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Future surface mass balance of the Elbrus Glacial Complex under climate change

Oleg Rybak[1,2,3], Taisya Dymova[4], Irina Korneva[5], Stanislav Kutuzov[5], Ivan Lavrentiev[5], Elena Rybak[2], and Pavel Toropov[4,5]

[1]Water Problems Institute of RAS, Moscow, Russian Federation (oleg.rybak@vub.be)
[2]FRC SSC RAS, Sochi, Russian Federation
[3]Earth System Science and Department of Geography, Vrije Universiteit Brussel, Brussels, Belgium
[4]Lomonosov Moscow State University, Department of Geography, Moscow, Russian Federation
[5]Institute of Geography of RAS, Moscow, Russian Federation

The evolution of the Elbrus glacier complex, consisting of two dozen of glaciers, in the last two decades of the 20th century and at the beginning of the 21st century generally corresponded to the trend of a decrease in the glaciated area of the whole Caucasus. Over the period 1960-2014, the area of Elbrus glaciation decreased by approximately 15%, and over two decades 1997-2017 - by almost 11%. As of 2017, the area of Elbrus glaciation was estimated to ca. 112 sq. km, its volume exceeded 5 cub. km. Elbrus glaciation contributes significantly to the formation of the hydrological regime in the region, and, therefore, may be considered as a major challenge ti the regional socio-economic development. The latter circumstance requires an accurate assessment of the glacial runoff, and, consequently, the calculation of the surface mass balance of the glacial complex. We use an energy balance model to calculate the current and future surface mass balance. The series of observations at the Terskol meteorological station, located fifteen kilometers from the southern spurs of Elbrus, and the Mestia meteorological station, located somewhat further, on the territory of Georgia on the southern slope of the Main Caucasian ridge, as well as data from automatic weather stations on Elbrus slopes and on Djankuat glacier a few tens of kilometers from Elbrus, were applied for model forcing to reproduce present surface mass balance. The modeling results were validated by comparison with the measured surfave mass balance components on Garabashi glacier, one of the glaciers on the southern slope of Elbrus. Climate projections until the end of the 21st century for the Elbrus region were composed on the basis of multi-model results of regional climate modeling within the CORDEX project for various scenarios.

We demonstrate that simultaneous surface air temperature and insolation growth accompanied by decrease in precipitation, predicted by multi-model regional climate modeling and downscaled to the Central Caucasus area, will cause essential lifting of the equilibrium line altitude and shrinking of accumulation area. As a result, we must expect an accelerated degradation of Elbrus glaciation in forthcoming decades.

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