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Mass balance of Djankuat Glacier, Central Caucasus: observations, modeling and prediction

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Djankuat is a typical valley glacier on the northern slope of the main Caucasus chain. Its present day area is approximately 2.5 square km with the characteristic ice thickness of several tens of meters.
As well as other glaciers in the region, Djankuat has been shrinking during the last several decades, its cumulative mass balance in 1968-2016 was equal to -13.6 m w.e. In general, Caucasus' glaciers lost approximately one-third of their area and half of the volume. Prediction of further deradation of glaciers in changing environment is a challenging task because rivers fed by glacier melt water provide from 40 to 70% of the total river run-off in the adjacent piedmont territories. Growing demand in fresh water is rather critical for the local economy development and for growing population, motivating elaboration of an effitient instrument for evaluation and forecasting of the glaciation in the Greater Caucasus. Unfortunately, systematic observations are sparse limiting possibilities for proper model development for the most of the glaciers. Under these circumstances, we have to rely on the models developed for the few well-studied ones, like Djankuat, which is probably one of the most explored glaciers in the world. Accumulation and ablation rates have been observed here systematically and uninterruptedly since mid 60-ies using dense stake network. Together with the mass balance components, changes in flow velocity, ice thickness and geometry were regularly evaluated. During the last several ablation seasons, direct meteorological observations were carried out using an AMS. Long series of meteorological observations at the nearest weather station allow making assessment of the glacier response to climate change in the second half of the 20th century. Abundant observation data gave us the opportunity to elaborate, calibrate and validate an efficient mathematical model of surface mass balance of a typical glacier in the region. Since many glaciers in the Caucasus are partially covered with debris, the model allows distinguishing between clear and debris-covered surfaces when describing heat exchange of the glacier with the atmosphere. Evaluation of the future state of the glacier is carried out using a hybrid downscaling technique.