

Changing glacier firn in Central Asia and its impact on glacier mass balance

Marlene Kronenberg

Regional-scale studies report recently balanced or positive mass changes for glaciers in western High Mountain Asia. A precipitation increase is discussed to be a potential reason for the anomalous behaviour. However, the lack of *in situ* data hampers strengthening this assumption as well as quantifying uncertainties. Unique historical data from Central Asian glaciers, measured within Soviet research programs from the 1960s until the 1990s, are essential to answer open questions about the glaciers' response to climate change.

Exceptional historical data including very detailed firn studies are available for Abramov glacier in the Pamir Alay located at the edge of the anomalous regions. This thesis investigates the historical and present firn conditions of Abramov glacier as well as the changes therein. The firn processes are related to the surface energy and mass balance to study the influence of firn changes on the glacier-wide mass balance. The underlying work involved (i) compiling and processing of historical firn, mass balance and meteorological data; (ii) measuring current firn conditions; and (iii) applying a coupled surface energy balance – multi-layer subsurface model.

The comparison of historical and current *in situ* data shows that the firn conditions have changed little between the 1970s and 2018. The data, however, also suggests a precipitation increase. The modelling results indicate that the earlier measured firn properties were the result of unfavourable meteorological conditions. Precipitation increased during the following decades and allowed the firn to recover. As a consequence, internal accumulation, which has been shown to substantially contribute to the glacier-wide mass balance of this temperate glacier, increased. For the most recent years, firn conditions became again icier and mass losses increased.

This thesis found *in situ* evidence of increased precipitation rates and their positive impact on the mass balance for a glacier located in the data scarce western High Mountain Asia. The work highlights the importance of firn processes for understanding the response of mountain glaciers to climate change. Moreover, it demonstrates the importance of historic (Soviet) research and the suitability of the Russian terminology for analysing firn processes.

Jury:

Prof. Dr. Horst Machguth (thesis supervisor)

Prof. Dr. Martin Hoelzle (internal co-examiner)

Dr. Stanislav Kutuzov (external co-examiner)

Dr. Francesca Pellicciotti (external co-examiner)

Dr. Ward van Pelt (external co-examiner)

Prof. Dr. Christian Hauck (president of the jury)