TanDEM-X – a feel for ice

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By Fabian Locher

Shelves of ice, hundreds of metres thick, breaking into thousands of small icebergs that melt away in just a few days. This is not a scene from a disaster movie, but actually happened in the Antarctic in 1995 and 2002. High-resolution images acquired by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) TanDEM-X satellite are helping glaciologists from the University of Innsbruck track down the causes.

The Antarctic Peninsula is the setting for some of the world's most dramatic climate changes, with temperatures rising throughout the last five decades. Over the course of just a few days in 1995 and 2002, the Larsen A and Larsen B ice shelves collapsed into thousands of small icebergs that melted as they drifted away on the ocean currents. Until then, these vast ice shelves had floated on the ocean, connected to mainland glaciers that held their massive ice sheets in place. These glaciers, which flow down from the mountains of the Antarctic Peninsula, 'fed' these shelves of ice. "Now that the shelf ice is gone, the glaciers are moving at up to eight times their previous speed," explains Helmut Rott, a glaciologist from the University of Innsbruck. He is using the data collected by the DLR radar satellites TerraSAR-X and TanDEM-X to conduct research into the correlation between climate change, shelf ice and glaciers.

Twin satellites measure the world in three dimensions

Two of the images shown here perfectly illustrate this development: the first shows a digital elevation model (DEM) of the region around the Drygalski Ice Tongue (the ice of which previously flowed into the Larsen A ice shelf). The second is based on mapping of height changes in the DEMs produced in 2011 and 2013. The detailed images allow the scientists to draw conclusions on changes in the volume of ice. Over this period, more than four billion tons of ice were discharged into the ocean.

The twin satellites TerraSAR-X and TanDEM-X remain in formation flight, orbiting at an altitude of over 500 kilometres, mapping the surface of the Earth and creating a highly accurate, three-dimensional image of Earth with uniform quality and hitherto unparalleled precision. The entire planet's ground surface was measured within three years, with the radar signals gathering data even at night and through cloud cover. But the satellites do not merely record surface levels; they also provide precise logs of elevation changes. "We analyse temporal changes in surface elevation. This helps us map how the volume and mass of glaciers change over time," explains Rott. "We can assimilate this data into climate and glacier models to improve our forecasts of sea level rise." TanDEM-X provides researchers with valuable information, especially on the impact that the loss in glacier mass will have on sea levels.

The Larsen A and B ice shelves are just two examples of this phenomenon, as large parts of the western Antarctic ice shelves are beneath the surface of the water and are relatively unstable. In this region, the two largest ice shelves are holding back glaciers with an area of approximately 900,000 square kilometres – three times the size of Germany. "If the same processes we observed in the Larsen A and B ice shelves prevail here, the ice masses released would be equivalent to a several metre rise in sea level. This alone shows why researchers are particularly keen to understand the underlying causes of what happened to the Larsen ice shelves." At the moment, sea levels are rising at a rate of just a few millimetres per year. Model calculations indicate that Greenland, above all, is contributing substantially to a rise in sea levels. "But these contributions add up over decades," explains Rott. "Things could become

extremely critical in the next century. A rise in sea levels of just 50 centimetres could have catastrophic implications, especially for coastal areas."

