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Evaluation of the most suitable threshold value for modelling snow glacier melt through T- index approach: the case study of Forni Glacier (Italian Alps)

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Glacier melt occurs whenever the surface temperature is null (273.15 K) and the net energy budget is positive. These conditions can be assessed by analyzing meteorological and energy data acquired by a supraglacial Automatic Weather Station (AWS). In the case this latter is not present at the glacier surface the assessment of actual melting conditions and the evaluation of melt amount is difficult and degree-day (also named T-index) models are applied. These approaches require the choice of a correct temperature threshold. In fact, melt does not necessarily occur at daily air temperatures higher than 273.15 K, since it is determined by the energy budget which in turn is only indirectly affected by air temperature.
This is the case of the late spring period when ablation processes start at the glacier surface thus progressively reducing snow thickness. In this study, to detect the most indicative air temperature threshold witnessing melt conditions in the April-June period, we analyzed air temperature data recorded from 2006 to 2012 by a supraglacial AWS (at 2631 m a.s.l.) on the ablation tongue of the Forni Glacier (Italy), and by a weather station located nearby the studied glacier (at Bormio, 1225 m a.s.l.). Moreover we evaluated the glacier energy budget (which gives the actual melt, Senese et al., 2012) and the snow water equivalent values during this time-frame. Then the ablation amount was estimated both from the surface energy balance (MEB from supraglacial AWS data) and from degree-day method (MT-INDEX, in this latter case applying the mean tropospheric lapse rate to temperature data acquired at Bormio changing the air temperature threshold) and the results were compared. We found that the mean tropospheric lapse rate permits a good and reliable reconstruction of daily glacier air temperature conditions and the major uncertainty in the computation of snow melt from degree-day models is driven by the choice of an appropriate air temperature threshold.
Then, to assess the most suitable threshold, we firstly analyzed hourly MEB values to detect if ablation occurs and how long this phenomenon takes (number of hours per day). The largest part of the melting (97.7%) resulted occurring on days featuring at least 6 melting hours thus suggesting to consider their minimum average daily temperature value as a suitable threshold (268.1 K). Then we ran a simple T-index model applying different threshold values. The threshold which better reproduces snow melting results the value 268.1 K. Summarizing using a 5.0 K lower threshold value (with respect to the largely applied 273.15 K) permits the best reconstruction of glacier melt and it results in agreement with findings by van den Broeke et al. (2010) in Greenland ice sheet. Then probably the choice of a 268 K value as threshold for computing degree days amount could be generalized and applied not only on Greenland glaciers but also on Mid latitude and Alpine ones.

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