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On the interest of positive degree day models for mass balance modeling in the tropical Andes, application on Antizana Glacier 15, Ecuador

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A positive degree day (PDD) model was tested against surface energy balance results on Antizana Glacier 15 (0.7 km2; 0o28'S, 78o09'W) to assess whether PDD models may reflect the local physical ablation processes in the tropical Andes. Modeling at one point shows that daily ablation processes are sometimes incorrectly reproduced by the PDD model because temperature variations are very low. Correlation between melting and temperature are only significant for ice surfaces and are mainly during periods with significant temperature variations Daily melt factors were calibrated for months with the highest temperature variations, assuming that ablation begins even if daily (or monthly) temperature is negative. Indeed, ablation is mainly related to the shortwave radiation budget, which may be high even during cold days (respectively months). Moreover, mean temperature value does not reflect punctual diurnal maximum which may exceed 0°C. Finally, high sublimation values may occur between June and September. The distributed surface mass balance was then estimated for the Glacier 15 of Antizana. Temperature variation with elevation was estimated assuming a lapse rate which was directly measured in the field, whereas precipitation was considered constant over the entire glacier. The PDD results correctly fit with annual mass balances measured in the field, showing that annual temperature and precipitation include important information on local main climate variability. However, our study suggests that the good consistency between mass balance measurements and distributed PDD results is mainly related to the important link that exists between the 0°C level, the snow-rain limit and the ELA.

Keywords: degree-day model, surface mass balance, ablation, database.