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Modelling spatial and temporal variations in melt rates on Gornergletscher using an enhanced temperature-index model

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Melt across an alpine glacier can be computed by means of physically-based energy-balance models or more empirical models usually known as temperature-index models. Temperature-index (TI) models have been used in a wide range of applications, and a number of enhanced versions of this approach have been recently proposed in the literature. However, a criticism that is normally moved to this type of approach is that such models depend on empirical parameters that are calibrated for the single glacier and are therefore not transferable.

In this paper, an enhanced temperature-index (ETI) model which was developed and tested for Haut Glacier d'Arolla, Swiss Alps, is applied to Gornergletscher, a much bigger and not entirely temperate glacier in the same region. The model requires knowledge of only temperature and precipitation data, although it computes the shortwave radiation flux. The original model parameters optimised on Haut Glacier d'Arolla against melt rates simulated by an energy-balance model are used in a first step. The model is applied in a fully distributed manner using meteorological data collected at one meteo station on the glacier together with several schemes for the distributions of the input variables. In a second step, the model parameters are recalibrated at the location of the meteo station using melt rates computed by the energy balance model. The model is also compared to a simpler version of the TI approach.

The model transferability is assessed through comparison of the model simulations with ablation stakes readings, continuous measurements from an ultrasonic range and photographs of the lowest part of the glacier. The robustness of the model empirical parameters is tested, together with that of the parameterisations of some of the input

variables (albedo and cloud cover). The model results to be robust, showing that the model empirical coefficients are representative of the average climatic conditions of the area. However, it overestimates melt in both the debris-covered and cold ice zones of the glacier. For this reason, an adaptation of the model parameters for both surface conditions of cold ice and debris cover is suggested.