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An energy-budget-based glacier melting model for the Tibetan Plateau

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There have been rapid glacier retreats during the past few decades on the Tibetan Plateau, which not only have far-reaching impacts on the water resources in this region, but also potentially threat the downstream by glacial lake outburst floods. It is therefore important to model the physical link between glacier melting and climate changes and its implication in water resources. There have been a few studies on glacier melting models, of which the applicability is limited to some areas and the simulation capability also needs to be improved. This paper presents a new energy-budget-based model for the melting of the mountainous glaciers. Enthalpy, rather than temperature, is used in the energy balance equations to simplify the computation for the energy transfer through water phase transition and within-snow liquid water movement. Heat transfer is computed in both snow and ice layers, and the inhomogeneous layering method is employed to describe the temperature profiles better, especially at the interface between snow and atmosphere as well as that between snow and ice. A new parameterization scheme is introduced into the model to calculate turbulent heat transfer over glacier surfaces. This model was validated based on the data collected from a field experiment which was implemented in the melting zone of the Parlung No. 4 Glacier in the southeastern TP from May to August in 2009. The result shows that the RMSE of the simulated hourly surface temperature is about 0.97 degree centigrade and the R2 is 0.81. The RMSE of the simulated hourly latent heat flux and hourly sensible heat flux are 14.5W m̂-2 and 23.5W m̂-2 respectively, and R2 are 0.92 and 0.93. In general, this energy-budget-based model could reasonably simulate the glacier melting process. The model is still under development for a better simulation of the glacier melting and its contribution to the water resources.