A DISTRIBUTED TEMPERATURE INDEX MELT MODEL INCLUDING ALBEDO: APPLICATION TO HAUT GLACIER D’AROLLA


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In this paper, an enhanced temperature index glacier melt model for the point scale is presented, in which the classical dependency on temperature is extended by considering albedo and global radiation. The standard approach has been recently improved by addition of a potential direct radiation term. Here, this approach is taken a step further by the inclusion of the albedo, which controls the amount of global radiation available for conversion to melt energy at the snow or ice surface. An additive form of the temperature index model is proposed, aiming at clearly separating the two important contributions to melt energy, namely the longwave radiation and turbulent fluxes in one term and the shortwave radiation in the other.

The enhanced temperature index model is a significant improvement over other formulations of the temperature index method. This was shown by comparing melt rates computed by the temperature index based models with calculations obtained using a physically based energy balance model at five sites on Haut Glacier d’Arolla. Detailed data for such comparison were available from five automatic weather stations located along two intersecting transects between May and September 2001. The results show that the enhanced temperature index model is capable of accounting
for about 90% of the surface melt rate variation at all the stations tested. Particularly, including albedo enables the model to capture the major increases in the surface melt rate due to snow metamorphism and the transition from snow to ice. Additionally, the more physically-based melt process representation of the enhanced temperature index model reduces the over-sensitivity to temperature fluctuations in comparison with simpler formulations of the approach, and offers greater transferability.

The enhanced modelling scheme is finally used to build a distributed melt model. Its application to Haut Glacier d’Arolla is discussed, thereby including the implications due to substituting observed input variables - obviously available only at measuring stations - with parameterised values, which are calculated for each point of the glacier surface using several modelling algorithms. The results highlight the main distinctiveness of the model, which offers a good compromise between accuracy, modelling effort and data requirements.