Abstract

It is widely accepted that significant changes in precipitation rates and temperatures will occur over the following decades as a result of human-induced global warming. In Switzerland, some of the most affected areas will be glacial and periglacial environments. In order to predict how global change will affect such environments and related phenomena (e.g., slope movements, water supply, sediment load), it is necessary to improve our understanding of the links between glacier surface speed, basal sliding speed, and erosion rates. Even though surface speed and erosion rates can be well estimated based on GPS data and sediment load, the basal sliding speed remains difficult to quantify because it is of the difficulty to access directly the ice-bedrock interface. One possible solution is to measure the internal ice deformation velocity using geophysical methods. Once this has been established, the basal sliding velocity can be inferred using ice flow models.

Our work focuses on the monitoring of a 80 x 100 m rectangular area of a temperate Alpine glacier using multiple 3D ground-penetrataing radar (GPR) surveys repeated at 1-month intervals throughout the summer season. The 3D surveys were conducted on the Gorner Glacier near Zermatt (VS), because of its easy access and relatively rapid flow rate ($\tilde{1}$0-20 cm per day in the field area). We used a 1-m spacing of GPR lines in order to track the changes between the data sets as a function of time caused by ice deformation, which allows us to deduce the internal speed of the glacier at various depths. In addition to the GPR surveys, drone images were acquired in order to estimate surface movements. Results suggest that cross-correlation analysis of the GPR data sets can provide useful information on the internal displacement of ice, and that unexpected important deformation speeds may occur in the shallow depth.