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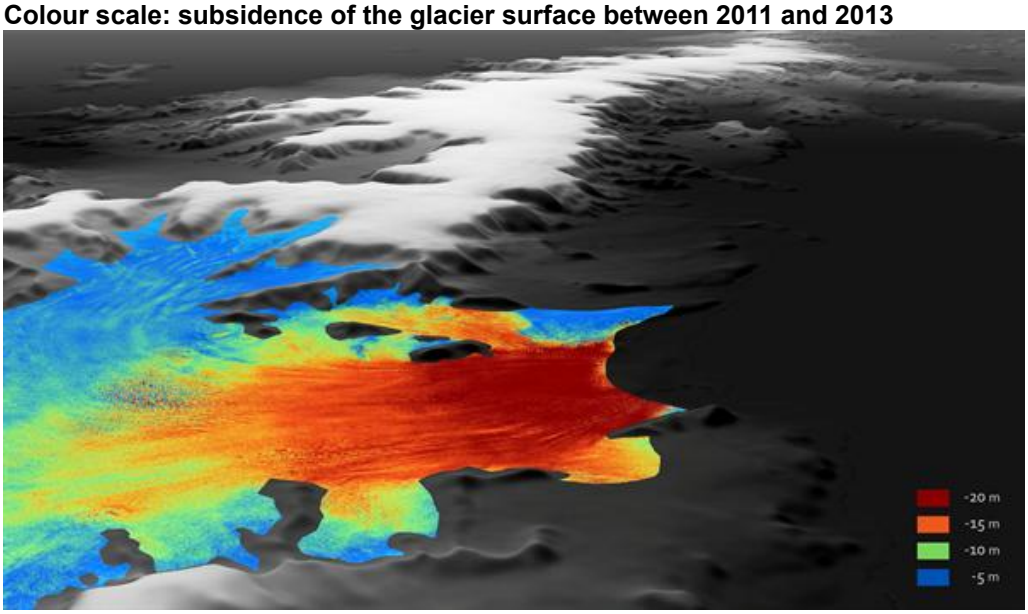
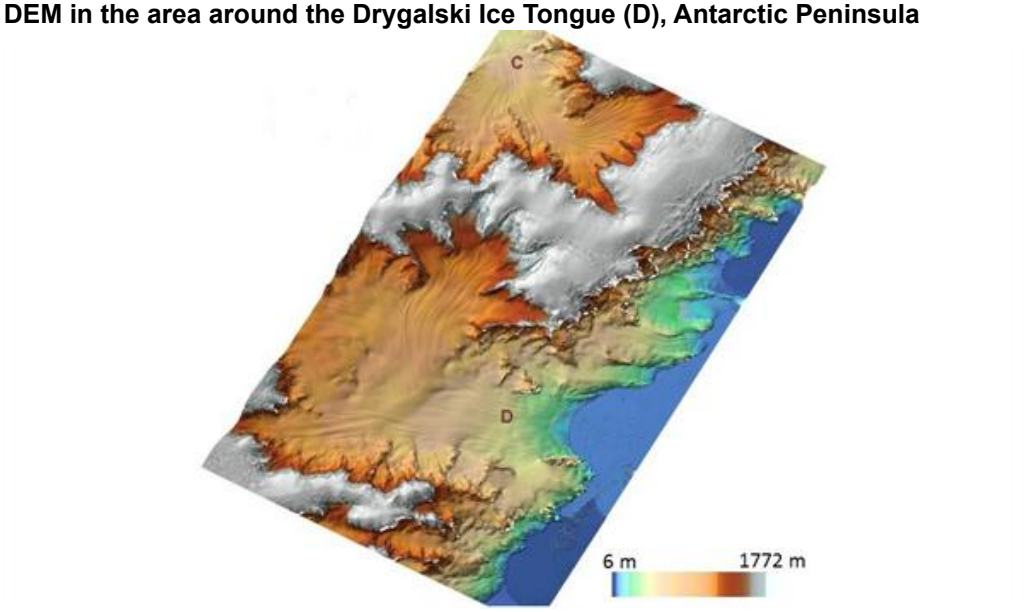
Colour scale: subsidence of the glacier surface between 2011 and 2013



Colour scale: subsidence of the glacier surface between 2011 and 2013.

Credit: DLR.

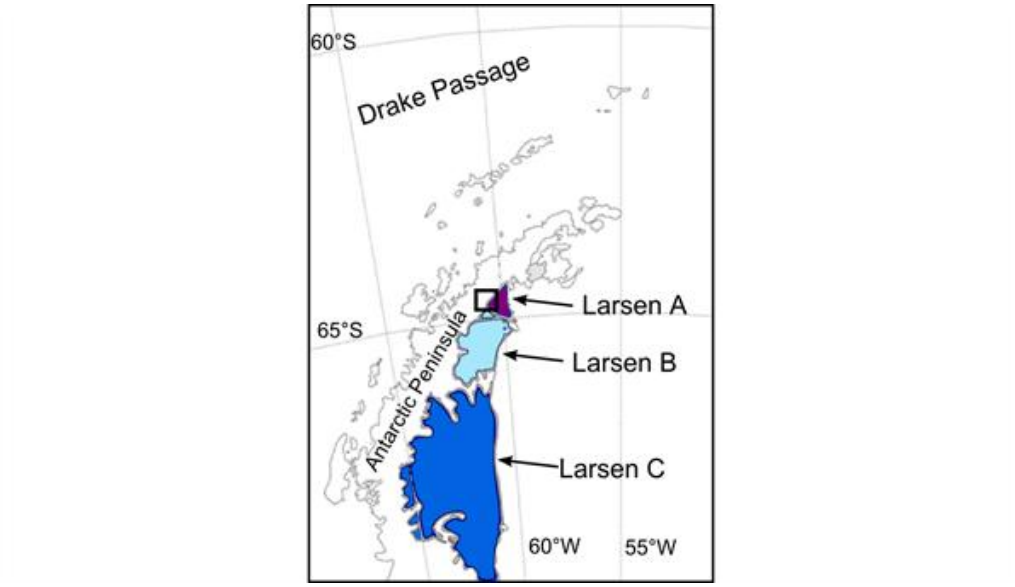
DEM in the area around the Drygalski Ice Tongue (D), Antarctic Peninsula



DEM in the area around the Drygalski Ice Tongue (D), Antarctic Peninsula.

Credit: DLR.

Location of the Larsen ice shelves



Location of the Larsen ice shelves.

Credit: DLR.

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