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A Testbed for Monitoring Crustal Deformation and Gravity Changes Caused by Alpine Glaciers

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The Bavarian Academy of Sciences and Humanities maintains since several decades an observation station at the glacier Vernagtferner (Ötztal) in Austria. The main focus of the research has been during the past decades to monitor and model the mass balance of the glacier by observing continuously the run-off and the precipitation. The Vernagtferner has lost during the past 150 years, when it has reached a maximum volume, approximately one third of its surface and two thirds of its volume. The reduction of the glacier is an ongoing process that is expected to increase in the next years due to the climate change.

Since 2010 a GNSS permanent station has been installed nearby the glacier and is located on rock in order to monitor crustal deformation in the vicinity of the glacier. The main signal observed by the site will be probably linked to plate tectonics caused by the collision of the African and Eurasian Plate. Therefore the data of this site will be processed together with GNSS permanent stations of the ALPS-GPSQUAKENET and many other GNSS sites in the Alps in a global reference frame. This will result in a deformation model of the Alps driven by plate tectonics. Perhaps it is then possible to detect a residual GIA signal caused by unloading the crust due to the melting ice that is part of the total displacement of the local GNSS site.

The GNSS station will also serve as a reference for local geodetic field work in order to monitor the dynamics of the glacier. Because the mass balance of Vernagtferner is well known from long glaciological records, the area can serve as a field laboratory to test and validate different geodetic techniques. In 2010 a first series of gravimetric measurements has been carried out and repeated observations are planned in the coming years. In the near future we would also like to supplement GNSS by InSAR for monitoring larger areas of interest instead of only selected points. In the long run, the expertise gained at Vernagtferner shall be applied to larger glaciated areas. Then additional techniques will be exploited, like satellite gravimetry, which cannot contribute to local mass balance studies. This whole set of geodetic monitoring techniques will allow the observation of GIA processes at the surface of the Earth and may contribute to a better understanding of processes related to the changing climate.