Observing Volume Changes and Mass Balance of Glaciers by means of TanDEM-X

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The mass balance of glaciers is an important climate parameter, sensibly responding to climatic change. Precise information on glacier volume and mass balance is essential for estimating the climate impact on water supply from glaciers. There are about 180.000 glaciers world-wide, but accurate mass balance data are available only for few glaciers. Precise, spatially detailed measurement of the surface topography of glaciers and its temporal change by means of TanDEM-X is an excellent basis for reducing the uncertainty of mass balance of glaciers and ice caps world-wide. The geodetic mass balance technique is applied to convert volume changes into net mass balance numbers. For translating volume changes into gain or loss of glacier mass, possible changes in the vertical density profile of snow and firn have to be taken into account. In addition, it is necessary to correct for the penetration of the radar signal into snow and ice. The elevation obtained with an interferometric DEM refers to the position of the scattering phase centre of the radar signal. Depending on the physical state of snow and firn, the apparent interferometric elevation at X-band refers to the actual surface in case of melting snow and ice, but can be up to a few metres below the actual surface for dry snow and frozen firn. In the project the impact of the physical state of snow and ice on interferometric elevation is investigated by comparing the interferometric signal to elevation data measured by GPS and by lidar sensors. Investigations are reported for glaciers on the Antarctic Peninsula and in the Austrian Alps, based on TerraSAR-X and TanDEM-X data obtained through the projects XTI_GLAC0457 and XTI_GLAC0331. On the Antarctic Peninsula mass balance studies are performed for calving glaciers. The calving fluxes, representing the main component of mass depletion for these glaciers, are computed from TerraSAR-X derived ice motion in combination with calving cross sections inferred from TanDEM-X derived height of the floating glacier front. For several glaciers of the Ötztal Alps, Austria, in situ mass balance measurements are available. The mass depletion over the period 2000 – 2012, derived from volume changes based on SRTM and TanDEM-X data, agrees well with the in situ measurements. This confirms the great potential of interferometric DEMs for estimating the mass balance of glaciers world-wide.