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Estimation of outflow from the bottom of a snowpack with a simple combined snowmelt-percolation model for prevention of snowmelt-induced hazards

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A large quantity of melt- and rainwater which infiltrate into the ground during spring melt season causes a decrease in stability of a slope, and thus may lead to slope failures and/or landslides. We propose a simple model to estimate outflow from the bottom of a snowpack during spring melt season which can be used in distributed application for prevention of snowmelt-induced hazards, based on field observations at Uonuma, Niigata Prefecture in central Japan. A temperature-radiation index melt model (Konya et al., 2004) is applied to the results of the heat balance observations at Uonuma for calibration of coefficients of the model. This simple melt model taking no account of seasonal change in albedo can well simulate temporal variation in surface snowmelt. Percolation process of water through a snowpack is modeled in this study using a power storage function based on the results of theoretical studies on unsaturated flow (e.g. Matsubayashi et al., 1994) and the field measurements of water percolation through homogeneous snow by Colbeck and Davidson (1973). This combination of the melt model and the percolation model can estimate outflow from the bottom of a snowpack without any controls of parameters through melt season when the following three input data are available: air temperature, global radiation and rainfall intensity. Temporal variations in outflow from the bottom of a snowpack calculated at 1-hour interval using these models agree quite well with those measured with a snowmelt lysimeter at Uonuma during the winter of 2010/2011.