SURFACE VELOCITY AND VARIATIONS OF OUTLET GLACIERS OF THE PATAGONIA ICEFIELDS BY MEANS OF TERRASAR-X

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The Patagonia icefields account for more than 60 percent of the Southern Hemisphere's glacial area outside of Antarctica. Accelerated retreat has been reported for the main outlet glaciers over the last three decades. Most of the glaciers are terminating with calving fronts. The frontal positions of calving glaciers are known to be related to various factors in addition to climate parameters, including bedrock morphology, calving depth and water temperature. Therefore observations of ice motion are of importance for the interpretation of glacier behavior. So far only few studies on glacier flow have been performed in this region, due to the difficult access to the glaciers and to the limited availability of suitable remote sensing data.

Previously, ice motion of several glaciers of the Patagonia icefields was mapped with 24 hour repeat pass InSAR data, acquired at L-band during the space shuttle experiment SRL-2 in October 1994. ERS tandem InSAR analysis was possible only on few glaciers because the C-band data decorrelate due to adverse meteorological conditions and due to ice deformation at fast flowing glaciers.

The German TerraSAR-X satellite, launched in June 2007, provides an unprecedented opportunity to study the dynamics of the Patagonian glaciers. The X-band SAR data can be acquired in various modes with spatial resolutions ranging from 1 to 16 m from 11 days repeat pass orbits, rendering TerraSAR-X an instrument well suited for frequent mapping of rapidly moving outlet glaciers at high resolution.

TerraSAR-X data acquired in stripmap mode with about 3 m resolution were selected to map glacier motion by means of the feature tracking technique. Particular emphasis of the study is on fast flowing outlet glaciers where the InSAR method fails due to the decorrelation of the interferometric signal. We use an incoherent amplitude correlation approach based on amplitude features typically related to small scale topography and local roughness of ice surface features. The correlation measurements are unambiguous in range and highly accurate with respect to the orbital geometry of the satellite. The amplitude correlation method delivers 2D displacement vectors in range and azimuth. The algorithm is applied on geocoded TerraSAR-X products which use the best available DEM of the area which is a combination of C- and X-band SRTM DEM. The high precision of the science orbit product, being better than 10 cm, assures an accurate coregistration of the images. This way the topographic across track shift contribution between two images is already compensated and the displacement can directly be estimated from the mutual shift.

Sets of repeat pass TerraSAR-X observations were acquired since the very beginning of its operational phase in January 2008 over several outlet glaciers of the Southern (SPI) and Northern Patagonia Icefield (NPI). The analysed data set of NPI includes the main outlet glaciers, San Rafael Glacier, one of the fastest glaciers world-wide, moving about 17m /day, and San Quintin Glacier, as well as a number of smaller glaciers. The data set of SPI covers also a wide range of different glacier types and sizes, including the largest outlet glacier, Upsala Glacier. For many of the glaciers the analysis provides the first data set on ice velocity. Time series of glacier velocity are derived to study their behaviour in different seasons. For Moreno Glacier TerraSAR-X data have been acquired before, during and after the recent burst event of the ice dam in July 2008, enabling detailed studies of the ice deformation in connection with this event. An analysis of the dynamics at the frontal zone of major Patagonian glaciers derived from recent TerraSAR-X images is presented and compared with field data and SIR-C based results from 1994, where available.