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On the interest of positive degree day models for mass balance modeling in the inner tropics

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A positive degree-day (PDD) model was tested on Antizana Glacier 15α (0.28 km2; 0o28'S, 78o09'W) to assess to what extent this approach is adapted to study glacier mass balance in the inner tropics. Cumulative positive temperature amounts were compared with field measurements of melting and with surface energy balance computations, showing a significant link if a separation according to surface state, i.e. between snow and ice, is performed. Significant correlations allowed retrieving degree-day factors for snow, clean and dirty ice. The relationship between melting and temperature is mainly explained by the role of the net shortwave radiation in both melting and surface layer temperature changes. However, this relationship disappears during the period from June to October (Period P1), because high wind speeds and low humidity induce highly negative latent turbulent heat flux. Nevertheless, this has a low impact on the computed total amount of melting at annual scale because both temperature and melting are generally low during P1. At daily scale, melting starts while daily temperature means are still negative, reflecting that incoming shortwave radiation around noon is very high and compensates for energy losses when the air is cold. The PDD model was applied for the 2000-2009 period considering meteorological inputs measured on the glacier foreland. Results were compared to the specific mass balances measured in the field showing good results, even though the melting factor values should be adapted to the glacier surface state and may vary with time. Finally, the model was forced with precipitation and temperature data from the remote Izobamba-Quito station and NCEP-DOE Reanalysis data, giving good results and showing that temperature variations present a homogenous regional-scale signal allowing the modeling of glacier mass balances over large areas.