

## Water balance of the highly glaciated Vernagt basin, Ötztal Alps, based on 32 years of measurements

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### Abstract

Annual glacier mass balances of the Vernagtferner have been determined by the Commission for Glaciology since 1964 using the direct glaciological method. Precipitation and other climatological variables, as well as discharge have been measured since 1974 at the gauging station “Pegelstation Vernagtbach”. This high alpine basin has an area of 11.4 km<sup>2</sup>, extends from 2640 m to a maximum elevation of 3630 m, and the glacier area decreased from 9.5 km<sup>2</sup> (85 %) in 1964 to 8.2 km<sup>2</sup> (72 %) in 2005.

The data analysis over the 32 years of record shows that the mean annual precipitation amounts to about 1545 mm (estimated error  $\pm 150$  mm). An evaporation value of 120 mm ( $\pm 20$  mm) is derived by experiments. Mean annual discharge amounts to 1790 mm ( $\pm 90$  mm), a value that can only be maintained by a mean negative glacier mass balance of -305 mm ( $\pm 30$  mm) with respect to the total basin area. While the Vernagtferner winter balances have remained more or less stable at a value of about 1000 mm over the past 40 years (in respect to an average glacier area of 9 km<sup>2</sup>), the summer balances show an obvious trend from values of -1000 mm in balanced years when measurements began, towards strongly negative values in the 1990s, culminating in the year 2002/03 with a record summer balance of -3120 mm, and basin runoff amounting to 3380 mm.

The drastic changes in runoff conditions (nearly balanced glacier mass budgets in the early part of the measurement period, strongly negative mass balances in the past decade, see table below) demonstrate the impact of global change in this high alpine environment, and it is of utmost importance to continue the monitoring efforts on a long-term basis.

$P = R + E + \Delta S + \varepsilon$					
Mean yearly sums [mm] over period	Basin precipitation P	Runoff R	Evaporation E	Glacier mass balance $\Delta S$	Residual $\varepsilon$
Total 1974 - 2005	1545 $\pm 150$	1790 $\pm 90$	120 $\pm 20$	-305 $\pm 30$	-60 $\pm 180$
Early part 1974 - 1985	1463	1399	120	-13	-43
Recent part 1994 - 2005	1617	2056	120	-449	-110