as both satellites orbited Earth only 24 hours apart. Radar images acquired in this way can be used to create uniquely high-coherence interferograms.

In spring 2000 the ERS-1 satellite encountred an unrecoverable failure in the onboard attitude control system, far exceeding its planned lifetime. ERS-2 remains operational and is expected to remain so for several more years, supplementing observations from its follow-on spacecraft Envisat, launched in March 2002.

More than 140 000 image pairs from the ERS tandem mission are today available for InSAR, and these have been utilised in many different ways beyond digital elevation model (DEM) production. The dataset played an important role in the European Commission-funded SIBERIA project, mapping boreal forests for global change studies. It was also used to monitor tropical deforestation and the detection of forest clear-cuts across Latin America.

Within the Polar Regions ERS tandem interferograms have been used to measure the motion of fast glaciers, important for understanding the dynamical processes associated with the polar ice balance.

The ERS tandem mission also paved the way for the coming generation of SAR spacecraft, with both Canada and Germany incorporating the tandem concept into their Radarsat-2/-3 and TanDEM-X missions respectively. The main change will be that the satellites will fly with a time separation measured in minutes rather than the one day between ERS-1 and ERS-2. This should further improve interferogram quality, with enhanced coherence because of smaller changes occurring on the ground between acquisitions.

Source: ESA