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Mass-balance modelling of Chhota Shigri and Patsio glacier in western Himalaya, India

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Projections of glacier mass-balance evolution in the Himalayas are afflicted with high uncertainty due to the diversity of the climatic conditions and the extremes in topographical relief. Large spatial variations in glacier mass balances are connected with the diverse precipitation patterns. While there are indications of recent glacier retreats in the Himalayas, only few glaciers have been monitored over long periods.

In 2002, a long term continuous monitoring programme of glacier mass balance was started on Chhota Shigri glacier (15.7 km^2). During the period 2002-2013, measurements show an average glacier-wide mass balance of -0.59±0.12 m w.e. after near zero annual mass balances in the 1990s. On Patsio glacier (2.3 km^2) mass-balance studies were initiated in 2010.

We apply a mass-balance model for the glaciers Chhota Shigri and Patsio using gridded data from two different regional climate models: 1) the Weather Research and Forecasting (WRF) Model for the period 1970-2005 (on 50 km resolution) and 1996-2005 (on 3 km resolution), and 2) the regional climate model REMO for the period and 1989-2013 (25 km resolution). The data are downscaled from its grid resolution to the glacier grid (300 m). Additional input are daily potential global radiation values, calculated using a digital elevation model (DEM) at a resolution of 30 m and considering slope, aspect and shading of the surrounding topography. The mass-balance model calculates snow accumulation, melt and runoff on a sub-daily (hourly) time scale. Calibration and validation data are the available seasonal and annual mass-balance measurements together with point measurements of temperature, precipitation and radiation.

Results show that this region of the Himalayas is situated in the transition zone between areas where the annual glacier mass balance ba is controlled by summer temperature and areas where ba is controlled by winter precipitation. In addition, summer snowfalls are a major influencing factor on the mass balance.