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A simple methodology to calibrate local meltrate function from ground observation in absence of density measurements

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Snowpack melting can represent a major contribution to the seasonal variability of the surface and ground water budget at basin scale: the snow pack, acting as a natural reservoir, stores water during the winter season and releases it during spring and summer. The radiative budget driving the melting process depends on numerous variables that may be affected by the ongoing climatic changes. As a result, a shift in time during the spring and summer discharge may significantly affect surface water management at basin scale. For this reason, a reliable model able to quantitatively describe the snow melting processes is very important also for management purposes. The estimation of snow melt rate requires a full energy (mass) balance snowpack assessment. The limited availability of necessary data often does not allow implementing a radiative (mass) balance model. As an alternative we propose here a simple methodology to reconstruct the daily snowmelt and associated melt rate function based only on solid precipitation, air mean temperature and snowpack depth measurements, while snow density observations are often missing. The model differentiates between the melting and the compaction processes based on a daily mean temperature threshold (i.e. above or below the freezing point) and the snowpack state. The snow pack is described as two-layer model, each of them considers its own depth and density. The first one is a fresh snow surface layer whose density is a constant parameter. It is modulated by the daily snowfall/melting budget or it can be compacted and embedded within the second layer. The second one is the ripe snow, whose density is a weighted average with depths of antecedent snowpack and possible first layer contribution. The two snow layers allow starting the fusion by the snowpack's top where the density is lower, while much water is released when the ripe snow starts melting during the late melting season. Finally, we estimate the associated degree-day and antecedent temperature index to derive the local melt rate function. The proposed methodology has been applied on the snowpack height observations located in the Southern Alps.