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Relationships between threshold melt temperature and glacier attributes

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Temperature Index (TI) models are a robust method of modelling glacier mass balance due to their reliance solely on climatic data and the relationship between air temperature and ice melt. Models are increasingly being used to estimate the mass balance of glaciers where no field measurements exist. Instrumental to the success of TI models is the use of a threshold temperature (T_{crit}) to initiate melt. Despite the sensitivity of model outputs to T_{crit}, the value is often selected arbitrarily. In order to gain a better understanding of an appropriate T_{crit} value, relationships between T_{crit} and various glacier attributes (length, slope, area, median elevation, aspect and supraglacial debris cover) were tested. The mass balance of 56 selected glaciers with measured data were modelled. The inputted T_{crit} value was calculated on a glacier-by-glacier basis based on the T_{crit} that produced thelowest Root Mean Square Error against the observed mass balance. Statistical testing between the T_{crit} and the attributeswas then completed. Measurement of the glacier attributes was completed via remote sensing. The results show a wide range of correlations between T_{crit} and the glacier variables.An average glacier length of between 2001 m to 3000 m displayed a strong positive correlation (r = 0.72) to T_{crit}, while an average length of 6001 m to 7000 m displayed a near perfect relationship (r = 0.97, r^2 = 0.94). Glaciers below ~2000 m a.s.l. recorded a weak correlation (r = 0.26) while those above 2000 m a.s.l. displayed a moderate negative relationship (r = -0.59, r^2 = 0.35). The correlation between T_{crit} and percentagesupraglacial debris cover (1 – 10 %) relative to glacier area displayed a negative weak relationship (r = -0.22); suggesting that as debris cover decreases a higher T_{crit} is required. For glaciers with an area of 10.1 to 20 km^2 a moderate positive relationship was observed (r = 0.40, r^2 = 0.16). This study helps shed light on the non-climatic factors that control T_{crit} and enable the determination of a T_{crit} value for mass balance modelling of glaciers with no measurements.