



## **Reconstructed centennial mass balance change for Golubin Glacier, Northern Tien Shan.**

Erlan Azisov (1), Martina Barandun (2,3), Tomas Saks (2), Mukhammed Esenaman uulu (1), Sergiy Vorogushyn (4), Ryskul Usabaliev (1), and Martin Hoelzle (2)

(1) Central Asian Institute of Applied Geosciences (CAIAG), Bishkek, Kyrgyzstan , (2) Department of Geosciences, University of Fribourg, Fribourg, Switzerland , (3) Analytical Chemistry, Paul Scherrer Institute, Villigen, Switzerland , (4) GFZ German Research Centre for Geosciences, Potsdam, Germany

Golubin glacier is a mountain glacier located in the Ala-Archa catchment, in the Kyrgyz Ala-Too, Northern Tien Shan. It has an area of  $\sim 5.4$  km<sup>2</sup> (in 2018) and extends over an altitudinal range between 3300 and 4400 m a.s.l. The mass balance of Golubin glacier was measured using the glaciological method from 1969 to 1994, and a continuous and modern monitoring programme was re-established in 2010. First length measurements date back to 1861. Precipitation and temperature data are available at the nearby Alplager meteorological station, located at an altitude of 2145 m a.s.l. since 1981.

In this study, we combine various data sets and methods to obtain a centennial mass balance time series for Golubin. We used a temperature index model calibrated with direct measurements and validated with secular mass balances derived from length change observations. The model was driven with meteorological reanalysis covering a period from 1901 to 2010. We further used daily meteorological measurements from 1981 to 2018 to evaluate the reanalysis data set and to complete the meteorological time series until present. Comparison to other studies revealed very good agreement.

Golubin lost  $-0.17 \pm 0.45$  m w.e. a<sup>-1</sup> for the entire period of 1901-2016. Mass loss increased in the second half of the century with an average mass balance of  $-0.21 \pm 0.42$  m w.e. a<sup>-1</sup> from 1950-2018 with the most negative value simulated for 2008. Direct measurements for the past decade confirm this tendency with a mass loss of  $-0.28 \pm 0.17$  m w.e. a<sup>-1</sup> (2011-2018). Comparison with long-term mass balance measurements from glaciers located in the Kyrgyz Tien Shan and Pamir show similar values and interannual variability since the early 1960 to present. Considering the elevation dependent distribution of the mass balance, we could identify a shift to a more negative/less positive regime with time, accompanied with a steepening of the ablation gradient for the most recent years.

With this study, we provide a unique, almost 100 year-long mass balance time series for Golubin glacier on daily resolution, combining meteorological measurements and re-analysis data, modern and historical glaciological measurements as well as length change observations. Such data sets are sparse for the Tien Shan, however are indispensable to enhance our understanding on the glacier changes of the High Mountain Asia.