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One-dimensional numerical glacier model and its applying for estimating the glacial erosion rate (by the example of SE Altai, Russia)

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For estimating the Holocene glacial erosion rate of Chagan-Uzun river basin (SE Altai, Russia) we employ a one-dimensional numerical model of idealized valley glacier. The values of physical constants, surface elevations and other parameters are corresponding to geomorphological conditions of SE Altai. We use mass-balance reference profile of Sofiyskiy glacier (Pattyn et al., 2003) and steady climatic conditions.

The glacier model describes the flow of ice along a central flowline. The dynamic behavior of the glacier is described in terms of changes in ice thickness along this line (the continuity equation). The depth-averaged ice velocity is the sum of local internal deformation and basal sliding velocities (equations suggested by (Paterson, 1994)). Although the model is one-dimensional, the two-dimensional geometry of the glacier is implicitly taken into account by using cross-sectional shape factor (a fixed-angle trapezoidal valley cross section is prescribed). The model assumes that the local erosion rate is proportional to the local basal sliding rate (Hallet, 1996) with the proportionality coefficient defined by field measurements (Hamprey and Raymond, 1994).

Numerical model implies some simplifications. It doesn't take into account the fluvial and the accumulation processes on glacier bed, and the contribution of basal water pressure. So the model demonstrates bed profiles that are smoother than real glaciated valleys and the lower bound of the glacial erosion rate.

Calculated erosion rate is about $2 \cdot 10^{-3}$ m/year and is the largest among the rates

of other surface processes in Chagan-Uzun river basin. In such mountain systems as Altai glacial erosion transforms now only the upper part of ridges. In Pleistocene there were more extensive glaciations which led to increasing the glacial erosion rate and to expansion the area affected by glacial erosion.

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